Research in Science Education (2020) 50:1961–1989
https://doi.org/10.1007/s11165-018-9760-5

Is Science Really Everywhere? Teachers' Perspectives on Science Learning Possibilities in the Preschool Environment

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Published online: 24 September 2018

Abstract
There is increasing interest in early childhood science education and a corresponding increase in research in this area. Studies have shown that in some countries the teaching of science in the early years remains low. These studies show that science pedagogy in the early years needs attention, despite the myriad opportunities afforded for the informal teaching of science concepts. What is not known is how teachers interpret the opportunities for science moments in these play-based environments. In drawing upon cultural-historical theory, this paper examines how teachers use the preschool environment to promote the teaching of science concepts. Specifically, two preschool teachers from one preschool site participated in an indoor and outdoor science walk where their discussion of the affordances for science learning was digitally recorded. Hedegaard's (2008) three-step analysis procedure and Tu's (2006) sciencing categories were used to analyse the data. Findings show that teachers in the same preschool setting have different levels of science awareness for the possibilities of informally teaching science. Specifically, an activity-oriented sciencing approach and a conceptually oriented sciencing attitude emerged. The complexity of teacher engagement in science teaching in play-based settings and their conceptualisation of science affordances in the environment point to new understandings about the relations between teachers' belief and practices in science learning. Therefore, the findings of this study contribute to early year science education just at a time when the Australian Government is seeking greater outcomes for the learning of STEM in preschools (Australian Government 2009).

Keywords Everyday and scientific concept · Early childhood science · Cultural-historical theory · Preschool environment · Teacher competence · Social situation of development

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Introduction

Drawing upon cultural-historical theory (Vygotsky 1987), the central problem reported in this paper is to explore how teachers in a single preschool conceptualise the environment for possibilities of teaching science. Play-based settings afford many possibilities for children to informally experience science education. However, the science activities in preschools are usually embedded with other aims, such as developing social competence and motor skills, and teachers may not extend the science learning possibilities of children (Sundberg and Ottander 2013). Yet the Australian Government, through the introduction of curriculum that includes greater cognitive outcomes and intentional teaching of concepts, has increasingly raised expectations for the teaching of more science concepts (Australian Government 2009). Therefore, one of the major challenges in preschool science teaching is how the existing pedagogy can support children to develop a scientific relationship to the play-based environment (Hammer and He 2014; Siry and Kremer 2011). A further challenge relates to teacher confidence and competence to teach science in the early years (Olgan 2014). For instance, research has shown that limited content knowledge of early childhood teachers is one of the major constraints underpinning their lack of confidence and competence for teaching science to young children (Garbett 2003). In addition, Sundberg and Ottander (2013) pointed out that preschool teachers' reluctance to teach science occurs because the teachers also have negative attitudes to teaching science. How teachers think and feel about the teaching of science may impact on how they view the science possibilities found in the play-based settings, environments that are rich with science learning possibilities (Fleer, Gomes and March 2014).

Research indicates that the problem of teaching science in preschools is much more complex than first thought, because teaching science in preschool is significantly different than teaching science in primary or secondary levels (Sundberg and Ottander 2013). Firstly, the play-based setting at the preschool level is less structured than upper levels. This means preschool science teaching demands that teachers' deliberately draw upon children's everyday play experiences and bring into this, science concepts in playful ways. Secondly, some teachers in preschool settings use the informal program to introduce science by simply placing objects of interest into the environment, with the aim to generate interest in learning science concepts through exploration of the materials. This discovery approach has been a longstanding practice in preschools. Previous studies have found other practices, such as formal, informal and incidental science teaching. But also, there are further sciencing (Tu 2006) opportunities available in everyday context that teachers could draw upon for teaching science in preschools—but may not do so. Thirdly, teaching in preschool contexts mainly takes place in teams, such as the main educator and an assistant teacher. As a norm, staff usually have different qualifications—therefore, competencies of a university degree and a technical diploma work together. We do not know how teachers, who traditionally work in teams in the same context, conceptualise their preschool environment or what affordances in terms of teaching science in a play-based settings may hold. Their views may be the same or different. We predict that how a teacher conceptualises science affordances in the preschool environment—as opportunities for conceptual learning or as a set of science activities—will influence their approach to teaching in the preschool environment. In the context of Government expectations for more intentional teaching of concepts in preschool settings, this is an important question that has as yet not been asked.

Therefore, to address this complexity of science affordances in the child's environment, confidence and competence to teach science and the building of scientific reading of everyday play-based settings means studying how teachers draw upon their preschool environment in support of teaching science concepts. The findings could productively contribute to knowing more about how to support early childhood educators working in teams in the changing curriculum context in Australia (Australian Government 2009). To achieve this goal, we used a cultural-historical concept of everyday and scientific concept formation and the social situation of development to understand what knowledge teachers' bring when interpreting the environment for supporting meaningful science learning. In examining the existing literature, we found that there were two key areas relevant to our study: teacher education studies on teachers' confidence, competence and content knowledge and the preschool context and science pedagogy. We introduce this literature, followed by the theoretical concepts, study design, findings and conclusion.

Teacher Education Studies—Content Knowledge, Confidence and Competence

Lack of content knowledge has been linked with confidence and competence in teaching science (Appleton 1992; Garbett, 2003; 2007). Early years science education studies from Australia (Fleer 2009), Turkey (Olgan 2014) and Greece (Kallery and Psillos 2002) suggest that developing teacher confidence and competence to teach science is often cited as the reason why so little science is taught in early childhood settings. For instance, Garbett (2003) found that most early childhood student teachers are unaware of key science content knowledge and that this appears to limit their understandings of how to design science activities for preschool children. However, others have suggested that content knowledge is not the only factor that impedes early childhood teachers' feelings about teaching science (Fleer 2009). Studies suggest that situating this problem within the individual ignores the broader social context and does not give a holistic picture of the problem. For instance, pre-service teachers are more likely to develop confidence in teaching science when they "see themselves having a role in generating scientific knowledge to inform their own scientific knowledge" (Fleer 2009, p. 353). Further, Andersson and Gullberg's (2012) analysis shows that other than content knowledge, teachers have other competencies, such as building children's confidence in their own learning, and skills in responding to the learning moments are more likely to develop a positive learning environment for children. Siry (2014) re-emphasises Andersson and Gullberg's (2012) point by saying, a much broader perspective on *what is science in preschools* and *what do teachers have to know to empower children* needs to be known since children's wonder and curiosity can often give content for investigation and that wonder and curiosity are often overlooked in studies of teacher competence.

Research has also shown that teacher competence is related to how the teacher interacts with and communicates science content to the learners. Studies have found that "in the context of teacher knowledge and confidence to teach science, the link between knowing science, and knowing science as it relates to the everyday cognition of children in their everyday lives, is significant" (Fleer 2009, p. 1074). Similarly, Thulin and Redfors (2016) emphasise that content knowledge is not the only aspect to be considered and that thought should also be given to the level of teacher experience in teaching generally and then in relation to the teaching of science content. Further, the authors mention that understanding a child's perspective as they experience science learning is also crucial, but this dimension is not usually discussed when considering teacher confidence and competence in teaching science. Considering a child's

perspective when teaching science means to take into account the child's everyday experiences—what they know about the science concepts in relation to everyday practice. Science learning becomes meaningful when the child's everyday experiences are purposefully linked to the concepts, and longstanding research has shown that teachers who find out what children already know work more conceptually with children in play-based settings (Siry and Kremer 2011).

In sum, it would appear that teacher confidence and competence in the teaching of science are a complex area, and having science content knowledge is not the only factor that needs to be considered when examining early childhood science education. We now turn to a review of research that has examined the role of the environment for the teaching of science content in preschool settings.

