Are We Play-Proofing Preschools, Kindergartens, and Schools?

Conceptual PlayWorlds as the Source of Children's Development of Imagination and Learning

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The author draws on Lev S. Vygotsky's conception of play and Gunilla Lindqvist's methodology concerning the aesthetics of play to discuss play practice in early childhood classrooms. Based on the study of an educational experiment at a primary school, she discusses how children in a school setting simultaneously engage in developed forms of imagining employing concepts in the shared intellectual space afforded by a Conceptual PlayWorld. She argues that, by showcasing for policy makers the advantages of this cultural-historical program, teachers can support play as a leading source for the development of imagination and learning for young children in preschool, kindergarten, and early classrooms. **Key words:** Conceptual PlayWorld; cultural-historical theory; imagination; imaginary play; pretend play; Vygotsky

Introduction

I aim to examine the problem of imaginary play and the learning of concepts (e.g., measurement) in the context of a schoolroom agenda. I hope to understand better children's imagining within their play from an intervention study in which teachers introduced a cultural-historical program called a Conceptual PlayWorld (Fleer 2021) to frame conceptual learning meaningfully. In a Conceptual PlayWorld, children and teachers enter the imaginary world of a storybook and become characters from the story. They meet other characters, experience the drama of play problems that arise in the imaginary situation, and become motivated to solve the problem using concepts they have researched to keep the play going. I direct my second goal at policy makers, because the results show that play-based programs can drive a learning agenda in ways that maintain and develop imaginary play. I argue that the development of imagination through

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children's play meaningfully supports children's learning. This sits in contrast to separating play from learning, in which there lies a high risk that policy makers may further formalize kindergartens and keep teachers from using play as a source of children's development. I offer my research as evidence to these policy makers and as a resource to help teachers maintain their play-based programs.

I begin by presenting the problem of the relationship between play and learning, and I follow with a discussion of children's development from a cultural-historical perspective. I do so because this cultural-historical theory of play is based on a dialectical logic that offers a rich system of concepts for research. In this context, I discuss how we can theorize imagination, play, and conceptual learning. I then offer the details of an educational experiment in which researchers and teachers worked theoretically on the synthesis of play and learning in the new practices of a Conceptual PlayWorld (Fleer 2021). I discuss the results and their interpretation in the context of a school-based learning agenda and speak directly to policy makers. I hold that the findings, when theorized from a cultural-historical perspective, could also act as a resource for teachers and researchers interested in supporting the development of imagination in play and in building foundational conceptual learning. And I conclude by arguing that, rather than framing play and learning as separate actions as we increasingly see in current policy, conceptualizing it instead as a synthesis in the practices of teachers underscores the importance of developing imagination through collective play. Based on these findings and theory, I suggest that, through the development of children's imagination, we can promote both the learning of concepts, such as those found in mathematics, and the development of children's imaginary play.

The Problem of How to Bring Concepts into Children's Play

Western countries have increasingly heard calls for better understanding the relations between children's play and learning (Bodrova and Leong 2019; Wood 2014) as some governments seek to increase the cognitive load for children in preschools and kindergartens (Pyle and Danniels 2017). Some have even argued that a decline in play (Singer et al. 2009) has resulted in a rise in psychopathology for young people (Gray 2011).

At the same, time several locations in the Southern Hemisphere, such as

Hong Kong, mainland China, and Singapore, have sought to support a more creative citizenship by disrupting formal learning early in life and legislating through policy (Ministry of Education 2012) and curriculum guidelines calling for preschools and kindergartens to become more playful (Curriculum Development Council 2017). Significantly, comparative studies between Germany and Hong Kong have also illuminated differing value systems and reform movements that problematize universal views on play and learning (Fass, Wu, and Geiger 2017).

Paradoxically, those studies that have focused on children's play and learning environments appear to be concerned with the same thing—the relationship between play and learning. However, they conceptualize this relation differently (Fleer and van Oers 2018; Gopnik and Walker 2013; Wah 2020). Rather than offer a binary between work and play (Pyle et al. 2020; Wright 2018) or counteract the binary of play and learning through introducing terms such as playful learning (Pramling Samuelsson and Johannsson 2006) or the playing-learning child (Pramling Samuelsson and Carlsson 2008), an increasing number of researchers bring to the literature a synthesis of play and learning. These studies and theoretical papers proffer such constructs together to address the problem of isolating play from children's learning or children's learning from their imaginary play.

Some researchers conceptualize play within a historical context across species, arguing that imagination, memory, and metacognition matter in pretend play (Wah 2020). Others focus on a psychological approach to the study of play (Bergen 2015; Elkonin 2005) or pay more attention to Vygotskian and post-Vygotskian views on children's play (Bodrova and Leong 2015). Some researchers have shown that teachers who adopt a biological perspective (Henricks 2018) believe children are not ready for learning because of a biological need to play (Elkind 2008).

From this literature, we learn mostly that there exist many conceptions of play (Eberle 2014; Henricks, 2018), beliefs about play practices, and differing views on what constitutes research in play (Lillard et al. 2012; Nicolopoulou and Ilgaz 2013). There appears to be more diversity than commonality. Despite such diversity of perspectives on play and the changing context for higher cognitive load in play-based settings, we still need to know more because of the changing agenda for more formal learning featured by kindergartens in the global north or the need for more play in formal kindergarten settings legislated by some countries in the global south. This means we need more insights into how imagi-

nary play supports imagining the kind of mathematical and scientific concepts valued by many policy makers. Like Bodrova and Leong (2019), I argue that the relations between imaginary play and the learning of concepts in the context of a school-based agenda requires further attention if we are to work toward maintaining or growing play practices in kindergartens and other school settings.

The Cultural-Historical Conception of Development

To understand how play acts as a source for developing children's imagination and learning, it is important to introduce briefly the cultural-historical conception of child development Lev S. Vygotsky (1997; 1998) first theorized in a series of seminal publications. He criticized previous generations of researchers for considering such development primarily in relation to a child's biological age and as directly linked to physical change. For earlier researchers, he argued, the benchmarks of change were not tied to empirical evidence but rather were randomly selected—using, for example, dentition to illustrate development. The shadow of this biologically determined view can still be found in current child development theories tying the stages of development directly to the age of a child. Philosophical beliefs about when education should begin and about progression through schooling were also used to discuss child development (Rogoff 2003). Vygotsky argued instead that child development was historically tied to institutional structures, and these structures continue to shape current government policies and curriculum expectations (Australian Government 2022).

