

Pedagogical Play Types: What Do They Suggest for Learning About Sustainability in Early Childhood Education?

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Abstract Sustainability education is increasingly understood as necessary for young children. An important aspect of early childhood sustainability education is associated with how best to integrate the conceptual basis of sustainability education with existing play-based pedagogies. Play-based pedagogies can be understood as occurring along a continuum, including more open-ended and freely chosen play to more teacher orientated play-based activities. Each of these play types suggests different opportunities for teacher's engagement with children's learning. This paper examines how three different types of play-based pedagogy, including open-ended, modelled and purposefully framed play, prompt teacher planning for children's learning about biodiversity as a knowledge subset of sustainability education. Vygotsky's description of combinatorial activity is used to consider the extent to which each play type prompts teachers to plan for children's engagement with biodiversity concepts in ways that are most likely to support knowledge construction.

Keywords Sustainability · Early childhood education · Play-based learning

Résumé L'éducation au développement durable est de plus en plus considérée nécessaire pour les jeunes enfants. Un aspect important de l'éducation au développement durable est associé à la meilleure façon d'intégrer le fondement conceptuel du développement durable aux pédagogies existantes, axées sur le jeu. Les pédagogies axées sur le jeu peuvent être comprises comme situées le long d'un continuum, allant de plus ouverte avec choix libre du jeu jusqu'à des activités axées sur le jeu plus dirigées par l'enseignant. Chacun de ces types de jeu suggère des

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occasions différentes d'implication des enseignants dans l'apprentissage des enfants. Cet article examine la façon dont trois différents types de pédagogie axée sur le jeu, soit jeu libre ouvert, modélisé et encadré dans un but spécifique, poussent l'enseignant à planifier en vue de l'apprentissage de la biodiversité comme sous-ensemble de la connaissance en éducation au développement durable. La description de Vygotsky de l'activité combinatoire est utilisée pour voir à quel point chaque type de jeu amène les enseignants à planifier pour que les enfants s'engagent dans les concepts de la biodiversité, des façons les plus susceptibles de soutenir la construction de connaissances.

Resumen La sostenibilidad en la educación o educación sustentable, se entiende cada vez más como algo necesario para la formación de los niños pequeños. Un aspecto importante de la educación sustentable para la edad temprana está asociado con cómo es mejor integrar el concepto base de sostenibilidad en la educación con pedagogías existentes basadas en el juego. Las pedagogías basadas en el juego pueden ser entendidas como un continuo, incluyendo un juego más abierto y libremente elegido, así como actividades basadas en el juego orientadas más hacia los profesores y sus estrategias. Cada uno de estos tipos de juegos, sugieren diferentes oportunidades para que los profesores se comprometan con el aprendizaje de los niños. Este artículo examina cómo tres tipos distintos de pedagogías basadas en el juego, incluyendo aquellas abiertas, modeladas y con un propósito enmarcado, apuntan a la planificación de los profesores hacia el aprendizaje de los niños acerca de biodiversidad, como un conocimiento que corresponde a un subconjunto de la Educación Sustentable. La descripción de Vygotsky sobre actividad combinatoria es usada para considerar el grado en el que cada tipo de juego apunta a que los profesores planifiquen para el compromiso de los niños con el concepto de biodiversidad de una forma en la que sea más plausible apoyar la construcción del conocimiento.

Introduction

As an aspect of environmental education, sustainability is generally understood as encompassing an understanding of the inter-connectedness and relationships between culture, people, spaces and environment (Duhn 2012; Liu 2011). For young children, this involves acquiring conceptual knowledge about the environment and sustainability, as well as skills for living in a way which is respectful of other species and the life needs of forthcoming generations (Independent Earth Charter Commission 2012; Brundtland 1987). Whilst there is increased discussion in the literature about what constitutes sustainability and sustainable practices *in* the early years, to date, there has not been as much focus on understanding how to teach children about sustainability in relation to existing play-based pedagogical practices in early childhood education. This is problematic because existing environmental education research has already identified that children require opportunities for both experiencing the environment and constructing conceptual understandings about the environment to learn about sustainability (Chawla 2006; Mackey 2011).

Elliott and Davis (2009) suggest that the problem of how to best integrate sustainability education in early childhood arises from several issues associated with historical and philosophical beliefs about children's learning, their play and the 'nature' of childhood:

1. Early childhood education has long valued its commitment to 'natural' play so that concepts such as sustainability are assumed to be addressed through children's outdoor play experiences;
2. Messages associated with sustainability can be overly frightening for young children, and therefore their 'natural' innocence should be protected by not exposing them to messages about climate change and global warming;
3. Concepts and content knowledge associated with sustainability are too complex for young children to grasp and therefore do not have a role in the early childhood curriculum; and
4. Traditional play-based pedagogies in early childhood education can make it difficult for teachers to effectively locate sustainability knowledge within the early childhood curriculum (pp. 69–70).