Studies of Science Affordances in Preschool Environments

Although there is an increased interest in researching early year science learning, not many studies have looked into what the preschool environment affords for the teaching of science. The literature shows that there is a belief by some preschool teachers that science is everywhere, whereas for many others, they find it difficult to conceptualise science learning opportunities within the everyday environment of the preschool (Edwards and Loveridge 2011). Eshach and Fried (2005) mention that there is an abundance of richness of science learning within everyday phenomena and within the objects and materials in children's everyday contexts. The authors also suggest that it is important for the adults to create an openness to looking at the interesting aspects of the environment, rather than resisting introducing young children explicitly to phenomenon. We know from teacher education studies that preschool teachers often struggle with explaining the scientific concepts, due in part to a lack of confidence and content knowledge. However, teachers can deliberately create an openness to inquiry with young children and support them to develop scientific understandings by looking at what is there in the environment and to interpret how objects and materials relate to their everyday lives (Eshach and Fried 2005; Roychudhury 2014).

Generally, in preschools, the children are in an environment where they manipulate, interact and explore objects with the help of the teachers. Whilst these environments afford many possibilities for science learning (Eshach and Fried 2005), research focused on determining if these possibilities are realised has noted that in some preschools, science corners are rarely utilised, often there is minimal interaction between children and the teacher to discuss and unpack a science experience, and in many cases the children are often left alone to play with the materials and "discover" the science concepts for themselves (Fleer 2009; Kallery and Psillos 2002; Nayfeld et al. 2011). In some cases, science concepts like space science, life science and physical science are taught only with specifically designed teaching materials in a designated science area once or twice a month (Sackes 2014). It appears that only focusing on designated science corners could ignore the myriad of experiences available in the general preschool environment. Therefore, Tu (2006) examined science learning possibilities in preschool sites, paying attention to what the teacher in charge focused on, as well as what science possibilities could be realised across 13 sites. Tu (2006) introduced the concept of a "*sciencing*" approach to name the science learning opportunities in preschool environments in relation to the materials available and the teachers' engagement with realising these possibilities. Her study examined the frequency and use of science materials. The study found that there are lots of materials available in the preschool environment that can afford science

learning for young children, but preschool teachers miss the opportunities to teach science. In analysing the environment from a researcher perspective, her study said little about the teachers' understandings of what might be the science learning affordances of that environment. In another study, Edwards and Loveridge (2011) pointed out that often teachers do not consciously recognise the learning opportunities existing in their preschool context because of a lack in pedagogical awareness of how to teach science in everyday preschool settings. In their study, some participant teachers also mentioned that the teachers do not catch the moment for science in an everyday situation because of their belief in the importance of children learning independently and with others.

Other studies have looked explicitly at the teacher's role in their environment and the pedagogical practices drawn upon to support science learning. In our previous study (Fleer et al. 2014), the concept of sciencing (Tu 2006) was extended to include a *sciencing attitude*. Studying the preschool environment and the teacher's perspectives, our previous study identified that "…with a sciencing attitude, preschool teachers are more likely to think consciously about the science that is already possible in the preschool environment" (p. 46). Siry and Kremer (2011) emphasise that learning does not happen if separated from its everyday context. In their study, the student teacher Isabella was curious to investigate children's conceptualisation of a natural phenomenon. Because of the geographical location, rainbows were a common everyday phenomenon for the children. The children thought that they could slide on a rainbow and wondered about where a rainbow comes from. A focus on the abstract concept of light in the everyday context of a rainbow was co-constructed between the educator and the children through sharing their ideas, through the recurring conversations and through responding to children's wonder and curiosity. In other words, children's learning needs to be embedded in the context of that which is meaningful to them.

The social and material relationship that teachers build with children about their environment matters for science learning in the early years. Whether or not teachers respond to a learning moment indicates how they interpret the relationship between the materials/environment and the child. Blake and Howitt (2012) explored science pedagogy in early learning centres. Their study found that through adult interaction in guided play, children could be supported towards developing conceptual knowledge in science. Their study also found that opportunities for teaching scientific concepts are often missed by educators because no follow-up or extension of the activity is afforded to children. In another study, they found that preschool children are able to develop understandings on forensic science concepts in the context of an educator developing an activity around a bear hunt (Howitt et al. 2011). The study showed that children found the forensic science concepts relevant to their everyday life because the program was contextualised within children's everyday life. The inquiry program supported furthering children's science learning skills, knowledge and imagination.

In other naturalistic studies of preschool environments, Hadzigeorgiou (2001) and Siry and Kremer (2011) discuss the significance of using wonder and curiosity as a pedagogical approach in the preschool environment. Hadzigeorgiou argues that a pedagogy is needed that will drive children into developing a scientific attitude that will guide children towards conceptual knowledge. He argues that a relationship needs to be built between the child and the environment. Roychoudhury suggests that by observing the everyday phenomena related to children's daily life-

> "…teachers and children are likely to develop a sense of personal connection to science. They will be able to see science is everywhere and it is closely related to many of their

> decisions and actions… feeling a personal connection to science may be crucial for the teachers of the preschool and elementary grades since they tend to have limited exposure to science and also a dislike for it" (Roychudhury 2014, p. 314).

In sum, the existing literature into science learning affordances in preschool indicates that not a lot is known about what preschool teachers think about the possible science concepts afforded in everyday preschool settings. Given the play-based nature of the preschool setting, more attention needs to be directed towards examining how preschool teachers can make use of the rich infrastructure available and what they see as the science possibilities. Also missing from the literature was studies that focused on or acknowledged the unique staffing arrangements of preschool settings. We know from practice, team teaching is a common structure in preschools, with usually a degree qualified staff member and an assistant or a team of variously qualified technically trained staff (i.e. one educator may have 2-year diploma and another a 1-year certificate). But we do not know how teachers in the same context use the same environments for teaching science within the everyday practices in the centre. We therefore argue that knowing how teachers in the same preschool context interpret their environments is important for enhancing the possibilities for the teaching of science in preschool settings. Consequently, our study sought to interview two teachers from the same setting, in order to explore this area. Now, we proceed to the theoretical framing of the study.

Theoretical Concepts

This study is conceptualised from a cultural-historical perspective. In particular, we draw upon two central concepts—social situation of development Vygotsky (1994) and everyday and scientific concept formation (Vygotsky 1987) for analysing the data and theorising the findings of this study.

First, we use the concept of the social situation of development for our analysis so that we may understand how preschool teachers in the same environment realise science moments within everyday preschool settings. Details of this concept are discussed further below. Since the literature suggests that teachers have the possibility to use everyday play contexts to support scientific thinking, then it is important to know if and how teachers see the environment as a resource for making science relevant to children's everyday life.

Second, we draw upon the analytical relation between everyday concepts and scientific concepts to capture the everyday experiences provided for children in preschools, at the same time as considering the scientific concept that could be afforded in the practices of that preschool. This relation gives analytical power for understanding how teachers talk about their practices, the environment and their beliefs about science teaching in preschool settings. Details of this concept also follow further below.

Together, the concepts of the social situation of development and everyday and scientific concept formation make visible how two teachers in the same environment bring their own pedagogical awareness and understandings of science learning affordances. We assume the teachers may vary in their perspectives. However, we predict that the findings could bring important understandings relevant to preschool teachers who traditionally work in pair and who have different qualifications.

Cultural-Historical Concept—Social Situation of Development This concept captures both the everyday situation in the environment and the characteristics of the person. The social situation of development is not something that is located in the situation but rather this concept captures the relationship between the person and the environment. Each person relates to the environment based on their personal characteristics or motives, which colour how they read or relate to the particular situation or everyday experience.