As I noted, we see the remnants of both a biological and an institutional view of development in the expected milestones of children's development suggesting what a child can do at a particular age and in age-related progression in schools. And we also see age-related milestones considered as foundational in many theories of play, even though the empirical work and theories of play by scholars such as Parten (1933), Smilansky (1968), and Piaget (1962) came long before the Internet, global travel, and smart phones changed the content of children's play and how they experience the world (Correa-Chavez, Majia-Arauz, and Rogoff 2015). Some have problematized Western-oriented developmental theories of play, arguing they are culturally biased (Goncu and Gaskins 2007) and do not take account of the context and community in which a child grows up. Nevertheless, theories of play continue to shape beliefs and practices in preschools and kindergartens (Fleer and van Oers 2018). Consequently, a belief

that play is biologically motivated and develops in relation to a child's age suggests that adults do not have a role in the development of children's play (Pyle et al. 2017).

To the contrary, I suggest that, in everyday life, the differing social situations of children are not devoid of adults. We know from the long-standing research of Correa-Chavez, Majia-Arauz, and Rogoff (2015), how cultural practices within communities create social situations that build cultural orientations and competencies for children in particular communities. The biological perspective holding that development follows predetermined milestones, which has dominated beliefs about children's play progression, misses the dialectical relation between a child's social situation in play and a child's particular developmental orientation to play, which Vygotsky (1994) saw as a unity.

A second key concept introduced by Vygotsky (1998) was cultural age. This concept captures the periodization of children's development as an alternative to what he named as the passport age of the child. He considered change in children's development not to be associated with age, but rather to be a cultural determinant and a social relation, one in which change was driven through socially oriented crises. Vygotsky (1998) said crisis could be viewed "as turning points of development," in which "the child becomes relatively difficult due to the fact that the change in the pedagogical system applied to the child does not keep up with the rapid changes in his personality" (Vygotsky 1998, 193–94).

Vygotsky introduced the concept of the social situation of development to explain how the formations of development emerge and transform in social relations, including crises within a pedagogical system. Vygotsky said, "At the beginning of each age period, there develops a completely original, exclusive, single, and unique relation, specific to the given age, between the child and reality, mainly the social reality that surrounds him. We call this relation the social *situation of development* at a given age." (Vygotsky 1998, 198; original emphasis). Each cultural age period has its own unique social situation of development.

Vygotsky established that children in the same social situation bring their own social situation of development and interpret the same environment differently (Vygotsky 1994). He showed that children growing up in the same family will interpret, for example, a crisis of neglect differently and that what constitutes a crisis for one child may not do so for another. A young child does not comprehend this social situation and becomes distressed, but an older child with a different social situation of development can understand the circumstances and act accordingly, even taking on the role of a parent to a younger sibling.

This has resonance for bringing changes to the pedagogical system through the introduction of a Conceptual PlayWorld. How children meet new demands can be better understood through examining the relation between the social situation of play and the social situation of development of a diverse group of children. When we apply this dialectical relation between social situation of play and of development to a more cognitively oriented pedagogical system in kindergarten, we find that a child whose leading activity is to play will address the same classroom activity differently from a child whose leading activity is to learn (Fleer 2017). As recurrent demands, learning concepts can collectively contribute to a developmental crisis in support of a new social situation of development.

However, Vygotsky did not use *leading activity* as category. Rather, he offered the idea of dominant motives within broad developmental periods in which the activity of a child, such as to play, develops particular psychological functions, such as imagination. Similarly, in the institutional practices of schooling, the dominant motive is learning, and the psychological function of memory is said to be developing. Vygotsky (1966) mentioned the concept of leading activity only in relation to play, but Leontiev (1978) developed it further, and I found this concept useful for a study of imagination in play and learning because activity as a construct offers us the possibility of looking at the developmental turning point or moments in a Conceptual PlayWorld in which the recurrent demands for play and learning are evident. Thus, I use it for its potential to conceptualize the changes over time in periods of development we might expect from children of kindergarten age.

I also take from Vygotsky his conceptualization of imagination as a psychological function within his theory of child development. Vygotsky (1998) argued that the "general structure of consciousness changes" (197) and that the cultural expressions and realities of children up to eight years old depend on the psychological function of imagination. Vygotsky's (1966) periodization of the development of imagination highlights its unique psychological function during the preschool and kindergarten years. Both—how imaginary play acts as the source of a child's development during this period and how this imaginary play changes from birth to eight years old—is especially relevant for our study. It is not only foundational for the developmental period of the study, it highlights play as the dominant activity of a kindergarten child's developing imagination. We were mindful that Vygotsky's psychological function of imagination could move our focus from cultural practices to the biology of a child. Still, we conceptualize imagination culturally rather than biologically. In this reading, the

intervention of a Conceptual PlayWorld can act as a source for the development of imagination in both the play and the learning of concepts as they become consciously realized in the drama of the narrative that teachers and children experience together.

Vygotsky (1966) suggested that when children create imaginary situations, they move beyond their perceptual field and change the meaning of the objects they see. This has significance for the imagining of concepts as the play itself develops. Vygotsky offers the example of a stick that becomes a horse for a child who, placing the stick between his or her legs, becomes a rider. The object acts as a pivot for new action in play. A new level of consciousness emerges in play as these object-based pivots get replaced by words (Vygotsky 2005). Later, children announce through words their intentions in an imaginary situation. Later still, roles and rules become more consciously understood in developed forms of play.

Vygotsky's (1966) illustration of this involved two girls pretending to be sisters in their play. They made conscious the concept of sisterhood in their play—how to act as a sister meant consciously exploring the roles and rules associated with sisterhood as an abstract concept realized in their play. Thus, conceptual development in play can create the conceptual conditions for learning. Theoretically, it also shows how children's development of imagination grows their capacity to learn new concepts such as sisterhood. Our study aligned with this theorization because the Conceptual PlayWorld creates the motivating conditions for playing and learning, in which the conscious realization of the concepts associated with the solving of particular problems emerges through play.

