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Multimodal interaction for science learning in preschool: Conceptual development with external tools across a science project

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ABSTRACT
This paper studies the scaffolding of conceptual development for children aged 4–5 years old during a science project at a Swedish preschool. It specifically examines how bodily knowledge and language are used in interaction, and how conceptual knowledge can be scaffolded with the use of external tools and artefacts. The science project was tracked for seven weeks and the analytical focus is on situations where a computer and a projected screen are used. The study shows how interactions afforded by the setup provide a virtual-physical setting where teachers and children can interact using both language and bodily modes. As such, it provided an interactional space where teachers can scaffold children’s tactile understandings towards conceptual knowledge by building on the children’s prior experiences, and knowledge is cumulated over time during the project. This is accomplished by focusing attention on the topic and through the use of tools in interaction. Possible implications and uses for early childhood education are discussed in the light of these results.

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Conceptual development; early childhood education; affordances; digital tools

Introduction
The aim of this paper is to study scaffolding of conceptual development for preschool children during a seven-week period of a science project at a Swedish preschool. It specifically studies how children aged 4–5 years develop knowledge out of their tactile understanding of phenomena, and how this is scaffolded into a conceptual language in interaction with teachers and external tools and artefacts.

The project was initiated by the teachers of the preschool as they saw a way to use the children’s interest in a commercial spinning top toy, a collectible based on a Japanese animated video serial, called Beyblade. The teachers incorporated the children’s interest in the spinning top in a project about spinning. This project can be viewed within the background of the curriculum that states how children should: ‘develop their understanding of science and relationships in nature, as well as knowledge of plants, animals, and also simple chemical processes and physical phenomena’ (National Agency for Education 2010, 10). While
this part of the Swedish curriculum stresses the importance of science in preschool, which in Sweden is state funded for children aged 1–5 years, other parts stress the additional function of preschool as a place for caretaking. This model, sometimes termed ‘educare’, has been pointed out by Sundberg et al. (2016) as a reason why science education in Swedish preschools ranges from being almost non-existent to more elaborately arranged programmes. The science project of this study can be seen as an example of how teachers try to incorporate the careful consideration of children’s interests into activities that aim towards the curriculum’s science goals. The teachers do not have any further education in science teaching, other than the teacher education programme.

Another point of departure for this paper is the ubiquity of digital technology today. As children grow up, digital tools often play an integral role in their environment. They are used in play, to learn, and to form relationships with others (Ito et al. 2008). The children in this study are highly interested in knowing about the Beyblade universe, which they can stream through YouTube, and play with ready-made toys or self-constructed artefacts. Such external tools are a part of everyday practices, learning and development through external tool use have been a central theme in sociocultural research (Vygotsky 1978; Hutchins 1995; Schoultz, Säljö, and Wyndhamn 2001). Empirically, studies such as Palaiologou’s (2016) indicate that young children are reportedly learning through devices such as these from an early age, something that isn’t reflected in preschool practices. This study probes into how a computer and projected screen, very familiar objects for the children, might be used as external tools to develop children’s knowledge.

**Conceptual development through bodily modes and external artefacts in preschool**

**Learning through digital tools**

Learning with digital tools has been reported to be an underused potential aid in early childhood settings (Zevenbergen 2007; Palaiologou 2016). One reason for the cautiousness of implementing digital tools is the question of whether or not digital tools are good for young children’s learning. Reports from parents in Palaiologou’s (2016) study describe that children are learning with digital tools from a young age. While digital tools in preschools might present opportunities, researchers such as Edwards et al. (2017) remind us that the necessity of digital tools in preschool does not necessarily follow, and should not automatically be seen as a problematic ‘disconnect’ between children’s home and preschool environments.