This concept can capture how different people with their own personal characteristics, values, attitudes and motives can experience the same environment differently. Vygotsky introduced the example of three children with a mother with a substance abuse problem, to explain the concept of the social situation of development. He wrote about how the same social situation was impacting differently on the development of the three different children based on their unique social situation of development. In his example, the eldest child in the family was a 10-year-old boy, who was taking responsibilities like an adult to help care for his younger siblings, as a result of his mother being unable to care for them. The youngest child who was also exactly in the same situation found the situation difficult because he did not understand the mother's problem. Based on the different motives and understandings of each child, the same situation was experienced differently.

Vygotsky says, it is important to note that as the child grows, his/her relationship to the same environment also changes over time, even when there is minimal change in the actual environment. Therefore, the same environment brings different meaning to the child at different stages of their development. "…whatever the situation, its influence depends not only on the nature of the situation itself, but also on the extent of the child's understanding and awareness of the situation" (Vygotsky 1994, p. 342). This conceptualisation of the environment and the persons in unity is drawn upon for analysing how teachers in the same preschool setting may be interpreting the same situation different.

Cultural-Historical Concept—Everyday and Scientific Concepts Vygotsky states that, "the strength of scientific concept is the weakness of the everyday concept, the strength of everyday concept is the weakness of the scientific" (Vygotsky 1987, p. 187). This means everyday and scientific concepts have different developmental pathways that are dialectically related. Both concepts support each other in the development of better understandings of a particular concept. Everyday concepts are experienced in regular everyday contexts. Everyday concepts are concretely experienced. It is with the adult's help that they are given scientific meaning in the everyday situation of the concrete setting of the preschool. Basic everyday concepts lay the foundation for higher-order scientific thinking. Everyday concepts are experienced in children's day-to-day practice. According to Vygotsky, "The development of scientific concepts begins with the verbal definition. As part of an organised system, this verbal definition descends to the concrete; it descends to the phenomena which the concept represents. In contrast, everyday concept tends to develop outside any definite system; it tends to move upwards toward abstraction and generalization" (Vygotsky 1987, p. 168). For example, children experience day and night in their everyday life. A mother wakes up the child every morning showing the Sun in the sky or during sleep time showing the Moon in the night sky. At a later time, the mother explains this everyday moment with a scientific explanation that the earth and other planets move around the Sun in the sky, which together are called the solar system. In this way, the possibilities are laid for the intermeshing of everyday and abstract concepts. As this example shows, the emphasis is on adult's interaction with the child during the process of developing scientific understandings. Vygotsky (1987) foregrounded the

importance of adult's role in everyday life of children since adults can provide scientific explanations and help children move beyond everyday understandings of the environment.

Research Question

The focus of this study was to examine how educators in the same preschool setting interpret the same environment for the possibilities of children's learning of science concepts. Our approach in understanding science affordances is in keeping with cultural-historical theory (Vygotsky 1987) and which we suggest speaks authentically to understanding the complexity of teacher competence and confidence to teach science in the preschool settings. We argue that through examining the science affordances of the same learning environment as identified by teachers, a better understanding of the complexity of preschool science education can be determined.

The main research question for the study was:

- How do teachers in the same preschool setting interpret their environment for science learning possibilities?

Study Design

The present paper reports on a study aimed to explore science learning possibilities for preschool children. The first named author's PhD study is linked to a larger research project led by the second named author that was funded by the Australian Research Council Discovery Scheme. Video data were gathered over 4 weeks in the preschool. However, a non-filming week due to staff sickness stretched the total duration of the project into 5 weeks. As part of the Australian Research Council Discovery Scheme project, the first named author in acting as a research assistant undertook the science walk and took photographs. As part of the first named author's PhD study, she also conducted interviews with the educators, administered a questionnaire and recorded field notes. All these methods are discussed later in this section.

Context of the Study

According to the centre director Rekha, the preschool was built 30 years ago as a long day care centre. It is located in a south eastern suburb in Melbourne. The centre is run by the parent committee for a not-for-profit body organisation. The centre philosophy integrates diversity and inclusion, respecting all abilities and voice of children to reward curiosity for better teaching and learning.

There are three rooms in the centre with different age groups of children. Each room has the standard learning areas of story books, dress-up area, a kitchen corner and as is expected with tables, chairs and hands-on materials in each learning area. There is an administrative office room, a staff room and a kitchen as well. The centre is well equipped with teaching materials and resources. The preschool building features the Victorian period with high ceilings.

Science activities are part of the preschool program together with literacy, numeracy and dramatic play activities and carried out almost in an equal proportion, as shown in the fortnight planning (Appendix 1). Planned science activities take place once every 2 weeks for preschool

children as well as incidental science experiences take place any time of a day. The planned science activities are mostly experiment based, for example making volcano with vinegar and bi-carb soda, weight and measurement, making bubbles, making aeroplanes, floating and sinking, colours and the absorption of different things, making boats and floating them and having races, marbles and ramps, etc. The educators regularly document these science activities with images named in a "science and technology ideas" folder.

There is a spacious outdoor area which all children have access to for playing together. The outdoor area is landscaped and includes trees, plants, vegetable patch, sandpit and mud pit, a cubby house, a ramp, a wooden decked area where children play with large blocks and an artificial turf area with physical obstacles in the open ground, a table and a couch where children often sit together for story time. (See Appendix 2 for the floor plan.)

Sample

In Australia, the term educator is a generic name for all staff working in early childhood settings regardless of their qualifications. Educators with mixed qualifications work in teams or pairs. Generally, a teaching pair/team constitutes a Teacher with a Bachelor degree and team members with a Certificate or Diploma qualification. A team of four educators Tamara, Riana, Dan and Rekha working in the preschool voluntarily agreed to participate in this study. In this paper, the term Teacher will be used for Tamara who has a Bachelor degree and the term Educator will be used for Riana and for referring the teaching team or pair together. Rekha was the centre director and responsible for managing and leading the service. Tamara, Riana and Dan mainly worked together teaching the same group of preschool age children during the duration of the data-gathering period. All four of them participated in interviews. Teacher Tamara and Educator Riana participated in a science walk (Fleer et al. 2014). Tamara is a Caucasian Australian and Riana comes from an Indian cultural background. Tamara has a bachelor degree in early childhood education. She is an early childhood teacher and holds the Educational Leader position in the centre. All together she had been teaching in the centre for 5 years, with three of these years teaching preschool children. According to Rekha, Teacher Tamara's responsibilities include focusing on the programmes and educational aspects, mentor peers and continue good research practices to guide overall development of the programs. Riana has an early childhood qualification and during the project she was studying towards a Diploma. She had been working in the centre for 1 year. Her role is to work collaboratively with Tamara.

Data-Gathering Procedure and Methods

Five main data collection approaches were used: digital video observations of the science walk, video and audio-recorded interviews, field notes, photographs and open-ended questionnaire. The data gathered that constituted the first author's PhD data set included video and audio-recorded interviews, field notes and open-ended questionnaire.

Digital video observations and science walk and interviews: From the second author's ARC project of 74 h, a subset of 1 h of video data constituted the science walk and interview which was analysed for this paper. Teacher Tamara's science walk took 10 min and the interview took 14 min. Riana's science walk took 36 min. The science walk and

interviews were conducted during the second, third and fourth weeks according teacher convenience.

Science walk is a resourceful interview method for gathering data because in a science walk a teacher is literally taking a tour in the preschool centre to explain all the science affordances they could think about (Fleer et al. 2014). In a science walk, the researcher follows the participant educators and captures their live detailing of the science affordances through video recordings and photographs. A science walk gives a teacher the opportunity to indicate every detail of their teaching practice that may not be possible to be captured through a traditional instrument or a regular interview.