Another of Vygotsky's key concepts explains development as the dialectical relation between the real and the ideal form. Vygotsky (1998) argued that the pedagogical system surrounding a child must come in advance of the child's actual development for such development to occur. In our study, we developed imaginary play as the ideal form in the Conceptual PlayWorld by having teachers assume a play role rather than a teaching role. Ideal forms of play exist in a child's environment always in relations to the child's present form of play. In principle, "the social environment is the source for the appearance of all specific human properties of the personality gradually acquired by the child or the source of social development of the child which is concluded in the process of actual interaction of 'ideal' and present forms" (203). This emphasizes the need for teachers to create the ideal forms of imaginary play as part of their pedagogical practice. The intervention of a Conceptual PlayWorld, in which we feature imaginary play and the imagining of concepts, pedagogically calls on teachers

to introduce into the children's environment ideal forms of imaginary play.

Taken together, all this makes it possible to see how Vygotsky theorized the development of the child not as a linear progression, but rather as "a dialectical process in which a transition from one stage to another [that] is accomplished not along an evolutionary, but along a revolutionary path" (193). This revolutionary view of child development proposed by Vygotsky features social relations and cultural age periods and suggests an active role for adults in children's play such as that also theorized by Lindqvist (1995), who drew on Vygotsky's theory of development for her drama pedagogy. Both Vygotsky's and Lindqvist's focus on the role of teachers in creating drama or crises to amplify development are central to this article (along with Vygotsky's theory of play).

Educational Experiment

Our research question, then, was: Under the conditions of a Conceptual PlayWorld, what was the role of imagination in the play and conceptual learning of children?

To understand the relations between play and learning in kindergarten settings, we undertook a study of three teachers and eighteen children from one school as an educational experiment (Fleer 2021). In a cultural-historical context, this educational experiment constituted a collaboration between researchers and teachers concerning a theoretical problem rather than merely a problem of practice (Hedegaard 2008). In our educational experiment, one field researcher helped teachers introduce an ideal form of a Conceptual PlayWorld, and we studied the play conditions social situation of child development under the intervention of a Conceptual PlayWorld (see Fleer 2020).

The Intervention

A Conceptual PlayWorld is a model to guide pedagogical practice. It was developed to help teachers design teaching programs in which concepts act in service of children's play (Fleer 2019) based on the premise that play creates the motivation for solving a problem. A Conceptual PlayWorld consists of five characteristics.

The first involves selecting a children's book with an emotionally charged, dramatic story line in which children empathize with the characters. In our study, the teachers chose the *The Secret Garden* by Frances Hodgson Burnett

both because it featured dramatic moments and was rich in possible play activity. (In the book, guided by Red Robin, the characters find a key and enter an overgrown garden). The second characteristic concerns designing an imaginary space in which both teachers and children can assume the roles of characters in the story and act out its plot. (Here, the teachers planned the imaginary space of a secret garden using the outdoor school play area). The third characteristic involves planning a routine for the whole group to enter and exit the imaginary space. (Here the teachers used a large metal key and pretended to unlock and lock the garden). The fourth characteristic introduces a play problem that supports conceptual learning. (Here, using a mobile phone recording with static sound effects, the teachers introduced the children to the problem of entering the garden and then undertaking space travel to go to the moon to rescue Cousin Robin. According to the recording, Red Robin had sent a satellite message to the children saying she was stuck on the far side of the moon, that her solar power was being depleted, and that she needed help. The plot was designed to fit the educational program for mathematics and science by studying the relations between the earth, the moon and the sun by considering their rotations and orbits but also by allowing children to introduce their own characters and play problems as the narrative developed.) The fifth characteristic relates to teachers planning their role as play partners to motivate play but also to make available to the children developed forms of play in which they might show (through their actions of being a character from the story) imaginary play in action and how the concepts act in service of the play problem (Fleer 2019).

Sample

The kindergarten and first-year classrooms were located in a middle-class community in Southeastern Australia. The first year of school in Australia goes by different names in different states, but it is the year in which a child turns six years old. The outdoor play area of our school was rich in natural materials, including climbing frames, pathways, trees, and green areas for running. The curriculum of the school followed the guidelines set by Australia's Department of Education, with elements taken from the international baccalaureate program for the early years of education.

Our three teachers were four-year university degree qualified and had between seven and ten years teaching experience. They were from European backgrounds. The teachers regularly planned their programs together and shared resources and teaching spaces when undertaking joint teaching programs. The

Conceptual PlayWorld was taught in the two classrooms and constituted both individual classroom teaching and team teaching.

Our lead researcher designed the broad intervention of the five characteristics, and our field researcher, an expert in the intervention, helped the three classroom teachers plan the specific authentic play problem and guided them toward becoming play partners with the children in the Conceptual PlayWorld of the Secret Garden. The field researcher mostly helped the three teachers assume their character roles and create the imaginary situation. Finally, a research assistant filmed the experiment.

A total of eighteen children aged 5.6 to 7.4 years (mean 6.4 years) consented to participate in the study. The children were of Australian/Anglo/ New Zealand , Euro Australian, Euro/New Zealand/Australian, and Asian Australian backgrounds. Seven children were girls and eleven were boys.

The Procedure

In step one—professional development—we introduced the teachers to the intervention of a Conceptual PlayWorld by showing them a planning proforma and examples of Conceptual PlayWorlds for each of the five characteristics, all of which took an hour.

In step two, the teachers workshopped the planning of a Conceptual PlayWorld for an hour using the proforma. They also workshopped the research problem of importing concepts into children's play and how teachers can do so as play partners.

In step three, The teachers and researchers designed the Conceptual PlayWorld program, and they met each week to review the play's progress and the additional problems they could introduce to help develop the imaginary play.

In step four, they implemented and documented the Conceptual PlayWorld over a period of eleven weeks as the research assistant made a total of nineteen visits to the school. The main researcher created a set of questions that the research assistant asked the teachers in situ during observation periods and also during the planning sessions—saying, for example, "We notice you..." or "Can you tell us more?"—to understand better the practices they had digitally recorded.

In step five, at the end of the teaching period, the research assistant undertook a stimulated recall with nine children in groups of two or three in which she showed the children two relevant video clips of their Conceptual PlayWorld in action (in total seven video clips of two minutes each) and asked them about

the content of the clips—for example: "Can you tell me about this? How did you feel? What was important here for you?" These sessions were digitally video recorded and transcribed.