Some of these issues have been addressed by counter-arguments about the capacity of young children to engage with complex ideas when learning and development are viewed in terms that do not focus only on stages and ages of development (Elliott and Davis 2009). The suggestion that childhood 'innocence' is a romanticised construct derived from historical philosophical beliefs has also been used to discredit the argument that children should be protected from learning about sustainability (Duhn 2012). The remaining issues tend to coalesce around the relationship between children's play-based experiences, the role of sustainability knowledge in children's play and the teaching of sustainability knowledge during play as a basis for environmental education in early childhood (Hägglund and Pramling Samuelsson 2009; Prince 2010). This paper focuses on these issues by examining teacher planning for children's learning about sustainability in relation to three main types of pedagogical play associated with early childhood education, including open-ended play, modelled play and purposefully framed play (Trawick-Smith 2008). In doing so, this paper contributes to research focussed on understanding how to more effectively integrate the teaching and learning of conceptual knowledge associated with sustainability education with play-based pedagogical practices in the early years.

Knowledge Construction

Play has historical role of importance in early childhood education with open-ended play in particular viewed as important for allowing children to engage with materials in ways that allow them to explore and construct their own conceptual understandings of the world (Langford 2010). Whilst still highly valued as a basis for curriculum (Vu et al. 2012), the role of open-ended play in early childhood education has undergone critique (Hatch 2010) with research increasingly indicating that young children do not necessarily construct knowledge through open-ended

play alone (Hedges et al. 2011). Rather, relying only on open-ended play as a basis for learning can result in children bypassing the intended concepts supposedly embedded in the play experience itself. Research by Fleer (2008) suggests that this occurs because children require adult support and engagement to access the knowledge embedded in play experiences. In the absence of such support children are likely to develop their own play scripts which reference their own everyday experiences of the world instead of focusing on the conceptual knowledge supposedly associated with the activity (Fleer 2010). This finding is supported by earlier research which also highlighted concerns with the extent to which children are able to construct knowledge through open-ended play experiences without appropriate levels of adult engagement and support (Wood 2007; Pramling-Samuelsson and Carlsson 2008). Findings associated with the Effective Provision of Preschool Education (Siraj-Blatchford et al. 2008) and the Researching Effective Pedagogy Years studies from the UK (Sylva et al. 2007), have also indicated that teacher engagement with children during play-based activities are necessary for supporting the construction of conceptual knowledge. More recent research is heavily focussed on the nature of interactions occurring between children and teachers during play in order to support conceptual learning (Howitt et al. 2011; Stephen 2010). There is also a strong focus on children's working theories and the co-construction of knowledge between adults and children as a basis for a more integrated approach to using play-based pedagogies than relying only on open-ended play (Hedges 2011; Peters and Davis 2011).

Whilst social interactions and co-construction during play are increasingly acknowledged as necessary for supporting children's knowledge construction, this focus does not necessarily take into account other aspects of play that are also associated with learning, particularly from a Vygotskian perspective. Here, Vygotsky's ideas about the role of combinatorial activity as a foundation for children's play add important insights into discussion regarding the construction of conceptual knowledge through child and adult engagements during play. This is because Vygotsky's account of combinatorial activity highlights the role of rich contexts in children's learning and provides opportunity for thinking about what it is teachers do *prior* to play that can also support the construction of conceptual knowledge. In the area of sustainability education, this is particularly important because the concepts associated with sustainability are unlikely to emerge only from child-teacher interactions during play without some consideration of what constitutes the provision of a rich context for learning.

Combinatorial Activity and Rich Contexts for Supporting Play-Based Learning

Vygotsky (2004) argues that there are two types of human activities that give rise to new objects, ideas and emotional experiences. These include reproductive and combinatorial activity (p. 7). Reproductive activity is when children produce (i.e. drawing a car) what they already see existing in their worlds and is considered important because it helps children to relate to their environment (Vygotsky 2004, p. 8). However, Vygotsky argues that reproductive activity is not sufficient for

learning because it does not help children respond in an adaptive manner to new or unexpected changes in the environment. Combinatorial activity in contrast, results in the creation of new objects, mental or emotional constructs that constitute learning because they are about change:

If human activity were limited to reproduction of the old, then the human being would be a creature oriented only to the past and would only be able to adapt to the future to the extent that it reproduced the past. It is precisely human creative activity which makes the human being a creature orientated towards the future, creating the future and thus altering his own present (Vygotsky 2004, p. 9).

Vygotsky suggests that combinatorial activity can be understood as imagination. In this definition, imagination is *not* understood as pretend play or ‘fantasy’, but as a mental function that allows children to re-work or re-interpret what they experience in their environments as an informant to their play, thus ‘a child’s play is not simply a reproduction of what he has experienced, but a creative reworking of the impressions he [sic] has acquired’ (p. 11). So what does combinatorial activity offer as a form of imagination that informs play in this productive way? Vygotsky (2004) argues that combinatorial activity draws on elements from life (reality) and experiences which are juxtaposed and re-combined to create new products, including objects and ideas. In early childhood education, this is important because new objects and ideas about the world represent what children are learning about their lives and experiences. Critical to the relationship between ‘life’ elements and imagination is the notion of experience. Vygotsky (2004) claims that ‘rich’ experiences are necessary for adequately informing imagination:

The creative activity of the imagination depends directly on the richness and variety of a person’s previous experience because this experience provides the material from which the products of fantasy are constructed. The richer a person’s experience, the richer is the material his imagination has access to. This is why a child has a less rich imagination than an adult because his experience has not been as rich (pp. 14–15).