Photographs: 303 photographs of the preschool environment were taken during the data-gathering period that related to the environment discussed during the teacher's science walk. Representative photographs from the science walk are presented in the data analysis tables.
Field notes: 14.5 h of field notes taken by the first named author were gathered and analysed for this paper.
Open-ended questionnaire and interviews: The educators were provided with a questionnaire designed by the first named author in the first week of the project. Responses from the open-ended questionnaire and the video and audio-recorded interviews captured data regarding teacher qualifications, teachers' views on science, play and science learning, science in children's everyday life, examples of regular science activities (planned or otherwise), play and imagination, teacher's role during play with children and teacher philosophy (See Appendix 3 for example of the questions).

Teacher Tamara and Educator Riana participated in the video and audio-recorded interviews conducted by the first named author. Educator Tamara's video recorded interview lasted for about 16 min. Tamara participated in two voice-recorded follow-up interviews for about 36 min. Educator Riana's video recorded interview lasted 22 min. No follow-up interviews were undertaken for Riana as she left the project site later in the year. Rekha participated in a 7-min audio-recorded interview. The interviews for Tamara, Riana and Rekha totalled 1 h 21 min.

Analysis Process

Science walk video data were analysed following Hedegaard's (2008) three levels of analysis process. The interview data, questionnaire responses and field notes supported the science walk data and gave context to the analysis. We will now discuss the three levels of analysis of the science walk data.

Common sense analysis: This first level of analysis gives a general understanding of the participants' interactions. According to Hedegaard (2008, p. 58), "This kind of interpretation does not demand explicit concepts, but some obvious relations stand out and the patterns in interaction can be seen". In this study, the two educators separately participated in a science walk. At this level, we analyse the preschool educators' identification of science in the preschool environment. The analysis shows that Teacher Tamara and

Educator Riana had differences in their views of science affordances with only a few common aspects between them.

Situated practice interpretation: At this level of interpretation, the general practice of the participant in an institution is identified. Any conflict between different person's intentions and possible new areas of development can emerge in this level. Data analysis at this level shows how the preschool environment affords with science in everyday practice of the educators in creating learning opportunity for the children. Both educators reflect on indoor and outdoor affordances. We identified different patterns are emerging from the two educators' responses.

Thematic level: At this level of analysis, "interpretation is directly connected to the aim of the research. Explicit relations are formulated by using theoretical concepts to find patterns in the situated complexity of the institutional practice level interpretation" (Hedegaard 2008, p. 61). At this level of analysis, the two educators' responses were analysed in relation to the aim of the study—how do preschool educators conceptualise the preschool environment. Theoretical concepts used at this level were everyday and scientific concepts and social situation of development. The educators' interpretations of the environment in relation to science learning affordances were analysed. New conceptual relations were formulated at this level of analysis.

Findings

During the science walk, the educators were asked to identify what science learning affordances existed in the preschool environment. The three levels of analysis unfold a nuanced understanding of how these educators conceptualise the preschool environment for science learning possibilities. We found two contrasting views of how the educators conceptualised the environment—conceptually oriented sciencing and activity-oriented sciencing. Secondly, the same affordances were identified but with different learning possibilities. Thirdly, affordances with possible scientific concept development are in a complex relationship. The themes that emerged are discussed in turn.

Scientific Concept Development vs. Activity-Focused Perspective

It was found that Teacher Tamara and Educator Riana's responses show science learning affordances in the preschool environment in two very different ways. Firstly, Teacher Tamara identified the affordances from a scientific concept development perspective and Educator Riana's identification was activity-focused. Teacher Tamara identified the science at an everyday level of children's life and then she continued relating the experiences conceptually, further mentioning teacher interaction with children in preschools that could help develop the scientific meaning of the everyday science concepts. In contrast, Educator Riana related science in children's life as a set of activities at an individual level focusing on what comes from children's interest only. Her focus was sensory and on motor skills development but not as an explanation of conceptual formation of science. Below are some examples.

During the interview, Tamara mentioned: "Children can learn science in their everyday life. Science is everywhere. Children notice things that we know scientific that they don't realise and that's our role to teach them or to expose them to the science concepts behind what's happening throughout our lives". For example, "…with storms, lightning and thunder and

things like that I think they are really fascinated by how and why it happens… they don't have the scientific concepts with them but they do know that if it's cloudy—it will rain, might thunder and storm and things like that. I guess in home in families… would teach them those types of concepts, the everyday is just an explanation I guess and then they can come in to kinder and we can teach them scientific concepts so they can make that connection". In the open-ended questionnaire, Teacher Tamara identified Science as "Experimenting, hypothesising, problem solving and understanding concepts". During the interview, Tamara mentioned that generally the children enjoy science experiments but that they do not always flow from children's everyday experiences. According Tamara, "It is a great way to start science experiences from children's everyday experiences on what they know and then introduce the science behind it".

During science walk, Teacher Tamara identified some features with science learning affordances in the preschool that the children encounter in their daily interaction, such as knowing about sound echo while using the hallway for group meal times. Standing on the hallway during science walk Teacher Tamara mentioned, *during lunchtime we talk about echo and how our noise from our voices bounces to the wall and makes it louder*. Children's awareness of everyday concepts associated with sound is evident because the younger children have their sleep time when the older children have their lunch in the hallway area. She also mentioned that the kitchen near the hallway area was used a lot for everyday cooking and baking experiences because they afforded science concepts like chemical reaction. Tamara continued walking into the staff room area and opened the freezer section in the refrigerator and said to the researcher, "We put ice trays up here to make ice, the children love to come in here and put the trays in here and come back after lunch time and find the ice and they play with the ice. This relates with melting and freezing concepts".

During the interview, Educator Riana also mentioned the everyday concept of sound. For example, "…they (children) see everything right from the start of the day to the end of the day, what is happening around, they listen to the sound around, they are able to identify what is this—sound of the animal or the sound of the tree or sound of the train which is quite very obvious specially here we listen a lot. The children are able to identify so there are a lot of things and examples". In the open-ended questionnaire, Riana identified Science as "A way of understanding the world around us, how these concepts work for example, concept of day and night. It is another good way of questioning, a lot of why questions. Why we have rainbow after rain, but not when cloudy or sunny?" Although having such understandings of everyday science in children's life, it was interesting to notice that during the science walk Riana identified most affordances as focusing on an activity and linked directly to sensory or motor skills development rather than science concepts. She mentioned, "There is a scientific concept, I have known in Jack and the Bean stalk corner, I haven't seen it yet in the children and nobody has told me, so I am just keeping my mouth closed, I am waiting for that one to come up because most of the children now know that the giant says 'fi fy fo fum I can smell the blood of an English man', but they really have not come across the concept of the smell. So there's a very big concept of smell in the story… this is one of the big concept of sensing of smell which is one of the main thing… but anyway, I mean you cannot give them the hint obviously, I would like the children to pick this up by themselves, not me giving or directing them, that there's another way of finding it out, I would like children to find it out themselves".

During the interview, Riana also mentioned the setting up of a sensory activity as a science activity, for example, "…corn starch and mixing them with water it feels gooey and foamy, using a sponge it does not get gooey in water—children may think why does it happen". Riana also identified other aspects in the outdoor and indoor environment such as water straws, taps, cubby house, couch, sand pit, mud pit, fruit and flower trees, play dough with no science concept development perspective but only describing from a set of activity perspective. For example, she said, "the jumping mat and the obstacle courses are very good, Nadia and I did some obstacle course setting out for the children. And we continued these activities… which was very good in making sure how much they can run, how much they can fly through the obstacles, are they really able to follow the pattern which was… based on all their ideas we created the obstacle course".