And finally, in step six, the research assistant interviewed the teachers for an hour about the planned and implemented pedagogical practices of their Conceptual PlayWorld of the Secret Garden (asking, for example, "What did you do? What were the challenges?").

Data Generated

We video recorded all sessions each week using two cameras, one on a tripod to capture the classroom and the other a handheld camera to follow the children as they entered the secret garden. We generated 34.2 hours of video data. We also digitally recorded all planning sessions in situ, 10.4 hours of digital interviews and planning, which we transcribed. We captured digitally samples of children's drawings and work. We took photographs of practices, displays, and relevant pedagogical materials. We generated ninety-six emails and digitally recorded planning documents during the educational experiment. We also gathered digital images of 182 drawings and prototypes and forty-three photographs of children working and digitally recorded twenty-three mind maps.

Analysis

We organized the digital data chronologically and placed it in seventeen numbered digital folders. Each folder contained subfolders of video observations, mind maps, photographs, field notes, transcriptions, children's drawings, teacher planning documents, YouTube URLs, and environmental displays. We logged and time stamped all digital video observations and organized them in relation to camera type and position (i.e., tripod or handheld).

We made our interpretations of a single video observation or several such observations in relation to concepts of mathematics, science, digital technology, design and technology, engineering, or to everyday conceptions of a phenomenon (like rainbows rather than refraction of light), or to imaginary play (for example, to signal how an imaginary situation like a key is used in the play. A child announces, say, "Here is the key to unlock the Secret Garden" to represent an idea such as turning the key and moving into the imaginary space. The key acts as a transition into the imaginary space and as a placeholder of the idea. That is, the key stimulates a narrative that all the children show they are part of—a collective imagining of the story narrative involving rescuing a character in the Secret Garden.

Next, we tagged contextual data to determine patterns and the density of data associated with the interpretations. For example, the categories of data we had identified, such as, a particular concept, we logged in the data set and made a digital copy of the play, which we placed in a folder labelled "concepts." In that folder, were identified subcategories such as "mathematics" or "science." This process gave a density to the data associated with each identified category (that is, to each folder of digital video data).

Finally, we brought to bear on the interpreted data set the dialectical conceptions of ideal and real forms of development (Vygotsky 1994), the social situation and social situation of development (Vygotsky 1998), and imaginary play (Vygotsky 1966) to help answer our research question. This theoretical analysis sat within Vygotsky's system of concepts and underpins his cultural-historical conception of child development.

Results

A cultural-historical conception of development shows imaginary play as the leading activity in the early childhood period associated with children's social situation of development (Leontiev 1978; Vygotsky 1998), and in the first year of school, it is associated with the development of memory. However, the children in our study came from both periods of development. Therefore, we enjoyed a rich research context in which to study the role of imaginary play in the conceptual learning of children. We expected that imagining the science concepts associated with the relations between the earth, the moon, and the sun, and associated mathematical concepts could be supported in the collective imaginary play of the Secret Garden. Overall, we found that children in a school setting in kindergarten and year one engaged in developed forms of imagining (creating or being in an imaginary situation; giving new meaning to the perceptual field; using objects or words as placeholders of imagined new meaning) even as they used everyday concepts in their thinking within the shared intellectual space afforded by a Conceptual PlayWorld. We identified that the imaginary play created a shared narrative that collectively solved the drama that emerged in the play narrative. We present these overall results for the children's conceptual thinking with typical examples of data featuring mathematics is as only an illustration of a particular concept. We note that children in this cultural age period are likely to work with everyday concepts

Mathematical Concepts	Making those Maths Concepts Visible in the Environment	Conceptual Play World
By the end of the Foundation year, students make connections between number names, numerals and quantities up to 10. Students count to and from 20 and order small collections. They group objects based on common characteristics and sort shapes and objects		
They compare objects using mass, length, and capacity		 Designing space suits at NASA training camp
Students connect events and the days of the week.	 Pancake Tuesday on a Wednesday?	 Day 1: preparing for space travel
They explain the order and duration of events.		 Working out what is needed for successful space travel
They use appropriate language to describe location.		 Describing location of earth, moon
Students answer simple questions to collect information and make simple inferences.		

Figure 1. Mathematical concepts for foundation level and associated play materials (column 2) and imaginary play (column 3)

or phenomena, rather than fully formed concepts, which Vygotsky (1998) called true concepts.

In figure 1, we summarize the two contexts: mathematics play area (column 2) and mathematics Conceptual PlayWorlds (column 3). First, let us consider the play area.

Mathematics Play Area and Display

The mathematics area offered a space for children to explore mathematical concepts and display what they accomplished in a single session. We found that the content of the mathematical activity on the displays did not interconnect or link directly to an imaginary play situation (e.g., figure 1, column 2). We also found the mathematical activity displayed had a single focus, which could be completed in one session. We know that the Australian education system views mathematic goals with their accompanying lessons as a valued practice (Australian Government 2022). In addition, researchers report that mathematics play activity areas have been set up for playful learning that involves free play, guided play, and educational math games (Hassinger-Das et al. 2018) or as tools for exploration and investigation in which creative play and mathematical reasoning give rise to "big" ideas in mathematics (Cheeseman, McDonough, and Golemac 2017). Our analysis shows that the beginning point for children in the mathematics play area was the learning of a mathematical concept but that the activity as presented (e.g,, pancake day) did not appear to encourage imaginary play.

Interpretation of Conceptual PlayWorld

In contrast to the mathematical play area, the Conceptual PlayWorld (column 3) began with the play problem as an imaginary situation. We found that imaginary play with the drama of a problem appeared to act as a glue to bind over time one learning experience to another. We suggest this is because the Conceptual PlayWorld sessions were thematically connected to the play problems that arose in the play narrative, which is different from single stand-alone sessions that are not interconnected or linked over time. For instance, row 2 shows the imaginary situation of children as astronauts, certified by NASA with a prototype they constructed using 3-D materials, coded as part of their rocket launch, and they count down from ten or five, all as part of a simulated NASA mission. The children also designed space suits, exploring sizes and comparing lengths within the imaginary situation of attending a NASA space training camp (row 3) to prepare for space travel (row 4). Plans not only included plotting the relations

between the earth, the moon, and the sun (row 5), but how to meet the play challenge of rescuing Cousin Robin, which meant collecting information about the percentage of oxygen still available to her and making simple inferences about what to do to save her (row 6).

