Balancing play and science learning: Developing children's scientific learning in the classroom through imaginary play

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Abstract

Models of teaching of science in the early years such as Discovery learning, Process approach and Guided Enquiry often begin with consideration of the science concept. But what if we want to begin with children's play? In this paper, we will look at a model of teaching science that begins with imaginary play. Through a case example of children playing being characters in the story of Robin Hood of Sherwood Forest, we explore how imagination in play supports imagination in science. The model presented is called a Conceptual PlayWorld for the intentional teaching of science and was developed from ten years of research in Australian early years settings. The five characteristics that make up a Conceptual PlayWorld are: selecting a dramatic story; designing an imaginary space; planning entry and exit; planning the science problem; and considering the role of the teacher. The pros and cons of beginning with the science concept or beginning with children's play are explored, together with a discussion of how to balance play and the learning of science in the early years.

Keywords: Play, science learning, early childhood, Conceptual PlayWorld

Introduction

Young children are curious about their world and express their wonder through active exploration and play. Evidence of this can be seen when children are outdoors digging for treasure, acting 'as if' archaeologists. Harnessing this active exploration and motivation for play to bring forward science learning is the goal of early years and primary teachers. But how do we do this in a way that preserves the child's desire to play, while systematically deepening their explorations to support science learning?

This dilemma can be split into questions about starting points and models of teaching, which will then be considered in turn:

1: *Do we plan in relation to everyday exploration and thinking that attracts the attention of the child, or do plan with science concepts in mind?*

2: *Do we draw on models of science teaching that begin with play or do we use a model that is oriented more to the science concept?*

Starting points for children's thinking in science

A synthesis of longstanding research into children's thinking in science across the globe (O'Connor, Fragkiadaki, Fleer & Rai, 2021) shows that studies either focus on the phenomenon, such as how a spinning top works, or the concept, such as what is the physics that keeps the spinning top moving?

Balancing play and STEM (Credit: Lara McKinley).

The former brings in children's interests in things in their everyday lives, such as their toys, whilst the latter is more oriented to planning for the scientific concept. Two examples of phenomena and their associated science ideas are shown in Table 1. The key question arising is: do we begin with the phenomenon or do we begin with the concept? There are many scientifically oriented phenomena

Table 1. Do we begin with the phenomenon or do we begin with the concept?.

The phenomenon that is of interest in the early years	Science topic	Children's ideas: What very young children might think
Rainbows (Siry & Kremer, 2011)	Light (e.g. Ravanis, Christidou & Hatzinikita, 2013)	Young children think about darkness rather than light. Being bathed in light during the day means that children do not notice the light. Some children think that beams of light are emitted from their eyes (often depicted in cartoons). Children do not necessarily think about the light going in straight lines, that it can be blocked (shadow), reflected with a mirror, absorbed by a dark surface or coloured cellophane, and refracted (rainbow).
Spinning top (Samuelsson, 2018)	Force (e.g. Klaar & Øhman, 2012)	Stored energy as we see in the spinning top, and the forces acting that bring the top to a standstill. Children experience force as they slide quickly down an icy slope. Children do not think about all the forces acting to stop motion, or when it is equally balanced (object is at equilibrium), such as when something is stationary.

Table 2. What are the pros and cons for beginning with the phenomenon or the concept?

Beginning with the phenomenon		Beginning with the science concept	
Pros	**Cons**	**Pros**	**Cons**
Connected to the life of the child.	Is more difficult to transfer the knowledge of the phenomenon to other contexts.	Big ideas in science give explanatory power to children, are predictable explanations, and can be used in different contexts.	Science concepts are complex, and focusing on concepts may not be personally meaningful to the child.
It is of interest to the child and therefore the child is more likely to want to understand the science that explains the phenomenon.	The science to explain the everyday phenomenon may be too complex for early years.	Having knowledge of scientific concepts helps children to navigate their world and make scientifically informed decisions.	The concept might not be relevant to the cultural community in which the child lives.

Jumping into the story (Credit: Lara McKinley).

that are of interest to young children and these can be brought into the learning of science concepts. Table 2 (on p.14) gives a snapshot of the advantages and disadvantages associated with making a decision about where to begin.

Models of teaching science in the early years

There are many ways of teaching science in the early years, such as:

1: Discovery learning: Provision of materials for self-learning, separate to the teacher, such as a science table or display in a pre-school

2: Process approach: Development of scientific skills, such as observing, classifying, inferring, etc. For example, giving children hand lenses and inviting them to observe something specific, such as a seed.