Detail identification of the affordances by the Teacher Tamara and Educator Riana is presented in Tables 1 and 2 of Appendix 4.

Same Affordances with Different Learning Possibilities

The second level of analysis showed that there was a pattern in the way both Teacher Tamara and Educator Riana identified scientific concepts in the same activity setting. For example, the vegetable garden and the insect table were the two areas of the environment that both Teacher Tamara and Educator Riana (Table 3 of Appendix 4) identified. Riana's emphasis on the vegetable garden was from a sensory feeling perspective. She mentioned that the children used herbs during their play. She mentioned that children usually pick rosemary from the garden when playing and notice the fragrance on her hands. In contrast, Tamara's sciencing emphasis for the same activity setting of the vegetable garden was focused on conceptual affordances of plant growth. Tamara mentioned that there were herbs and carrots in the garden. The children collected the baby carrots and made sushi with the carrots in the kitchen. Tamara said that from this gardening experience, the children were able to develop understandings about plant growth and what the plants need to grow.

A similar difference for identifying science learning affordance with the insect table was also evident. Educator Riana mentioned that the insect table was set up because "It has come up from an interest, that is, it comes from children because we have been reading information about dangerous creatures. So out of their curiosity and interest we set up this insect table". Riana focused on the children's interest but did not mention any science concepts. In contrast, Tamara's focus was on the development of scientific concept. Tamara mentioned, "At the moment the children are really interested in mini beasts, bugs and things. We have started to set this up in the environment. The interest comes from out in the garden. Children find bugs, snails or slugs…they catch them, look at them and inspect them… we usually put the bugs in jars so that they can have a look at it throughout the day…to have an experience (the indoor insect table) where they can play with the bugs, talk about their habitat or what they eat". Teacher Tamara explained the insect table in relation to science affordances. First, she identified insects at an everyday level where the children experience insects in their everyday life in the outdoor and then she explained the purpose of having an indoor play area set up for exploring and explaining insects to children from a conceptual level such as insect habitat and living.

Affordances with Possible Scientific Concept Development

In summary, Educator Riana mostly identified affordances in relation to a sensory or activity-focused perspective. However, we found that she mentioned some other affordances that could be linked to some scientific concepts, but she did not mention the scientific concepts explicitly. In Table 4 of Appendix 4, we identify the affordances with what might be the possible scientific concept development as mentioned by Educator Riana. For example, musical instruments were identified as affording high and low pitch as a sound experience. Lego blocks, magnetic connectors in the indoor area, ramp and large blocks in the outdoor area were mentioned as affording informal sciencing or incidental science learning. The ramp in the outdoor area was a constant area in the preschool that Educator Riana mentioned from an everyday perspective to roll or slide toys. She also mentioned the water straws in relation to developing problem solving skills that she thought was not directly a science experience but a possible science learning skill. It is important to note that she mentioned the imaginary corner created by the educators and children during the project as affording learning science concepts on plant growth during the project.

Data analysis and findings show that Teacher Tamara and Educator Riana experience the same preschool environment differently. The different relationship with the environment exists at two levels. Firstly, Teacher Tamara relates to the environment from a conceptual development perspective, which could suggest a conceptually oriented sciencing attitude. Educator Riana appears to primarily present an activity-oriented perspective, suggesting an activity-based sciencing attitude. Therefore, it can be argued that the two educators are interpreting the same environment from two different perspectives.

Reading the environment from the perspective of science *concepts or as science activities appeared to orient the educators in different ways, as the interview data also showed.* In "The problem of the environment", Vygotsky (1994) discussed that the relationship between the environment and the person is important for understanding development. He mentioned that people in the environment may experience the same environment differently when they have different levels of awareness of the environment and what meanings it holds for the person. Findings in the present study echo with this understanding, as we found that the same affordances were identified from a different perspective. Also, different affordances actually give different meaning and this describes the relationship between people and objects, materials or everyday phenomena perceived in different ways.

According to Vygotsky (1987), everyday concepts give practical meaning to abstract scientific concepts, and abstract concepts help name everyday practices—both are important and are interrelated. Findings from this study show that when the relationship to the environment is scientifically oriented as a concept-focused sciencing attitude, then both everyday and science concepts relevant to children's life were brought together as a science affordance. However, it was also found that when an activity-oriented approach to the environment featured, then only everyday explanations of the affordances were mentioned. Figure 1a, b below shows the dynamic relationship between environment and the person. Teacher Tamara's responses (Table 1 of Appendix 4) tell us that there are both everyday and scientific affordances in the environment. From cultural-historical theory, we know that everyday and scientific concepts are dialectically related and adults

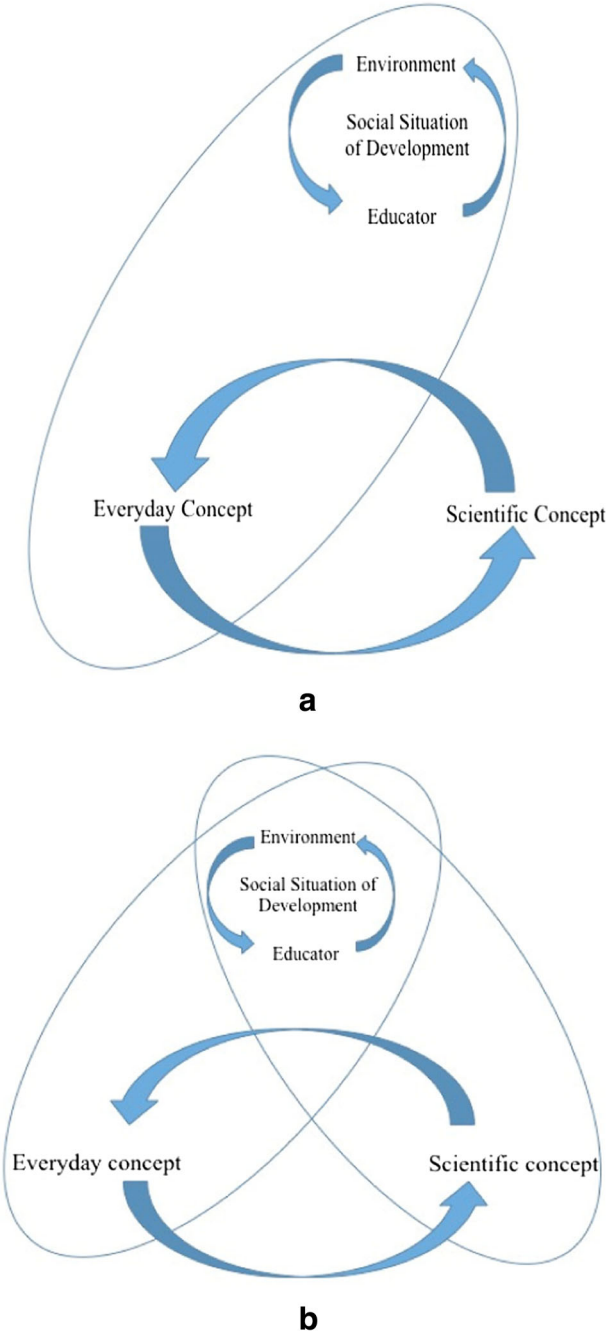


Fig. 1 **a** Scientific concepts are fragmented or left out in an activity-oriented sciencing. **b** Conceptually oriented sciencing relates the environment from both everyday and scientific perspective

play an important role in helping children to be oriented scientifically to their environment and through this to better understand scientific concepts.

In summary, when a teacher embraces conceptually oriented sciencing awareness, the concepts, environmental affordances and the person all interact in a dynamic way that we have captured in Fig. 1b. Data showed that affordances identified from an activity-oriented approach generally captured the everyday aspect of the affordances and are in contrast with less or no focus on the relationships to scientific concepts. This is represented in Fig. 1a.