The imaginary situation entailed both NASA space training camp and rescuing Cousin Robin from the far side of the moon, creating the need to imagine rocket designs (realized as drawings) plus the steps and criteria for successful space travel and the coded flight path for the rocket in relation to the moon, the earth, and the sun. These imaginings are all tied directly to the mathematical concepts shown in column 1 and expected to be achieved at the end of the foundation year in Australia (Australian Government 2023). The imaginary play situations appeared to create a context for imagining mathematical concepts to support the children's play.

We suggest that children do not think in curriculum boxes, and the results shown here align with this view. The imaginary play appears to interconnect all the curriculum concepts from the mathematics curriculum and (as we will show) helps make mathematical concepts personally meaningful to the children. This is consistent with findings by Li and Disney (2021) about preschool children in a mathematical play world that "peer relations and interactions in the play world also stimulated the motivating conditions to inspire the whole group of children to engage in problem solving and enhance their collective thinking" in mathematics (12).

Recognition of Children's Social Situation of Development

Our study found that teachers (Patrick, Olivia, and Cassandra) appeared to draw on children's play as a leading activity to support the children's learning of concepts. Even though schools foreground learning as the primary function of the institution and educational systems expect teachers to create conditions for meeting the achievement standards, the teachers in this study noted the children's social situation of development when planning a Conceptual PlayWorld.

> Cassandra: You are jumping into the children's world. They are very adept in that play. We are coming in and hoping to introduce things within the play scenario. It is so much fun to do.
>
> Patrick: As teachers we intuitively know that play works. And play is the child's world. And we enjoy playing as well, that's why we are teachers. So often we find it difficult to know why a school would

> not take that approach. So, for us it was so easy. We are playing. We are dealing with [or covering] the concept [too].

Knowing children's social situation of development, the teachers prepared new social situations that they believed would motivate the children to learn the concepts expected in the achievement standards. They provided an example of an observation of a Conceptual PlayWorld in which teachers create the motivating conditions for a simulated rocket launch as part of the imaginary situation of Mission Control for astronauts:

> The children are now towards the end of their ten-week program focusing on STEM. They are seated in a circle as astronauts in Mission Control (classroom) with their teachers who are also astronauts and have just viewed their simulation of their rocket launch on the big screen using a software program. This session was based on previous weeks of designing and prototyping, as well as embodying through play the imaginary situation of visiting NASA in character as astronauts and scientists preparing and launching into space. On the screen the rocket launches successfully, but then explodes as it enters the second stage of the launch. The children in Mission Control discuss their unsuccessful launch and later move into groups to further research how to change their plans for a successful launch. The children take back to Mission Control their solutions. This is done in the imaginary context of continuing in their role as astronauts and scientists on a mission to save Cousin Robin and Colin who are on opposing sides of the moon (far and near sides). As part of the debriefing, Astronaut (Teacher) Cassandra asks, "Can you think of some things that did work about our original design?" Astronaut Freya responds, "Original not so good. Because I think we needed a [pause], not so many booster packs because … so that we could not make it so many altogether…."

The social situation of a Conceptual PlayWorld offered the possibility for the children to consider why the rocket launch had failed, which then provided a system of concepts for explaining what happened that enabled them to plan the next launch better. In the astronauts' reflections about the rocket launch following what we just quoted, Astronaut Mitch explained how the collective mass of the rocket does not support the propulsion needed.

Astronaut (Teacher) Cassandra: So, can I ask a question?
Astronaut Mitch nods yes.
Astronaut (Teacher) Cassandra: I didn't think to count how many booster packs were on there, if you had to guess, how many boosters do you think we had on that rocket
Astronaut Mitch: Eighteen.
Astronaut (Teacher) Cassandra: Eighteen. Do you think that is too many?
Astronaut Mitch: YES! I think that rocket blew up [pointing to big screen] because it had too many stuff on there.
Astronaut (Teacher) Cassandra: Too many?
Astronaut Mitch: Something. Something on the rocket. Something that was connected too many. And it gets pushier and pushier and then it just exploded [shows collection with hands].
Astronaut (Teacher) Cassandra: So, you think it was carrying too much?
Astronaut (Teacher) Olivia: I am really connecting with you. So, it had too many boosters and was too heavy and couldn't get the proper propulsion that it needs to go further through the atmosphere.

The imaginary play offers the system of concepts needed to explain why the rocket launch failed—force, mass, and number, which the teachers name in the imaginary situation. Astronaut (Teacher) Cassandra sets up the moment for Astronaut Mitch to share his understandings in the imaginary play, but it is Astronaut (Teacher) Olivia who supports Astronaut Mitch through affirmation of his inference (i.e., "rocket blew up . . . because it had too many stuff on there") and then provided some of the conceptual language to capture his thinking using scientific and mathematical terms (i.e., "too many boosters and was too heavy and couldn't get the proper propulsion"). This typical example illustrates of how teachers in character and in play introduce the language of concepts to children but do so at moments when the children are imagining—through collective play—particular imaginary moments related to the narrative of the play plot. Our research showed that this kind of imaginary play, illustrated here between children and teachers, over time produces conceptual language within a system of concepts bound within imaginary play. It can be argued that the foundation for theoretical thinking (Davydov 1990) could be supported in imaginary play, which is more complex than that shown in figure 1, column 2 for the mathematics play area.

How Concepts Act in Service of Children's Play

To understand how concepts acted in service of the collective imaginary play inside Mission Control among astronauts (teachers and children), we present in figures 2 and 3 a detailed analysis of the dialectical relation between conceptions of the everyday phenomena introduced into the imaginary play of this example of a rocket launch and the curriculum concept that the teachers have planned. Collectively they offer a typical example of teachers introducing concepts into the imaginary play situation and children's real understanding of the concepts as shown in figure 1, column 1.