3: Guided enquiry: The teacher guides the learner while giving some aspects of decision-making during the enquiry process to the children: for example, setting up a problem for small groups, such as how to make dirty water clean.

4: Conceptual PlayWorlds for the intentional teaching of science: Creating an imaginary play situation where problems arise, which draws on specific conceptual knowledge from science, technology, engineering and maths (STEM) to keep the story narrative going, such as in the story of Robin Hood, who needs help with getting into the castle but does not know about the mechanics of drawbridges.

If we consider the spread of pedagogical models of play and science learning that already exist in the early years' and primary classrooms, they can be represented as shown in Figure 1. This figure shows, on the far left side, children's play activity that is not oriented to science. On the far right side is represented science learning where no play is featured. The graduations between these two extreme ends show either more play activity or more formal learning of science with minimal play.

In the early years, children engage with others and their world through play. Spontaneous play and exploration (left side of Figure 1) may not result in deep science learning. For example, in discovery learning, placing magnets and a range of materials on a science table may lead to children thinking that cold things are attracted to magnets.

In the more recently developed models of teaching science in the early years, such as guided enquiry or Conceptual PlayWorlds for intentional teaching, both play and learning are considered. We will look at two case studies from the perspective of the continuum of play and scientific thinking using science concepts.

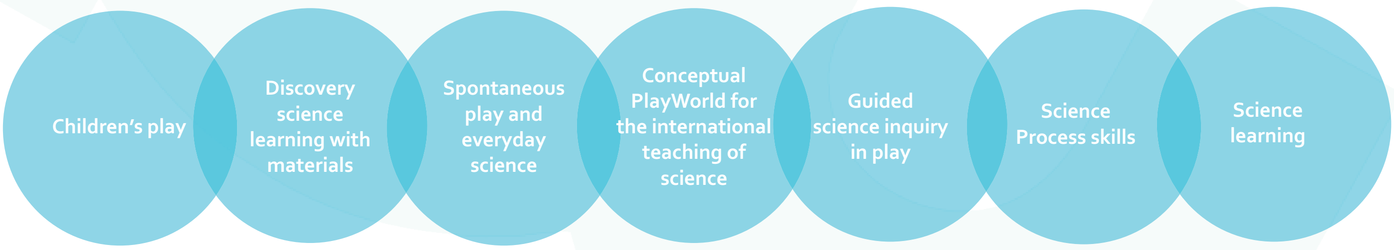


Figure 1. A continuum between play and science learning – where do you sit? (Figure 1 copyright Conceptual PlayLab).

Case example of forensic science – beginning with the concept

Howitt, Lewis and Upson (2011) used a guided scientific enquiry model that began with science concepts. They introduced forensic science to early years children by leaving footprints in the classroom and inviting children to work out who left them.

Their planning was stepped as follows:

1: Determining guided scientific enquiry process.
They worked with these guided scientific enquiry process skills:

- Students ask questions;
- Students are actively involved in finding answers to their questions;
- Exploring and investigating phenomena through using materials; and
- Making observations and developing explanations.

Focus	Learning activity	Making connections	Science process skills
Lesson 1: Discovering bear footprints in the classroom.	Who left these footprints? An evidence board is prepared.	Make cutouts of own footprints and compare those to the footprints found.	Making comparisons – my footprint is smaller/bigger.
Lesson 2: Planting fake fur around the classroom.	Using gloves, tongs and ziplock bags, children find and bag the evidence.	Class code pictograph is prepared, and children categorise hair colour.	Making comparisons – compare and discuss.
Lesson 3: A messy pawprint is found (honey is on the print).	Using cotton buds, the children take samples of the messy substance.	Children make own fingerprints using inkpads and paper.	Observations – using magnifying glasses, the children look at their fingerprints.
Lesson 4: Who left the evidence?	Children look at the evidence board and draw pictures of who they believe left the footprint/fur/messy pawprint.	Children plan an investigation. The research question was 'What foods can we make fingerprints from?'	Using evidence to make predictions.
Lesson 5: Undertaking an investigation.	Children carry out the investigation previously planned. Visiting the outdoor area as a group, going on a bear hunt and finding more evidence. Then finding a bear cave and discovering a note from the bear.	Fruit is placed on to 5 plastic sheets. The children press their fingers onto the fruit and then onto a plastic sheet to leave a trace. Children look at the fingerprints using magnifying glasses. Using a worksheet, the children match the fingerprints to the fruit.	Observations – using magnifying glasses, the children look at their fingerprints. Use observations as evidence. Represent and communicate their results.