This explains one of the ways Vygotsky understands the relationship between knowledge construction and play because experience is argued to give rise to life elements which children can draw on to inform their combinatorial activity. Combinatorial activity can be understood as imagination which operates as a mental function supporting play, therefore allowing children to ‘rework the impressions they [sic] have acquired’ (p. 11). In this way of thinking, play is not ‘imaginative’ as such—rather play draws on imagination which draws on elements of reality for its richness (Diachenko 2011). Vygotsky’s ideas about combinatorial activity are important because they highlight the importance of context in relation to children’s construction of knowledge through play. Vygotsky’s ideas about combinatorial activity are in addition to many of his more well-known ideas about play in early childhood, including the separation of meaning from object as a basis for mature play (Vygotsky 1976) and the relationship between play and the zone of proximal development as the basis for developmental progression (Vygotsky 1987). In this

article, the focus is on Vygotsky's concern for the richness of children's experiences as a basis for combinatorial activity. This is important because thinking about the relationship between combinatorial activity and play provides an opportunity for examining what is offered to children within the context of the early childhood setting as 'rich experiences' for supporting the development of conceptual understandings about sustainability. Importantly, consideration of the context enables more attention to be paid to teacher planning for children's engagement with sustainability concepts *prior* to play rather than continuing to focus only on the role of social interactions and the co-construction of knowledge *during* play between children and teachers.

Understanding Context

Our research in the area of early childhood sustainability education is informed by Cohen et al. (2003) and Ball and Forzani's (2007) understanding of context as comprising the relationship between learners, teachers and content (Grieshaber 2008). This definition of context emphasises how learning is constructed as teachers and learners interact with each other in relation to the content or conceptual knowledge forming the basis of the learning (Ball and Forzani 2007, p. 530). In early childhood sustainability education, this means thinking about context in terms of the relationship between teachers, children and conceptual knowledge about sustainability (such as biodiversity). Importantly, the teacher element of this definition includes identification of the focus of engagement *and* the range of pedagogical strategies teachers intend to use to support learner engagement with conceptual ideas (Ball and Forzani 2007, p. 531). Context from this perspective therefore includes consideration of what will be made available to children as a basis for learning prior to their participation in play-based activity per se. This connects strongly with Vygotsky's (2004) suggestion that children require access to 'rich experiences' to inform the combinatorial activity that represents knowledge construction because what teachers plan to do and what they make available to children constitutes an important aspect of the experiences made available to them within the educational setting. In our work, we are interested in what teachers identify as the conceptual basis of their engagements with children and the pedagogical strategies they intend to use with young children when using different types of pedagogical play associated with early childhood education, including open-ended play, modelled play and purposefully framed play. This is because research has established that young children require access to conceptual knowledge to foster their learning in the area of sustainability (Mackey 2011), but not enough is known about how to provide this access in relation to typically used play-based pedagogies in early childhood education.

Pedagogical Play in Early Childhood Education

Whilst play is frequently defined as an intrinsically motivated, freely chosen, pleasurable and nonliteral activity (Rubin et al. 1983; Hughes 1995, pp. 2–3), the

concept of pedagogical play has gained traction in early childhood education (Wood 2010). In part, the concept of pedagogical play is a response to research challenging the assumption that children are able to construct conceptual knowledge through freely chosen open-ended play. Pedagogical play attempts to integrate arguments regarding the need for teacher engagement during children's play-based activity in order to support learning. Generally described as a seeking to achieve a balance between child-centred and teacher focussed activity, pedagogical play has also been described as 'intentional teaching' (Duncan 2009; Epstein 2007), 'conceptual play' (Fleer 2011), 'pedagogical activity' (Dockett 2010) and/or 'educational inquiry' (Youngquist and Patray-Ching 2004). Pedagogical play tends to include a deliberate focus on the role of the teacher, and whilst potentially viewed as 'traditional' teaching, the focus is more on the role of the teacher during children's play as a support for learning than it is on a more didactic teacher orientated approach (Stephen 2010). In our work, we specifically use Wood and Attfield's (2005) conceptualisation of pedagogical play which positions play along a continuum with 'freely chosen' and 'open-ended' play towards the left of the continuum and 'non-play' (teacher directed activity) towards the right of the continuum (p. 5). The continuum includes reference to a range of play activities such as 'role play, imaginative play, socio-dramatic play, heuristic play, constructive play, fantasy play, free-flow play, structured play, rough and tumble play, all of which involve a wide range of activities and behaviours and result in varied learning and developmental outcomes' (Wood and Attfield 2005, p. 5). Our work in early childhood sustainability education has involved examining three different types of play located along this continuum, including, open-ended play, modelled play and purposefully framed play:

1. *Open-ended play*: is located towards the left of the continuum and involves play experiences where the teacher provides children with materials suggestive of a sustainability concept, and with minimal engagement and interaction allows them to examine and explore the materials as a basis for learning about the concept.
2. *Modelled-play*: is located in the middle of the continuum and involves play experiences where the teacher illustrates, explains and/or demonstrates the use of materials suggestive of a sustainability concept prior to allowing children to use the materials with minimal adult interaction as basis for learning about the concept.
3. *Purposefully framed play*: is located across the entire spectrum of the continuum and involves play experiences in which the teacher provides children with materials suggestive of a sustainability concept and provides opportunities for open-ended play, followed by modelled play and then teacher-child interaction/engagement (Edwards et al. 2010).