Curriculum concept (Australian Government, 2023)	What children are bringing to the imaginary play situation
Connections between number names, numerals and quantities up to 10	Astronaut Anamika: You put too many [boosters] on it [rocket]. If you only put 4 on, it won't explode. (Too many booster explode Eileen)
	Astronaut Michelle: We may have needed 30 petrol tankers on like trucks to get the whole rocket eered [filled] it (tankers 30 to fuel)
	Astronaut (teacher) Olivia: Not double, but three times the amount of fuel. Astronaught Sylvia: Actually, it is four times (double-4 times fuel)
	Astronaut Anamika: I am thinking that the rocket just blew up. Astronaut (teacher) Olivia: Why? Astronaut Anamika: Because there were too many boosters. Ruth: So we need to think, how many boosters? (Reflection Anamika too many boosters)

Figure 2: Children's real form of development of mathematical concepts in the context of an imaginary situation

In figure 2, the children use number concepts when discussing how many boosters were needed for a successful launch (rows 1 and 3) and how many fuel tankers were needed to fill the boosters (row 2).

These typical examples illustrate the use of abstract mathematical concepts being brought to bear on the problem that had arisen in the imaginary play of the children. The simulated rocket launch was the culmination of their preparation for space travel, their prototyping, and the drama of saving Cousin Robin (our overview is shown in figure 1, column 3). Figure 3 offers an example of one child's play plan to save Cousin Robin, establishing the priorities for the rescue by using numerals and noting the drama and urgency through recording the percentage of oxygen left (15 percent). Also evident are the directional arrows that signal how to leave the rocket station and travel to the far side of the moon.

To understand fully how concepts support the imaginings of children, we need to go beyond the real form of children's thinking (e.g., as when Mitch says, "rocket blew up. . . because it had too many stuff on there") and also look closely

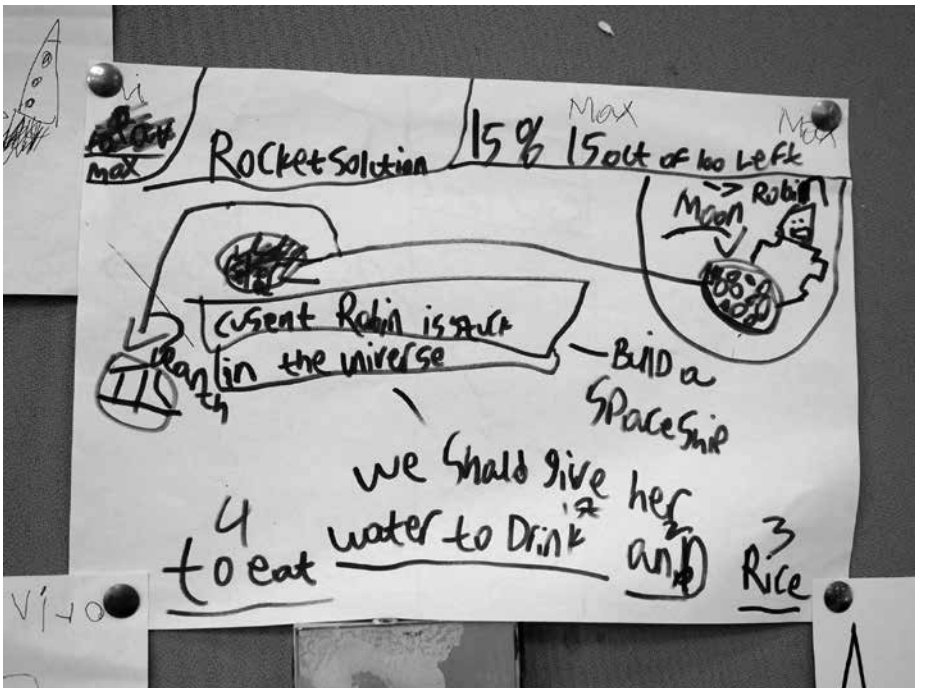


Figure 3. Rescue mission

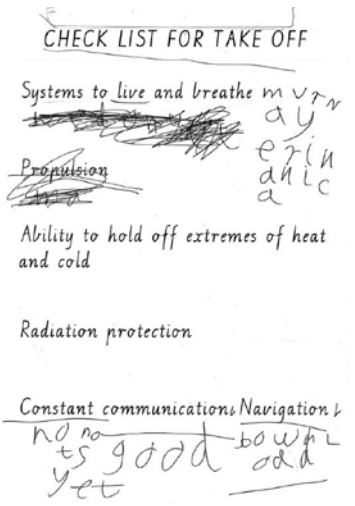
Achievement standard	What teachers are bringing to the imaginary play situation
Connections between number names, numerals and quantities up to 10	Astronaut (teacher) Cassandra is standing holding a clipboard with a colourful sheet with NASA logo and says, "Here is the calculations that NASA has provided us with. We will have a good look at this to make sure what we are thinking of is what's described here. So that will help us". Cassandra then picks up a clip board with the heading: Checklist for take-off, and says pointing to each line of text, "The 5 technologies that we need to ensure that our rocket has". She continues to point and read out each line, with elaboration. 
	The children and teachers organize to move from the circle to their workshop where they revise their launch plans. Astronaut (teacher) Patrick stands and says, "We need 5 teams". He gently taps Astronaut Anamika and she stands as Astronaut (teacher) Patrick says, "You are Team number 1". He then takes Alysa by the hand and brings her next to Astronaut Anamika as he says, "Your Team number 2. You are going to stand here". Astronaut Sylvia turns and faces to form the head of the line. Astronaut (teacher) Patrick then taps both children on the head as he counts, "One, Two." Astronaut (teacher) Patrick moves to create a space for Team three, as he says, "Orchid, your Team number 3 over here". He then repeats, tapping each child on the head and counting to 3. He invites the leader of Team 4 saying, "Nareen, up you come to me". Astronaut Nareen moves into the position, as Astronaut (teacher) Patrick invites the 5th child, "And Chloe, you can be 5". Astronaut (teacher) Patrick invites children one by one to stand behind a team leader calling the number as each child stands in the respective team (Sort into teams). The children move in their groups to separate areas in the classroom and work in their teams to revise the rocket launch plan.