Table 3. The plan for the forensic science programme studied by Howitt, Lewis and Upson (2011).

2: Understanding the principles of forensic science. They determined that forensic science involved:

- Application of systematic scientific process and knowledge to a legal problem; and
- Every contact leaving a trace (e.g. fingerprints, hair, fibres, soil, pollen, etc.).

3: Making connections between everyday ideas and scientific concepts within the forensic science programme. This is shown in Table 3, Column 3:

Part of guided scientific enquiry is the teacher supporting the children as they try to make sense of the phenomena under study – such as the principles of forensic science. The beginning point is the science enquiry skills and the science concept.

Case example of Robin Hood of Sherwood Forest – beginning with imaginary play

The second case study example begins with children's play. The context of the play is introduced through a book or storytelling, where problems arise that need scientific solutions. For instance, the story of Robin Hood from Sherwood Forest sets up social problems of poverty and the need to retrieve the treasure from the castle and redistribute the wealth to the villagers. Creating an imaginary situation by being players in the story of Robin Hood, and meeting problems during the play – such as how to get the drawbridge up – drives the children's play and amplifies the science learning opportunity.

The Conceptual PlayWorld for the intentional teaching of STEM involves five characteristics

Selecting a dramatic story (Credit: Lara McKinley).

that are thoughtfully planned and implemented. They are shown in Table 4. Developing children's imaginary play (Robin Hood) and imagination in science (how to get the treasure out of the castle) is supported through the five characteristics of a Conceptual Playworld for learning science (simple machines and how they work). The imaginary play situation can last a morning, or it can take place over a whole term. This example of Robin Hood took a full term.

Characteristic	Details
1. Selecting a dramatic story	The story of Robin Hood was selected because it is full of drama and excitement – social problems arise because children want to help the villagers, who are poor. There are many different kinds of adventures (chapter books) or storylines that children or teachers can introduce so that the imaginary play situation can be dramatic and last for days, weeks or even months.
2. Designing an imaginary play space	The outdoor area with its play equipment becomes Sherwood Forest. The climbing equipment becomes the castle, where a drawbridge with a double pulley can be secured.
3. Planning the entry into the Conceptual Playworld	The fort becomes the time machine that takes the children back into the time of Robin Hood. Entry into the time machine has a countdown and children are taken back in time. Children return to the classroom through the time machine.
4. Planning the problem that needs science concepts	**Problem 1:** How to get into the castle to rescue the treasure to give back to the villagers who are starving. **Research:** Find out how drawbridges work. Make prototypes of castles and drawbridges. Study *YouTubes* about the science of drawbridges. **Problem 2:** Designing an escape plan to quickly escape and then to hide in Sherwood Forest. **Research:** Look at Google Earth to see castles, the children's school, their neighbourhood. Parent shows the children how to draw from a bird's eye view, front view, cross-sections – to help them design their plans. Look at books containing pictures of castles with cross-sections. **Problem 3:** Friar Tuck goes into the time machine and visits the children, carrying a letter from the Dragon who is stuck in the dungeon and needs help. **Research:** After visiting the Castle Engineer back in time, the children plan a simple machine to use to retrieve the treasure. Children look at *YouTubes* of cranes, and the science surrounding cogs and wheels. **Problem 4:** How to design a simple machine to retrieve the treasure. **Research:** The children use a pulley system, role-play being links in a chain, cogs and wheels, and make, with support, a prototype of their simple machine.
5. Planning the role of the teacher	The teachers are characters in the play, taking on a role and role-playing together with the children. Sometimes they ask for help, sometimes they give help, and sometimes they do things equally together. The different roles allow the educators to model or support the asking of questions, the investigation process, predicting, planning and trying out ideas, gathering evidence, discussing the evidence, presenting and communicating their ideas, etc.