These play types appear in other categorisations of pedagogical play (Shaffer et al. 2009), including most notably the work of Trawick-Smith (2008) who identified 'trust in play' (open-ended), 'facilitate play' (modelled play) and 'learn and teach play' (purposefully framed play) as three distinct forms of play-based learning used in early childhood settings. Whilst research continues to examine how

teachers teach and what children are likely learn from these different types of pedagogical play (see for example, Blay and Ireson 2009; Tzuo 2007), there has been limited consideration of how the play types influence teacher planning for learning prior to the implementation of the play types themselves. Given the Ball and Forzani (2007) definition of context includes both content (concepts) and teacher planning for learning, this is significant in relation to early childhood sustainability education because it is not known to what extent each play type prompts teachers to identify the concept associated with the provision of a play type and the pedagogical strategies they intend to use to support children's engagement with the identified concept. We considered this issue in a project aimed at examining the sustainability concepts and pedagogical strategies associated with teacher planning for, and implementation of, open-ended play, modelled play and purposefully framed as representatives of typical pedagogical play types in early childhood education.

Methodology

Participants

Sixteen early learning centres across Melbourne (Australia), including inner city locations, outer suburban and metropolitan settings were involved in the project. All settings included children and teachers from pre-schools (kindergartens) with children aged 4-5 years ($n = 114$). Settings were characterised by a mix of socio-economic and cultural backgrounds, with inner city locations having children from higher to middle socio-economic backgrounds than those from outer suburban and metropolitan settings. The participating teachers ($n = 16$; 3 male and 13 female) were all qualified at the Bachelor degree or higher level. Teaching experience ranged from four to twenty-five years. Six of the teachers had existing interests in teaching sustainability in early childhood education and of these four teachers were involved in settings with an explicit focus on sustainability in the program and curriculum. The project was conducted with full ethics approval from the relevant university committee and the Department of Education and Early Childhood Development. Informed consent was obtained from parents and informed assent from children using appropriate forms prior to data collection, in addition to verbal consent from children on actual days of data collection. Informed consent was also obtained from teachers.

Method

The project was established across six research clusters with each cluster representing a different iteration of the play types. For example, cluster one implemented the open-ended play experience first, followed by modelled play and then purposefully framed play. Cluster two implemented open-ended play, then purposefully framed play and finally modelled play and so on for each of the six clusters. Participating teachers were invited to attend a professional learning session

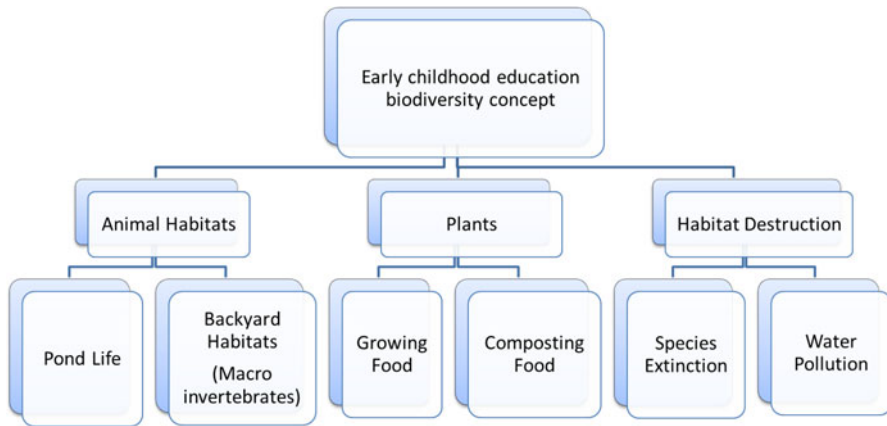


Fig. 1 Concept map for thinking about biodiversity concepts in early childhood education

in which the project was outlined and definitions of the three play types were provided and discussed. The teachers then self-selected into the play clusters according to their interests in the play types and the various iterations of the play types across the six clusters. Teachers were asked to select an aspect of biodiversity (as a knowledge subset of sustainability), and to develop play experiences that embedded a biodiversity concept according to the order of play types assigned to their cluster. For example, a teacher selecting macro-invertebrates for her concept would design three play experiences that embedded this concept according to the order of play types being implemented in her cluster (i.e. if cluster one then opened, modelled and purposefully framed play).