Findings of the present study also reveal that there is a complexity in the relationship between the educators and the environment. In the interview data, the Teacher with a *conceptually oriented sciencing* perspective mentioned that during the research project the educators developed activities around the scientific concept of plant growth as part of their regular science experiment as well as a part of the research project. The everyday and scientific concepts were in constant interaction with the various planned activities. By bringing such awareness to the environment, the Teacher creates a social situation of development for learners. Although Educator Riana relates to the environment generally from an activity-oriented perspective, she also mentioned (Table 4 of Appendix 4) that the project imaginary play corner and the sound instruments afforded some science learning, such as teaching the concepts of plant growth and the concept of different sound pitch during the project. Therefore, during the project duration, the educators were aware of creating conditions and possibilities for the children. This indicates that during the duration of the project, the educators were interacting in relation to activities and concepts, which together raised the personal awareness of the educators to the affordances of their environment. This suggests that there are possibilities for the development of perspectives from an everyday to scientific concept level through how educators with different qualifications and understandings of science affordances can develop themselves through planning learning experiences together.

Discussion and Conclusion

In the context of an Australian curriculum landscape for the intentional teaching of concepts (Australian Government 2009), this study aimed to explore how the preschool environment is conceptualised by preschool educators to create conditions for teaching informal science. Two educators were interviewed in the same preschool context. Previous studies (Fleer et al. 2014) found that there are many opportunities available in the environment for everyday science learning beyond the formal, informal and incidental sciencing opportunities. More importantly, they found that sciencing attitude enables educators to use the preschool environment in diverse ways to teach science within any traditional infrastructure or incidental circumstances in everyday life including formal teaching of science.

The present study found that the two educators in the same environment perceive the environment differently because of their sciencing attitude. The two educators identified different aspects within the environment that held completely different affordances for the children's learning of science. One was in relation to science learning and concept development. This teacher showed a conceptually oriented sciencing attitude to both indoor and outdoor facilities and consistently took a science learning perspective. The other educator's identifications centred on activities with less focus on science or

concept development. She primarily held an activity-based perspective. Previous studies have found that science teaching is very limited in preschools (Sundberg and Ottander 2013). In most cases, science learning is less focused and the activities centre mainly on physical or social skills development perspective (Sundberg and Ottander 2013). Findings from the present study suggest that this is an *activity-oriented sciencing attitude*. Similarly, the *conceptually oriented sciencing* attitude has not previously been highlighted in the literature. Participant educators in our study mention science is everywhere. However, the deeper exploration of their awareness about science in the environement revealed that the eduactor with a conceptually oriented sciencing attitude is also pedagogicaly aware of identifying science in the preschool environement. The educator with an activity-oriented sciencing attitude appears to have some understanding about science concepts in children's everyday life; however, in terms of identifying the science affordances in the environment and bringing examples from her practice, the educator generally identified science within physical or sensory activites. Especially for early childhood settings, knowing the difference in this brings to pedagogical practice a more nuanced understanding of how the everyday educational context can bring about conceptual learning in science, and this awareness could support educators to be more confident in identifying the possibilities for teaching science to young children. This finding is consistent with studies that emphasise the importance of relating science to children's everyday experiences (Roychudhury 2014; Siry 2014) and the need for building teacher content knowledge, confidence and competence for teaching science (Appleton 1992; Garbett 2003, 2007).

Earlier studies mention that having science infrastructure may give teachers more opportunity to teach science in preschools (Worth and Grollman 2003). However, studies found that despite having designated science corners or plenty of materials, there was scant science teaching happening in the preschools (e.g. Nayfeld et al. 2011; Tu 2006). Our findings show that regardless of the materials or equipment, it is rather significant how the environment/materials/equipment are conceptualised by the educators for teaching science. This matters, and this finding has not been previously reported in the literature.

We also found that Teacher Tamara identified less affordances but was more focused on concept development. On the other hand, Educator Riana identified many affordances but with a limited focus on conceptual development. In addition, we found that the two educators described the same activity settings and materials with these different affordances. Both these findings suggest that the kind of sciencing attitude a teacher possesses is rather important. These findings also contribute to the existing literature and foreground new thinking about how educators conceptualise the environment, and this may be a key contributor to understanding the teaching practices of science in preschools. These findings are also consistent with research that suggests preschool environments and the everyday phenomena could give content for teaching science (Eshach and Fried 2005; Roychudhury 2014; Siry and Kremer 2011). But it should be noted that our study was conducted in one preschool with two educators who participated in a science walk. As such, the findings are not representative of all childcare centres in Australia or elsewhere.

In summary, the present study found that the two educators conceptualise the environment from different perspectives. This tells us that the educators interact with the environment from the level of their awareness of science affordances for children's conceptual learning in

science. The finding of two educators identifying different affordances in the same environment may not seem significant. However, from a cultural-historical perspective, it can be argued that the findings support the view that scientific concepts are not developed in the person but are built in cultural and social practice. Therefore, it matters how educators conceptualise and draws upon the preschool infrastructure as part of interacting with children to afford science learning.

Our findings suggest that the science possibilities can intentionally be built in practices with any infrastructure. That is, the relationship between everyday and scientific concepts needs to unfold through the guidance of the educators who supports the linking between the everyday experience and the final form of the scientific concept. Conceptual development not only takes time but also a conscious awareness on the part of the child is needed to be able to think differently about an everyday situation and to think conceptually, using concepts to inform everyday practice (Vygotsky 1987). But to do this, the educator also needs to be aware of the possible scientific moments that everyday practice can afford for the child and to name these practices in ways that give new meaning for the child—as scientific meaning. In this way, young children will be able to build a conceptual relationship with their environment. Children with a conceptually oriented sciencing attitude are more likely to respond to their environment in scientific ways. Similarly, when the environment is interpreted from only an activity or sensory-based experiences, this can be limited because this orientation develops particular skills but does not fully accommodate conceptual development of science (Fleer & Pramling 2015). Our study offers insights into how teachers could deliberately draw upon the conceptual-contextual relationship and shows that teaching science in early childhood settings is much more complex than the literature has suggested. We suggest that it is simply not appropriate to demand that more intentional teaching takes place through curriculum initiatives. Rather, we argue that it is important to recognise that early childhood educators work in teams, where differing expertise is brought to bear on the interpretation of curriculum initiatives. The findings of our study therefore have implications for better understanding this context and for more appropriately identifying the professional support needs of preschool teachers. In this way, our study does add to the body of literature that blames early childhood educators for a lack of competence and confidence in science teaching. However, our findings give a new way of thinking about the special nature of the team context and the corresponding rich play-based preschool environment that affords different kinds of possibilities for the teaching of science in preschool settings.

Acknowledgements This paper was presented at the 2016 ASERA conference, Canberra. A very special thank to the cultural-historical research community at Monash University for constructive feedback in the presentation of this manuscript. The first author is a PhD student at the Faculty of Education, Monash University and recipient of the Australian Postgraduate Award (APA) and the Monash Graduate Scholarship (MGS). Her study was situated in the broader context of an Australian Research Council Discovery Grant scheme (grant number DP110103013) project which the second named author is Chief Investigator for. The first named author acted as a research assistant for the ARC project but also undertook her own PhD study, which was linked through ethics to the ARC study. The science walk data presented in this paper are part of the ARC project. The unstructured interview data are part of the first named author's PhD study. A special acknowledgement to field leader Sue March for overall project management. Research assistance was provided by Feiyan Chen, Yijun Hao, Hasnat Jahan, Mahbub Sarkar, Shuhuan Pang, Shukla Sikder, and Pui Ling Wong. Support from Madeleine Holland and Rowan Fleer-Stout with data organisation is appreciated for the broader project. Special acknowledgment of the participants in the study is made, as without their participation new understandings would not be possible.