Figure 4: Mature form of mathematical concepts are introduced by the teachers in the context of the imaginary situation

at the developed concepts available in the environment. Figure 4 shows examples of mathematical concepts introduced by the teachers inside the imaginary situation. The checklist for the rocket launch supports the children's reflections about what went wrong with the take-off, but it is presented by Teacher Cassandra in a way that references the numerals 1 to 5 (five technologies in Row 1). Similarly, row 2 shows how the teachers organize the children into teams of five to reinforce sets and support number sense associated with the respective numeral.

But to understand the children's engagement with the concepts, we need a synthesis of the developed and real forms of imaginary play. This indicates how teachers create the motivating conditions for children's learning of concepts. The examples here were consistent with the data set, showing evidence that the children were invested in the imaginary play and wanted to help the characters to rescue Cousin Robin. In the following example midway through the imaginary situation of launching the rocket as a simulation, field researcher Ruth amplifies in her character as an astronaut the drama of the problem, which is emphasized by the teacher to give urgency to the imaginary problem of Cousin Robin and Colin on different sides of the moon.

> Astronaut (Researcher) Ruth stands up from the circle and says to all the other astronauts, "I didn't want to worry everyone, but I think it's time." The children look to her as she walks and says, "When I was on the phone to NASA this morning [pause]. The reason I was on the phone in the car, was because they had some communication with Colin and Cousin Robin and their supplies [pauses]. And today's the last day." Astronaut (Teacher) Patrick says, "So we have got to go?" Astronaut (Researcher) Ruth replies, "Yes we have to go today. NASA did recognize that we can work as a team. They have recognized that our prototype is incredible. Our science knowledge is [pauses]." Astronaut (Teacher) Patrick finishes the sentence, "Not good." Astronaut (Researcher) Ruth responds instantly, "No! It is very very good. It is strong." Astronaut (Teacher) Cassandra says, "It launched." Astronaut Simon says, "It crashed (referencing the pilot launch)." Astronaut (Researcher) Ruth looks to Astronaut (Teacher) Cassandra and asks, "Cassandra, do you have some of those revisions? The equations and calculations for our revisions that NASA sent us to help us?" Astronaut Francine taps Astronaut (Researcher) Ruth and inquires about the new calculated launch, "But we are going to crash." Astronaut

> (Researcher) Ruth responds dynamically saying, "No no, we will not crash because NASA has shown us what our current situation is, and in teams we can make the revisions."

Astronaut (Researcher) Ruth amplified the imaginary situation. She brought the children back to the urgency of saving Cousin Robin. Consistent across the data set was the amplification of the problem in the imaginary play situation. The examples from the data set collectively suggest that the play problem that arose was personally meaningful to the children. Engagement in the play problem enacted in the imaginary situation of Mission Control—looking at simulations of the rocket launch—supported opportunities not only to explore the play problem but also to hear mathematical language in a meaningful context. Although teachers set up the imaginary situation through the story and the drama of the play problem, the children appeared engaged in this process, which was also evident when they directed the NASA mission with their designed solutions (e.g., figure 3), when they designed their own imagined space suits, and when they collectively became astronauts in the rocket (the playground frame was used as a rocket) helping Cousin Robin and later Colin. In line with the children's social situation of development, the problems that arose in the imaginary situations needed to be solved for the play to continue.

Discussion

Our study sought to understand the role of imaginary play in the conceptual learning of children. Imagination appeared to resource the children's learning of concepts. The results showed that children brought into the collective imaginary play a system of concepts for solving the problems that arose in the narrative of the Conceptual PlayWorld. For example, we saw how imaginary play of Astronaut Mitch established that, in the imaginary play, the number of boosters—with their combined mass and under the conditions of earth's gravitational force—could not create the propulsion needed for a successful rocket launch.

The study found that the imaginary situation acted as the glue for bringing together the learning of concepts over time. Rather than one-off sessions focused on a particular mathematical concept (see figure 1, column 2), such as time, in which events and days of the week were recorded as Pancake Tuesday or on a calendar, the imaginary situation built a narrative that matured from lesson to les-

son. For example, when children prepared for space travel—designing space suits, preparing rocket prototypes, and calculating their rocket launch—they worked with the concept of time and space. Significantly, the study identified that the imaginary situation began with a play problem, and the one-off session began with the concept. The content analysis of the concepts and how concepts were introduced to children revealed imagining over time within the classroom and the possibilities for imaginary play to support conceptual learning as part of children's schoolwork. This aligns with the mathematical play world study of Li and Disney (2021) who used the narrative of a children's book to show how to link a problem situation from one preschool session to another in ways meaningful to young children.

Our results also show that, in imaginary play, children are motivated to learn mathematical concepts. The teachers recognized that children's social situation of development and leading activity was play. The children were highly invested in the play problems that arose, because they wanted to help the characters involved, and this meant drawing on concepts to solve the problem. For example, the children drew maps and used directional arrows to work out flight plans (figure 3) for their rocket so that it could navigate to the far side of the moon and rescue Cousin Robin. The teachers added more problems over time, such as Colin traveling to the moon in search of Cousin Robin, but landing on the near side of the moon. With two destinations to plan for, the complexities of the earth's rotation and the moon orbiting the earth, meant bringing in new mathematical concepts of percentages of oxygen and doubling and tripling fuel calculations in relation to the number of launches needed. The play problems created the drama that in turn drove the need for learning the concepts. The problem was successfully resolved using mathematical concepts in the collective imaginary situation. This resulted in motivated conditions for learning. The finding builds on studies working with the premise that curiosity and wondering emerge from materials (Cheeseman 2019) and the need for adults to notice children's wonderings (Cheeseman, McDonough, and Golemac 2017). In these studies the drama of the problem acts as the motivating force, which we believe is currently missing in the inquiry-based learning described in the literature (Sullivan et al. 2021). Relevant are the writings of Watt, Carmichael, and Callingham (2017), who in citing Eccles (2016) and others discuss emotional engagement in mathematics. Emotional engagement has been shown to be positively associated with student achievement, notably through deeper learning and adoption of self-regulated learning strategies. Enjoyment and interest in the learning

tasks are typically associated with emotional engagement (Watt, Carmichael, and Callingham 2017).