When selecting the specific biodiversity concept that would be embedded into each play type, the teachers were provided with a concept map suggesting ways to think about biodiversity and how it could be considered within an early childhood context (see Fig. 1). Biodiversity was selected because it represents a significant knowledge subset of sustainability in early childhood education that helps children to understand the relationships between living and non-living organisms within their local contexts (Blanchard and Buchanan 2011). Concepts associated with biodiversity, such as the habitat, life-cycles and sustenance needs of different organisms, are important for children to know and understand. This is because knowledge of the life needs of different organisms helps children understand the importance of sustainable practices, such as recycling, composting and maintaining worm farms (Littledyke and McCrea 2009). In this way, sustainable practices are located for children in relation to understandings about biodiversity that are built on conceptual knowledge, rather than simply assuming that opportunities for exploratory-based outdoor play will foster pro-environmental dispositions. In addition, biodiversity concepts are considered to offer opportunities for early childhood educators to connect more readily with existing centre-based practices (i.e. composting or growing food) and/or curriculum interests (i.e. macro-invertebrates) (Cutter-Mackenzie and Edwards 2006).

Teachers selected the main concept that would inform the three play experiences he or she would implement from the map. This meant some teachers focussed on macro-invertebrates (small animals with no backbone such as millipedes, snails, earthworms and beetles) and their habitats in the early childhood outdoor environment, whilst others focussed on plants, growing food, composting and worm farms. Two teachers diverged from the suggestions provided in the map and focussed on ideas associated with recycling. Their reasoning for this was to align the project play activities with the children's current interests concerning recycling.

When developing their play experiences the teachers maintained their normal planning and curriculum documentation. They also completed reflective journals following the implementation of each play type. The planning and curriculum documentation combined with the reflective journals were collected and used as data for examining the concepts teachers were focussed on for each play type and the pedagogical strategies they intended to use with the children. Each implementation of the play types was video-recorded. The recordings were then shown to the participating groups of children as the basis of a video stimulated recall group interview (CutterMackenzie and Edwards 2009). These group interviews were also video recorded and focussed on discussing with the children what they were doing, and what they believed they were learning during their participation in each play type. The children's interview footage was later shown to the teachers who discussed the children's responses to their participation in each play type in relation to what they had planned as the biodiversity content knowledge to be learned and their pedagogical strategies for supporting learning. The teacher interviews were also video-recorded (Edwards and Cutter-Mackenzie 2011). The teacher interviews were also used as data for cross-referencing with the data recorded in the planning and curriculum documentation and in the reflective journals.

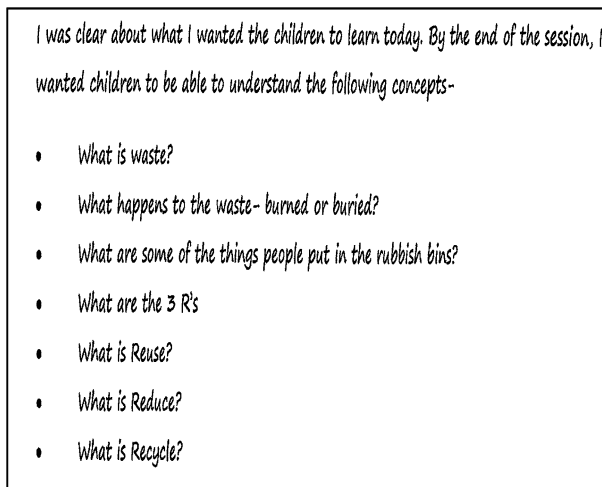


Fig. 2 Example of teacher data from planning and curriculum documentation for purposefully framed play

Data Analysis Strategies

The focus of analysis for this paper is on the concepts about biodiversity and the pedagogical strategies teachers intended to use with the children according to their planning for each play type. Planning for each play type was recorded in the planning and curriculum documentation and the reflective journals by each of the participating teachers. In this paper, some reference is also made to the interview data in which teachers clarified or expanded upon their selection of the biodiversity concepts and pedagogical strategies they intended to use in relation to each play type.

Data from the planning and curriculum documentation and reflective journals were analysed according to each play type implemented by the teachers. This included reference teachers made to biodiversity concepts and the pedagogical strategies they intended to use in relation to each play type. This information was collated from the 16 submitted sets of planning and curriculum documentation. The concepts and pedagogical strategies identified in the documentation for each play type were measured as frequencies and calculated as a mean for each measure (Cohen et al. 2007). This showed the extent to which teachers were likely to identify the biodiversity concepts they associated with each play type and the pedagogical strategies they intended to use to engage the children in learning about the concept for each play type. Figure 2 provides an example of teacher data from the planning and curriculum documentation. Here, the teacher listed seven concepts for engaging the children in learning about recycling. Each of these was recorded as a frequency for referencing concepts associated with purposefully framed play.