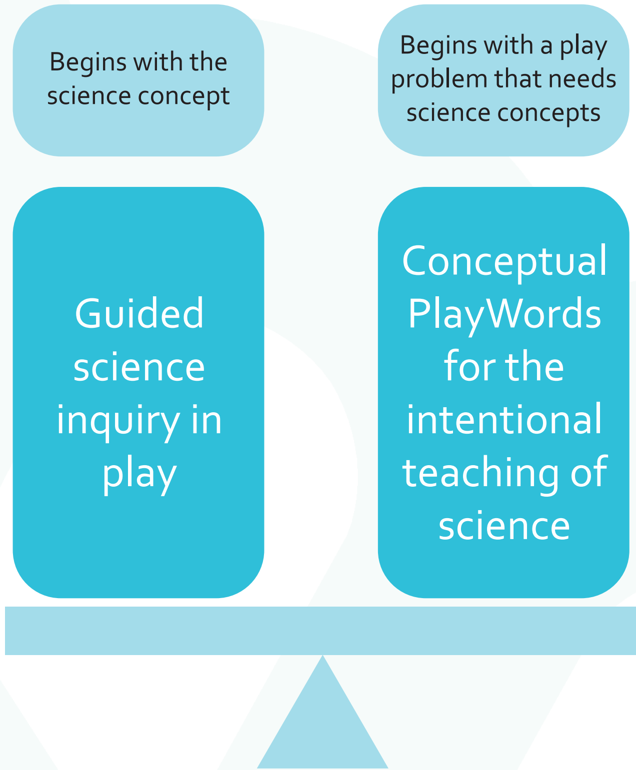
Planning a Conceptual PlayWorld for the intentional teaching of STEM (Fleer, 2020).

Table 4 shows how imaginary play is used for the teaching of STEM concepts. For the children's play to continue, they need to do some research. They take back into the play their ideas, such as their escape plan, which they take to the Castle Engineer for advice. Similarly, children take their hand-held devices and record how the castle drawbridge works, and then return with their data to the classroom, and discuss how to build a prototype of a drawbridge. As the children learn more about drawbridges, simple machines and design drawing, their play is enriched with science in the imaginary Conceptual PlayWorld of Robin Hood. Further examples are shown as videos in the resource list below.

Conclusion

In this paper, two case studies of science teaching were presented. One approach began with the science concept and the other with children's play. Table 5 presents some pros and cons of both ways into science learning. Figure 2 invites you to consider the balance of play and science learning in your programme.

Figure 2. An invitation to consider the balance in your context for beginning with a science concepts or beginning with children's play.



As teachers, we need to make decisions about what approach will work best for the particular children and the setting that will draw on individual pedagogical beliefs about how children learn and develop. For example, in providing opportunities for a child to go outside and look for slaters (woodlice), they are building ideas of the play area as a habitat, looking for a species under its food source of rotting logs. In this example, the child has built a rudimentary relational model of a core concept of an ecosystem (habitat – structural features of a species – food source). This is the kind of scientific thinker that we hope will emerge in the early years.

This paper invited you to consider how to preserve the child's wish to play and systematically deepen their explorations for the learning of science concepts. We investigated beginning with the phenomenon, a play problem or the scientific concept. There are many pros and cons associated with making decisions about teaching and learning

Beginning with play		Beginning with the science concept	
Pros	**Cons**	**Pros**	**Cons**
Children are highly motivated in play. When they want to help the character to solve the problem, they are really in tune with the science concept.	Children may not be interested in bringing science concepts into their play.	The science concept and the process skills drive the learning activities. There is more confidence that the science is being covered.	Children may not be motivated to focus on the science or the process skills.

Table 5. What are the pros and cons of beginning with the play or the concept?

in science in the early years. What is key for effective learning is planning a programme that brings to children not just scientific lenses for understanding their world, but a passion and motivation for scientific activity and thinking.

Further information and resources

Go to the project website for a wide range of examples and supporting materials, including a planning proforma to design your own Conceptual PlayWorld for the intentional teaching of science: https://www.monash.edu/conceptual-playworld/early-childhood-educators/playworld-starters-for-educators

Early years in school: The Secret Garden

Overview: https://youtu.be/Uou55FDiu88
Characteristic 1: Select a story: https://youtu.be/_fZ2PVNQaDY
Characteristic 2: Design the space: https://youtu.be/ArS_-F-EoVw
Characteristic 3: Plan entry and exit: https://youtu.be/kXykFMxeKUA
Characteristic 4: Plan the play inquiry: https://youtu.be/NtVrL2x_6OM
Characteristic 5: Plan teacher interactions: https://youtu.be/S47u8W5r4jU

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