Appendix 1

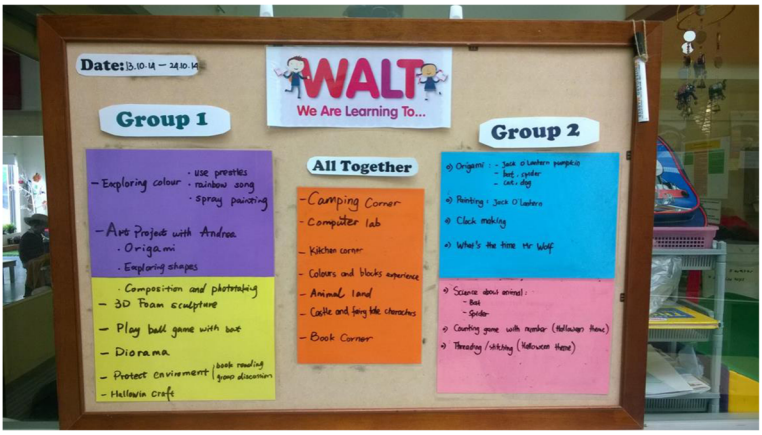
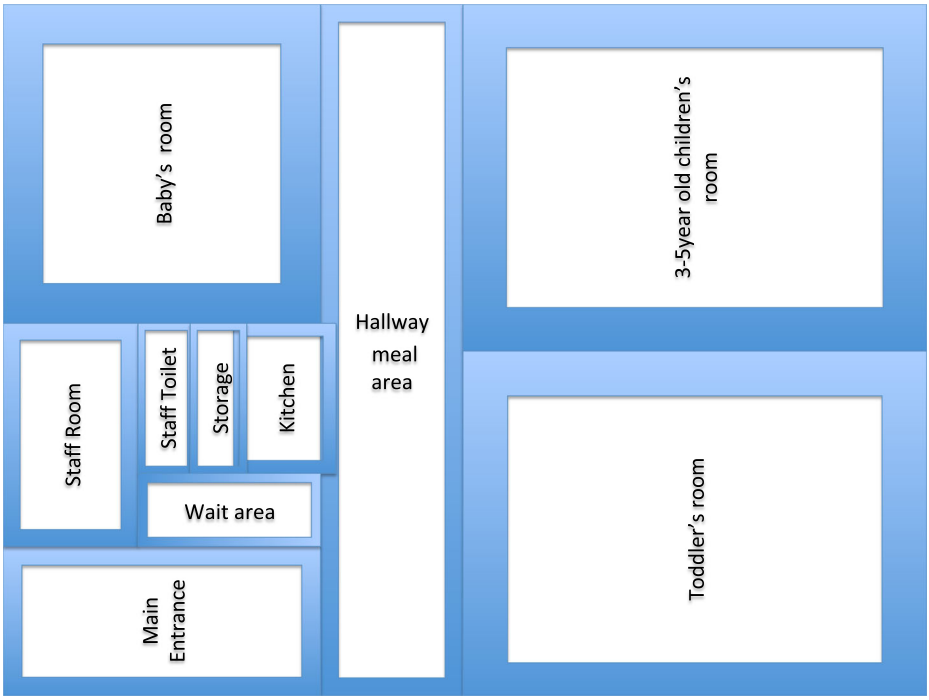
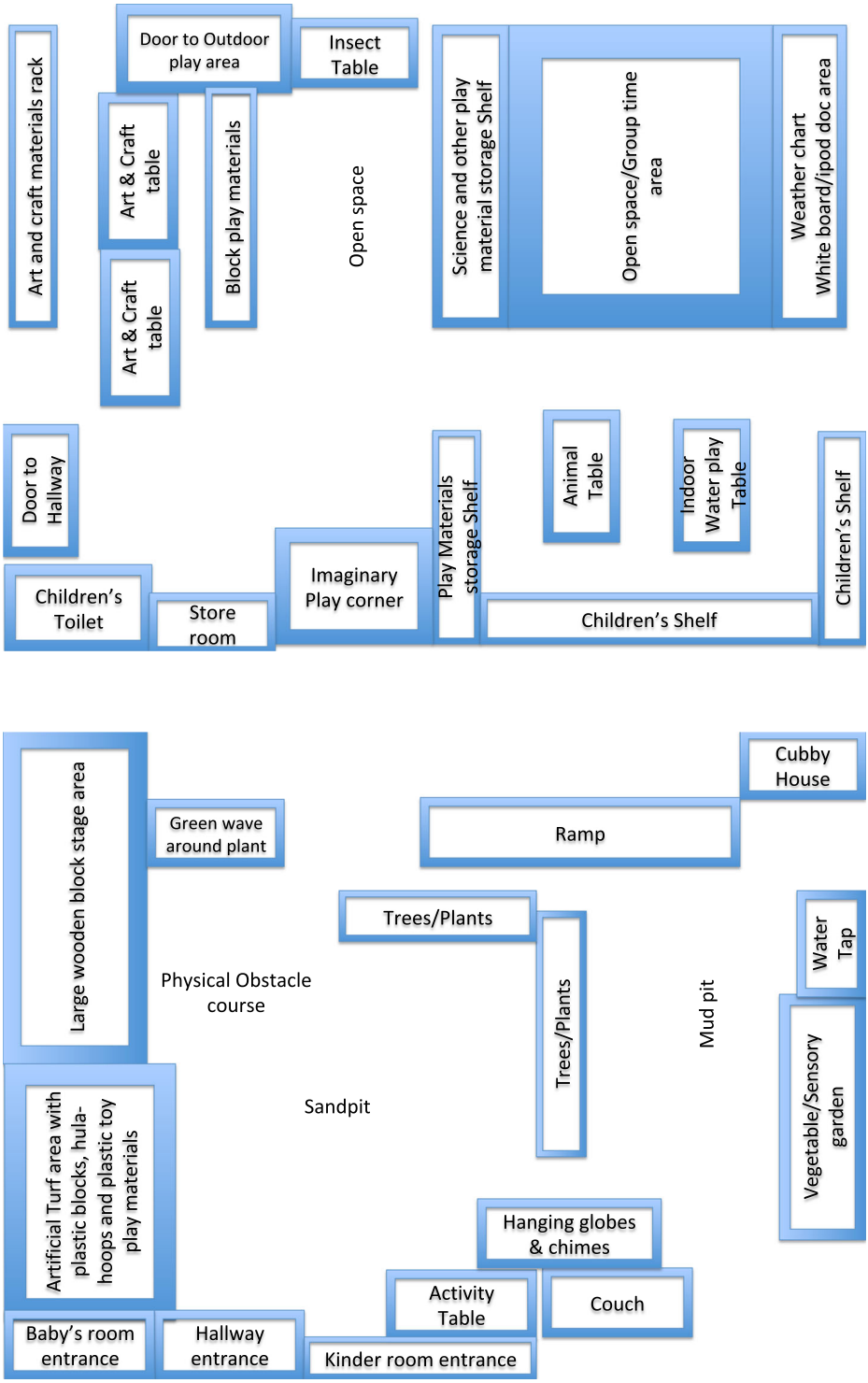


Fig. 2 Example of the preschool science activities as sits in fortnightly planning. WALT stands for "We Are Learning To". Children are split into two groups. Group 1 is the children going to school next year and group 2 are the younger children. There are experiences planned for each group as well as all together

Appendix 2




Art and craft materials rack
Door to Outdoor play area
Insect Table
Art & Craft table
Art & Craft table
Block play materials
Open space
Science and other play material storage Shelf
Open space/Group time area
Weather chart White board/ipod doc area
Door to Hallway
Children's Toilet
Store room
Imaginary Play corner
Play Materials storage Shelf
Animal Table
Indoor Water play Table
Children's Shelf
Children's Shelf
Large wooden block stage area
Green wave around plant
Cubby House
Ramp
Trees/Plants
Water Tap
Physical Obstacle course
Trees/Plants
Mud pit
Vegetable/Sensory garden
Artificial Turf area with plastic blocks, hula-hoops and plastic toy play materials
Sandpit
Hanging globes & chimes
Activity Table
Couch
Baby's room entrance
Hallway entrance
Kinder room entrance

Appendix 3

Science walk question

1. What science learning affordances can you identify in this preschool indoor and outdoor area?

Interview questions

1. Please tell me about yourself.

– Qualifications and teaching experience? How long have you been teaching in this centre?