Findings

Analysis of the planning documentation showed that only one of the 16 teachers used the project definition of purposefully framed play. This definition was

‘play experiences in which the teacher provides children with materials suggestive of a sustainability concept and provides opportunities for *open-ended play, followed by modelled-play and then teacher-child interaction/engagement*’

Table 1 Number of references (frequencies) to planned concepts for learning and intended pedagogical strategies for supporting learning about biodiversity across the three play types

Variable	Open-ended play		Modelled play		Purposefully framed play	
	Frequency	Mean	Frequency	Mean	Frequency	Mean
Concepts	11	0.68	21	1.31	27	1.69
Total	16		16		16	
Pedagogical strategies	25	1.5	58	3.6	64	4.0
Total	16		16		16	

The remaining teachers did not precede the teacher-child interaction/engagement part of this definition with open-ended and modelled play. Instead, these teachers implemented purposefully framed play as an approach that involved a mixture of teacher-directed activity and child-focussed conversation. This suggested the teachers tended to view purposefully framed play according to the ‘non-play’ end of the Wood and Attfield (2005) continuum, and combined this with a focus on the role of social interactions as basis for supporting children’s learning. This had implications for the type of pedagogical strategies the teachers identified as those they intended to use to support the children’s learning about biodiversity for the purposefully framed play type as the strategies tended to be descriptive of teacher activity and the provision of opportunities for child-focussed discussion, rather than including reference to either open-ended or modelled play.

The results suggested that open-ended play was the play type least likely to prompt teachers to identify a biodiversity concept and the pedagogical strategies they would use to engage children with the concept. This was followed by modelled play which showed some references to biodiversity concepts and associated supporting pedagogical strategies. Purposefully framed play was the play type most likely to prompt teachers to identify specific biodiversity concepts and pedagogical strategies for engaging children with the identified concepts.

Table 1 illustrates the frequencies for identified biodiversity concepts and associated pedagogical strategies for supporting learning across the three play types. Means were calculated by dividing the number of references to concepts and pedagogical strategies by the number of participating teachers ($n = 16$). Whilst the sample size is limited, the intention of the table is to illustrate the references teachers made to biodiversity concepts and pedagogical strategies for engaging children with the concepts across the different play types.

Table 2 Illustrates sample references to concepts for each play type as they appeared in the teacher planning documentation for three of the participating teachers

	Open-ended play	Modelled play	Purposefully framed play
Concept descriptions	Animal habitats	What happens underground?	Sorting worms from worm farm so we can add them to compost
	Reduce, reuse, recycle	Planting seeds	Measuring, deep holes, less water
		Collect kinder rubbish and sort worms for farm	What do children know about bugs and beetles in my garden? (sounds, markings, camouflage, food supply, identification, classification, habitat)
		Landfill (rubbish outside)	Reduce, reuse, recycle (What is waste? What happens to waste—burned or buried? What are some of the things people put into their rubbish bins? What are the three R’s? What is reduce? What is reuse? What is recycle?)
		Introducing the concept of habitat	
		Water, food, shelter, space	

In open-ended play, the number of references to biodiversity concepts was less than the number of participants. This was because five of the teachers did not list any biodiversity concepts for open-ended play. The modelled play experience showed 21 references to biodiversity concepts by 16 teachers. In this play type, four of the teachers listed two or more types of biodiversity concepts as the focus of their planned modelled play. Purposefully framed play had 27 references to biodiversity concepts by 16 teachers. This was because four teachers listed two or more types of biodiversity concepts as the focus of their purposefully framed play.

For pedagogical strategies the highest recorded number of strategies was related to purposefully framed play, then modelled play and finally open-ended play. In the purposefully framed play three teachers listed no strategies, seven teachers listed two to four strategies and six teachers listed five to nine strategies. In modelled play, all the teachers listed at least one strategy with the highest number of listed strategies by one teacher being eight. For open-ended play three teachers listed no strategies, nine teachers listed one to two strategies and four teachers listed between three to four strategies.

The actual descriptions of the biodiversity concepts also varied across the play types. Open-ended descriptions were statements of the broad concept (i.e. animal habitats) associated with the play type, whilst modelled play descriptions were more focussed on aspects of the concept itself (i.e. water, food, shelter, space as constituents of habitat). In contrast, purposefully framed play descriptions highlighted the nature of the activity that would be associated with the experience, and also provided detailed statements about the elements that contributed to the definition of the concept such as sounds, markings and camouflage. For purposefully framed play, teachers also posed questions they considered relevant to the concept, for example 'what happens to waste?' Table 2 presents sample concept descriptions for each play type as recorded in the planning and curriculum documentation of three teachers.

Pedagogical strategies for supporting learning about biodiversity prompted varying levels of detail for each play type. Pedagogical strategies for open-ended play included reference to the equipment needed to provide the experience, inviting children to participate in the experience, teacher observation of the resultant play and the use of open-ended questions during play. Pedagogical strategies for modelled play focussed on showing children how materials could be used to explore biodiversity, the provision of information about biodiversity, the sharing of resources (i.e. books) and informal discussions. Pedagogical strategies for purposefully framed play were the most detailed. These included a strong focus on discussion, sharing, demonstrating and explaining information about biodiversity between children and teachers. Purposefully framed play also included more references to resources aimed at supporting learning, such as books, posters, resource cards and equipment (i.e. a computer microscope). This was also the only play type in which teachers mentioned reflecting on learning and returning to learning experiences with children as a pedagogical strategy for supporting learning about biodiversity. Table 3 presents sample pedagogical strategies described by six teachers for open-ended, modelled and purposefully framed play.