Overall, we can argue that a shared intellectual space was developed through the collective imagining of the children and the teachers. That is, the imaginary play created a physical and intellectual space where children and teachers shared in a set of authentic mathematical problems. Under the conditions of a Conceptual PlayWorld, the role of imagination in the learning of mathematical concepts appears to be foundational. The results of the study suggest that imaginary play appeared to act as an important source of children's development of imagination and mathematical thinking. But, without further research, the digital observations of behavior and children's drawings can only suggest this outcome. However, the suggestion is in keeping with Vygotsky's (1966) premise of imagination developing during early childhood through play and that the emergence of logical memory and abstract thought occurs for the school age child through the development of children's imagination.

The findings of our study are also consistent with the outcomes of research by Bodrova and Leong (2019) using their Tools of the Mind program to support teachers to create conditions for the development of children's play. There too, imaginary play acts as the source of children's development to support learning. Seen in the context of an increasing "play deficit" in the United States, their training program makes an important contribution to understanding the relations between play and learning because it offers developed forms of play, supports children's play actions and coregulation with props such as play plans, and enriches children's play experiences through excursions and incursions. The results of our study also support these findings and show their relevance for an Australian context. However, we need further research into how Conceptual PlayWorlds supports the interconnections between imaginary play and children's conceptual learning so that policy makers have more evidence of the value of play for learning and teachers have resources to support them with maintaining play as foundational for learning.

Conclusion

The current historical and political call for greater cognitive content in kindergartens brings new challenges to teachers who support play-based learning. Bodrova and Leong (2019) argue that in the United States, "It has grown

harder and harder to persuade school administrators and even some classroom teachers that learning through play is the right kind of learning—and often the best kind of learning—for young children" (37). Similarly, Clerc-Georgy and Martin (2022) argue that in French-speaking schools in Switzerland, free play and collective learning are disappearing in the first years of school in favor of printouts taken from workbooks or downloads from the Internet. The results of our study into how children and teachers in the first two years of school experience the play-based program of a Conceptual PlayWorld, with its focus on the dual development of children's imagination and conceptual learning, offers an alternative for administrators and governments.

We know that governments generally want children to learn the concepts detailed in curricula. But in Australia policy makers understand less well how this can be done through children's play for the foundational year of school. Traditional views of child development that emphasize the age of the child are mirrored by age-related and compartmentalized curriculum knowledge is (e.g., Australian Government 2022). But, a cultural-historical conception of development gives a different kind of reading of child development. Theorized play acts as a source of a child's development and as their leading activity in kindergarten. The development of imagination results through rich play experiences (Vygotsky 1998). As we argue through our research, a Conceptual PlayWorld supports the imagining of complex concepts found in mathematics and science curricula. This paper, then, speaks directly to system level policy makers by showcasing that concepts can be embedded in imaginary play to support children's development and that children can experience mathematical situations as they solve play problems through imagining solutions.

The results of our study also speak directly to teachers who are interested in evidence-informed practices that maintain play-based programs and in responding to government demands for the learning of concepts detailed in the curriculum. Our study found that in a Conceptual PlayWorld of the Secret Garden, the children embodied the drama of the play problem of helping Cousin Robin. We saw through children's play actions as astronaut characters with their play partners (including teacher astronauts) in Mission Control how they imagined their visual field to be something else. Vygotsky (1966) has theorized that through imaginary situations children free themselves from situational constraints and change the meaning of the objects they see—such as when a classroom becomes Mission Control or when the outdoor climbing frame becomes NASA's rocket launch pad. Vygotsky (1966) also suggested that in imaginary situations children

can act and think more consciously, conceptually being a head taller than themselves, as seen in our study with the drawing of flight plans for a rocket launch to solve the problem of how to rescue Cousin Robin on the far side of the moon. We found that the imaginary play of the Conceptual PlayWorld offered these possibilities to children, and we determined that when children express their solutions to the play problems (such as when Astronaut Mitch talked about why the rocket launch failed), their everyday language finds support from their teachers in character using the language of mathematics and science. In other words, the imaginary play was collectively experienced and, in this play, the children had in their environment mathematical and scientific language to enrich their everyday expressions. This is consistent with Vygotsky's (1994) conception of that which you wish children to develop must already be in their environment from the very beginning: In our study, this was made available by the teachers when acting as play partners. As argued by Vygotsky (1966), play creates this zone of proximal development.

Vygotsky (1998) also showed that learning is the dominant motive when children begin school. This has direct relevance for understanding how the development of imagination conditions the development of memory as presented by Vygotsky in his theory of periodization in child development. As Clerc-Georgy and Martin (2022) state, imaginary play "facilitates the distancing of immediate perception and the development and use of memory, thus allowing the development of the ability to act in a manner that is both conscious and voluntary [abstract concepts: system-bound, decontextualized and symbol-mediated thinking]" (8). Van Oers (2012) shows this through the context of an observation of a six-year-old who draws a train track, using only lines to represent sleepers and declaring, "I don't draw them all, it goes on like this." Van Oers writes that this etcetera act "is an act of imagining new instances that enables people to see the continuation of a series without having to show all the individual instances per se" (151). He says, "Abstract thinking is often an act of imagination" (151). Our study has shown how, under Vygotsky's (1998) theorization of child development, in school play the development of a child's imagination resourced the child's development of memory. For example, in Mission Control with its imagined but authentic problem of the failed rocket launch, we saw everyday words used by Mitch to explain his conception of the problem of propulsion, thrust, and weight. Imagining the problem gives possibilities over time for Mitch to take up the conceptual meaning of mathematical and scientific terms introduced in the play

by the teacher astronauts. There, in the hearing of terms used to explain the imagined problem, we suggest that this supports the development of memory, because Mitch hears these terms when trying to solve the problem and because these imaginary play moments are emotionally charged and dramatic. This is consistent with a cultural-historical conception of development in which the environment has a "unique influence on pupils as it is refracted by their interpretations and emotional valorization of the situation" (van Oers 2012, 142). In a cultural-historical view of child development, the social situation of play and the child's leading activity to play are always theorized in unity as their social situation of development. Conceptual PlayWorlds created new pedagogical conditions in the school where both leading activities were acting in unity. That is, in a Conceptual PlayWorld, the children needed to work within a system of meaningful concepts when engaged in imaginary situations, and this in turn appeared to nourish their play intellectually and to support learning. In conclusion, we suggest that play acts as the source of children's development of mathematical thinking and that imagination appears to be foundational for supporting the development of mathematical education in the first years of school.

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