2. What do you think about children's play and imagination?
3. What do you think about children's play and science in their everyday life?

Open-ended questionnaire science and play related questions

1. Please briefly describe what you understand by science.
2. Do you think young children experience science in their everyday life? Can you describe with an example?
3. Do you think children should be taught science concepts through play?
4. Do you do any science activity with preschool children? If yes, please give example of a recent planned science activity with preschool children.
5. Do you do any informal science activity with preschool children? If yes, please give an example of a recent informal science activity with preschool children.
6. Have you ever done any incidental/unplanned science activity with the preschool children? If yes, please give an example of a recent unplanned science activity with preschool children.

Appendix 4

Table 1 Scientific concept development affordances in everyday life

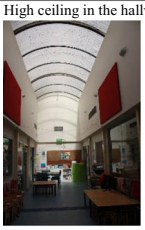
Teacher Tamara		
Sciencing from Teacher Tamara's perspective	**Everyday practice/ Teacher Tamara's science walk comments from video data)**	**Scientific concept mentioned by Teacher Tamara**
Light switches in the hall way 	Turning light switches on and off	Electricity
High ceiling in the hallway area 	During lunch time we talk about echo and how our noise from our voices bounces to the wall and makes it louder	Echo
In the kitchen baking and cooking 	We use the Kitchen a lot for cooking and things like that, I guess the chemical reaction is in baking and cooking and making things	Chemical reaction
Freezer in the staff room 	We bring the children in here and we put ice trays up here to make ice.	Melting and freezing
Blocks 	Play	Building and imagination.
Weather chart 	We have special cards that the children will have a look and look at the window and decide what the weather might be	Weather change, day concept

Table 1 (continued)

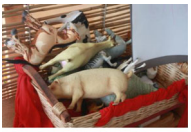
Animal table/plastic animals  	Some of the children have been to the zoo	Play using their imagination
Science & Technology folder  	Use the activities form the book for setting up Science experiments and keep children engaged	Weight and measurement, colours, absorption of different things, sinking and floating etc.

Table 2 Activity-focused affordances

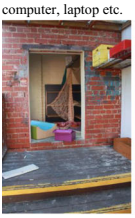
Educator Riana		
Sciencing from Educator Riana's perspective	**Video data** **Everyday practice/ Educator Riana's science walk**	**Scientific concept mentioned by Educator Riana**
Straws	Sometimes in summer we put those straws on the ground and get the children sit on the chair and put their feet inside them and feel cool and relaxed	Creates a relaxing atmosphere
Water trolly 	In winter because of rain they are not using them	Not mentioned
Water Taps 	To have access to water whenever they want, which is really good because to have water access always is good and handy as well.	-
Cubby House with Television, computer, laptop etc. 	Children use it as an imaginary space… You can't say it's not targeting on science, but you can say it is science in the way that wellbeing is looked after because this is something that comes as a natural way for them to have little room for them.	Wellbeing
Ropes, Hula-hoops 	Interesting and challenging things…some outdoor experience. I used them in a different way on the floor on circle to create a race to jump to the end.	Physical development activity
Green wave surroundings around the Plant 	Getting the children on walking on those…based on lot of gross and physical motor skills…move in circle to follow the pattern.	Motor-skills activity
mats and jumping mats, physical obstacles, ladders 	The jumping mat and the obstacle courses are very good, I and Nadia did some obstacle course setting out for the children. And we continued these activities…which was very good in making sure how much they can run, how much they can fly through the obstacles, are they really able to follow the pattern which was… based on all their ideas we created the obstacle course.	Physical development activity focus
Baby's toy basket	Music play	-
Activity table 	That table there, the purpose of that table is …most of the times we leave it empty, but whenever some activity is planned for outside, we usually get it outside. Like I used the leaves and other things in here. It's another feature of outdoor play. Because it's not only for one particular age group. When I did this activity, babies also did came and did some artwork.	-

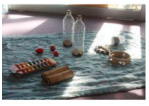
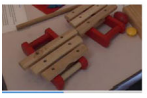
Table 2 (continued)

Blue couch and book shelf 	Story time	
Sand play not only buckets and shovels but also pipes, kitchen area, constructions, dump trucks 	Self-explanatory but we have provided enough resources like pipes, kitchen cabinet etc.	-
Mud pit near sand pit Hanging globes & Chimes 	Close to the tap…Usually children bring a lot of water and use that place. When the sun shines they are attractive	
Picture drawing on the wall 	It's very catchy and the children identify the different creatures, the cat, the monkey etc. in it	-
Workman's place- a feature in the centre	Children are just fascinated by it, curious why the workman go up all the time?	-
Trees: Apple tree, Eucalyptus tree and Gumnuts, flower tree  	In summer time…growing time...children pick it (Apples) and eat it	-
	Children use them on sand play for making cakes, decoration	-
	Sometimes the boys ask me to pick them the flowers. They want to take them for their mom. And sometimes they make soup as well with the flowers and water.	-
Playdough 	Nothing much scientific	-

Table 3 Identifying different science learning affordances within the same content

Sciencing from teacher's perspective	**Scientific concept**	
	Riana	**Tamara**
Vegetable and Herbs garden (Carrots, mint, rosemary)  	Sensory feeling (fragrances)	Plant growth
Insect table (mini beasts, and insects and bugs) 	No particular concepts mentioned	Habitat and food habit

Table 4 Affordances with possible scientific concept development

Sciencing from Educator Riana's perspective	**Scientific concept development possibilities** **Riana's responses**
Lego 	It has got lot of things if you see… because when they are doing constructing, they really realise the base has to be strong and if the base is strong, then the building or whatever they are constructing will survive.
Magnetic connectors	They are really very good. They accidently put this one in here (sticking it to the wall) and that's how they came with the learning that it connects, so they try to take this piece and lock it on the other places in the room, on the pillars to see where it attracts. This is always available… and they come up with different properties as well.
Musical/sound play instruments  	Concept of high and low pitch, sound, how the sound works, sound waves
Imaginary space created for the story, children's artwork on rainbow 	Science concepts during the broader research project
Ramp used for through to emergency exit 	It is very popular for toddlers putting their bikes, and other things. Even the other children they use their cars or other thing, they slide their toys or roll the balls…
Blocks	Blocks are very very popular…these construction box, they made spaceship with the blocks…they try to get the other resources and use their own imagination. …this is the spaceship and I think these ones over the top one over there are the controllers, these ones over there, the coloured one I think something to trigger the bullets or something like that
Water straws	A science experience- Connecting straws to make it as a pipe connecting with injection syringes to develop the keenness to know how the water flows in that pipe, where does it stop, what do you do to make it go in the trolley. Obviously you have to put more water to put more pressure more water with the help of the syringes. Even though it is not very directly targeted, they are all indirectly connected to the scientific concept. Not only providing with the experience of water and the play. It is not enough but some more activity on those lines as well.

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