Table 3 Sample references to planned pedagogical strategies for each play type as they appeared in the teacher planning documentation of six of the participating teachers

	Open-ended play	Modelled play	Purposefully framed play
Pedagogical strategies	Provide equipment for building worm farms	Explain that we are going to look underground	Step the children through the process
	Invite children to build	Model process ask children if they can remember steps	Share a book
	Books and posters available		Explain the children might to look next time they come to the experience
	Allowing children to think of the process themselves before I give information	Begin with initial time for observations and informal discussions	Position worm farm in room so all can access.
	Lead children over to play	Step children through the process of creating their own worm farms	Talk about changes and observations
	Observe from a distance		Share posters about minibeasts
	Ask open ended questions: what have you found? Where do they live?	Information at the start, some questioning whilst they are looking	Discussion about posters
			Demonstrate whilst children work
		Speak with children about recycling (triangle)	Sort
			Provide information
		Read stories	Open ended questions to prompt discussion
		Engage in dramatic play	
		Show how to make a habitat—rock, stones, compost, plants	Explain procedures, modeling, step by step
			Looking for existing knowledge
		Take children for a walk around the gardens to look at habitats	Question—what do you know about bugs?
			Discussion, observation, look, feel, share,
			Look at insects and use magnifying glass
			Draw an insect using fine black markers
			Show them the computer microscope and children look at some pond water using this
			Children draw what they see under the microscope and cross reference to books
			Group reflection
			Sing song about worms

Discussion

According to a Vygotskian perspective, play is the manifestation of experience. Rich experiences in ‘rich’ contexts give children access to materials for building combinatorial activity, which in turn, results in the production of new objects and ideas. In our work, we have used Cohen et al. (2003) and Ball and Forzani’s (2007) understanding of context as comprising the relationship between learners, teachers and content (concepts). This is because according to their definition we can think about the extent to which teacher planning for supporting conceptual learning helps provide children with rich experiences for learning about biodiversity prior to children’s participation in different types of pedagogical play. We consider this an important aspect of early childhood sustainability education because not enough is known about how different types of pedagogical play relate to the teaching and learning of sustainability in early childhood education (Hägglund and Pramling Samuelsson 2009; Prince 2010). At the same time, research has shown that conceptual knowledge is an important aspect of young children’s learning about sustainability because it helps children to understand why sustainable practices such as recycling and composting are important (Littledyke and McCrea 2009; Mackey 2011).

In this project, open-ended play was found to be least likely to prompt teachers to identify biodiversity concepts and pedagogical strategies for engaging children than either modelled or purposefully framed play. This finding suggests that open-ended play may not provide sufficient opportunity in terms of ‘richness’ of experience for supporting combinatorial activity (Vygotsky 2004, p. 14). Whilst open-ended play has a strong historical positioning in the literature as supporting child-initiated and directed activity (Langford 2010; Vu et al. 2012), it is possible from a Vygotskian perspective that a reduced teacher focus on concepts and pedagogical strategies for learning means that open-ended play is more orientated towards reproductive activity. As Vygotsky (2004) notes, reproductive activity is important because it allows children to relate to their environment. However, reproductive activity alone is insufficient for generating new objects and ideas because it does help children respond in an adaptive way to unexpected changes in the environment. Given we are interested in examining how to align the teaching and learning of sustainability with play-based pedagogical practices, this suggests that open-ended play alone may be an insufficient basis for early childhood environmental education. This is reflected in the data whereby teachers would list only the concept itself, such as ‘habitat’ rather than detailing the aspects of the concept that the children would engage with via their participation in the play type.

In contrast, modelled play indicated an increased focus on the identification of concepts and pedagogical strategies for learning. This suggests the provision of a potentially richer set of experiences that increase children’s opportunities for participating in combinatorial activity. This is because biodiversity concepts that are focussed, for example, on the ‘concept of habitat’ or ‘water, food, shelter, space’ (Table 2) provides more ‘elements of experience’ for children to work with than biodiversity concepts that are listed only as ‘animal habitats’ as was the situation for the concepts identified by teachers for open-ended play (Table 2). In modelled play,

the teachers identified the concepts as habitat and were able to detail accompanying aspects of this such as water, food shelter and space. In this way, the teachers were focussed on providing children with access to ‘something’ (Hatch 2010; Pramling-Samuelson and Carlsson 2008) to combine so that they could produce a new idea or insight into where macro-invertebrates or Australian animals might live and why. These new combinations have the potential to inform play so that children are they interpret what they have achieved through their combinatorial activity. Teachers might then see dramatic play about different animals or mini-beasts interacting within an ‘imagined’ eco-system created by the children. In fact, this occurred in one setting where the teacher described seeing open-ended play enacted by the children using small figurines of Australian animals. She suggested their open-ended play had been informed by knowledge they had acquired during their earlier participation in a modelled play experiences about Australian animal habitats:

The learning that they did beforehand then influenced their play. I think they took on board a lot of those conversations and they just continued it. And I was able to influence that a little bit. I think at one point they wanted to put the lizard onto the pebbles and I said ‘it needs somewhere to hide, watch out a kookaburra is coming!’ and I think that he brought it back across and he went ‘hang on a minute, there are more rocks over here’. I think that is what happened (interview transcript, 25th August 2010).

This suggestion is supported by the findings associated with the purposefully framed play. Purposefully framed play was the play type with the most detailed references to biodiversity concepts and pedagogical strategies. In this play type, the teachers described biodiversity such as ‘sounds, markings, camouflage, food supply, identification, classification and habitat’ (Table 2). These descriptions were more detailed than those associated with open-ended play which talked about ‘habitat’, or modelled play which talked about ‘water, food and space’. By identifying more specifically concepts associated with biodiversity such as ‘camouflage’, ‘classification’ and ‘food supply’ the teachers were potentially creating opportunities for combinatorial activity that move beyond what seem to be offered through open-ended play. This raises an important question regarding the teaching of sustainability concepts through pedagogical play in early childhood settings—that is, how might children’s play as an interpretative process differ when they have access to concepts such as ‘sounds, markings, camouflage and food supply’ to draw on as an informants to their combinatorial activity compared to open-ended opportunities for exploring only the concept of ‘habitat’? Some insight to this question arises from Diachenko’s (2011) study into children’s language acquisition. She showed that the ‘use of words across many contexts and the breadth of content of each context were the key factors for the development of imagination’ (p. 22). Similarly, Wallerstedt and Pramling (2012) found that providing children with prior access to concepts about musical composition influenced the later quality of their improvised musical play. In other words, contexts providing experiences that support access to concepts are important for feeding combinatorial activity in ways that adequately inform children’s play according to the Vygotskian definition of imagination. Our findings suggest that the provision of such experiences can be related to the use of

pedagogical play in which different types of play, such as open-ended, modelled or purposefully framed play may prompt teachers to think about the identification of these concepts in qualitatively different ways such that each play type offers variable opportunities for combinatorial activity.

This means instead of focussing only what teachers can do during play to support the co-construction of knowledge that the three play types of pedagogical play can be understood in terms of what they enable teachers to provide as concepts prior to play. Developing an approach to sustainability education in early childhood is therefore possible because concepts and pedagogical strategies can be seen as elements of the context that teachers can manipulate in particular ways to recognise reproductive activity (which is appropriate) and/or support the combinatorial activity necessary for informing play as an interpretative process. In this way, one play type does not have to be valued over another because teachers can choose one of the three, or a combination of two or three pedagogical types to create opportunities for children to access sustainability concepts and strategies for engaging with those concepts. This can be in terms of what teachers intend for children to learn either in a reproductive sense, for example, perhaps re-creating a habitat; or through more interpretative play realised through combinatorial activity, for example, incorporating knowledge of food systems into their play. This was illustrated in the example of the children playing with the Australian animals where previous experience in the modelled play helped the children to engage with the concept of 'food sources'. This meant that in the later open-ended experience the child was able to understand why the lizard would need to hide under a rock when the teacher declared 'look out the kookaburra is coming!'

Conclusion

In recent years it has become increasingly established that sustainability should feature in early childhood education. However, a key issue associated with sustainability education in early childhood has been with how existing play-based pedagogies can be used to help children learn concepts associated with sustainability. This is a significant issue because environmental education research has already established the importance of conceptual knowledge in developing and supporting children's understanding of sustainability. In this project, we investigated three main types of pedagogical play located on Wood and Attfield's (2005) play-based learning continuum. The intention was to identify the extent to which each play type was likely to prompt teachers to identify the biodiversity concepts and the pedagogical strategies they intended to use with children upon implementation. Our findings suggest that teachers are more likely to identify detailed concepts and pedagogical strategies for modelled and purposefully framed play than they are for open-ended play alone. Vygotsky's ideas about the role of combinatorial activity in play and Ball and Forzani's (2007) ideas about children, teachers and content forming a context for learning suggest that each play type may prompt differing levels of concept and pedagogical strategy identification from teachers. Sustainability education in early childhood could be conceived in terms of

what each play type prompts teachers to provide either conceptually and/or pedagogically. For example, teachers could use only purposefully framed play with a deliberate focus on engaging children with biodiversity concepts such as camouflage and classification. However, they might also decide to begin with open-ended play in order to support reproductive activity, prior to implementing modelled play with the intention of moving children towards combinatorial activity and then end with purposefully framed play in order to deepen children's access to more sophisticated concepts for furthering their combinatorial activity as a basis for knowledge construction through play. This represents an important contribution to sustainability education in early childhood because it provides a methodological basis for integrating conceptual knowledge about sustainability with existing approaches to pedagogical play. Further research is needed to determine how teachers might use different combinations of the three types of pedagogical play to support children's engagement with sustainability concepts and what might be the most commonly preferred combinations and why.

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