Roseberry, Hirsh-Pasek, and Golinkoff (2014) note several findings in the developmental science literature that point to the ineffectiveness of passive learning from video, as compared to human interaction. However, they note that for interactive media, the results are different. They can provide ways for children to learn with the screen through social functions, such as joint attention, and in making children active in their construction of knowledge (Roseberry, Hirsh-Pasek, and Golinkoff 2014). This study is concerned with digital tools as part of teacher–child interactions and how they may aid this interaction. Schoultz, Säljö, and Wyndhamn (2001) have pointed to the centrality of external tools and artefacts as an auxiliary means whereby children reason and learn about science concepts. Children’s understanding can be scaffolded by teachers or more advanced peers in concrete activities in relation to artefacts around them that they are trying to make sense of. Fleer, Gomes, and March (2014) studied how teachers scaffold
science learning in preschool through affordances in the preschool environment. The researchers point out how artefacts provide learning opportunities when their physical properties might enable the exploration of a concept, e.g. how a tyre can permit children to explore force and motion, or how digital tools can provide representations of scientific concepts. Siry and Kremer (2011) suggest that these opportunities arise where children’s interests are aligned with a drive to understand the phenomena. Fleer, Gomes, and March (2014, 46) call this a ‘sciencing attitude’, where teachers see openings for conceptual learning in the objects in preschool that they affectively engage in with the children.

**Science learning through embodied interaction**

For this study it is not of concern whether children can learn science passively from digital tools or not, but rather how tools are used for learning within human communication in activities. Following Lemke’s (1990) studies on school science, science communication combines verbal discourse with other meaning-making resources, such as ways of observing, reasoning, argumentation and so forth – or in short, emerging ways of doing science. For children of preschool age, embodied experiencing is fundamental alongside the emerging verbalisation of knowledge. Siry, Ziegler, and Max (2012, 315) take the view that preschool ‘[c]hildren’s discourse science formats are not seen as something they have, rather they are what they do, and what they use as they interact with multiple modes in science-related activities’. They studied water-related science activities in preschool by looking at children’s interactions. They found that the children orient their discourse to the science activity format. Science discourse in their view is built up of speech along with the embodied use of other modes such as gesturing. Gestures and other embodied means of communication are of interest following Goldin-Meadow’s (2003) research showing that gestures are a part of conceptual learning, and might be used by teachers in scaffolding interactions. In this study it is also explored how this unfolds over a science project. Roth and Lawless (2002) also pointed out the key role of gesture in science learning, most specifically the use of deictic (i.e. pointing) and iconic (depicting) gestures, and saw that these can develop into, and together with, the emerging verbal language during science projects. Danielsson (2016) observed how teachers use spinning gestures to explain concepts during instructional activities, and noted how different modes affords that different aspects of phenomena to be explained. These embodied means are seen in Hvit Lindstrand’s (2015) study of how children explore spinning in front of an interactive whiteboard (a device similar to the one in this study) and in their interaction use their bodies to draw round objects depicting spinning.

Language is the modality of central importance in this study, both as an object of research and in that it is assessed by teachers according to the curriculum’s goals. Bruner (1986) distinguished between narrative descriptions as explanations, and paradigmatic or abstract accounts that are seen as fundamentally different in character through their detachment from the deictically ‘here and now’ discourse. Peterson (2009) studied children’s use of the language types identified by Bruner (1986). The teachers mixed different types of explanations and it is suggested that narrative explanations guide children’s experiential knowledge in the development of paradigmatic explanations. She concludes that teachers’ use of speech that includes paradigmatic explanations, true across events, over time can scaffold children’s abstract language use.
In sum, science learning in preschool concerns how experienced meaning of children develops into understandings that can somehow be explicated through the cultural means available. Similarly Vosniadou (2007, 55) asserts that conceptual development happens in ‘a constructive interaction with the world through a variety of mediated symbolic structures, some internal and some external, in rich sociocultural settings’. For the present study, how this can be done is explicated through the aid of external digital tools in a Swedish preschool’s science project about spinning.

**Theoretical framework: conceptual development through embodied interaction and languaging**

Conceptual development can be said to be inherently complex: it is concurrently a matter of experientially grounded understanding of phenomena, cognitive capacities, and the scaffolding of prior knowledge in sociocultural activities (Nelson 2007). As such, conceptual knowledge can be viewed as relying on both individual factors and the culturally accumulated knowledge that can be distributed among social, semiotic and material resources such as teachers, peers, artefacts, tools etc. (Vygotsky 1978; Hutchins 1995). Artefacts and resources in the environment afford action and promote learning opportunities based on their inherent properties in relation to the user (Gibson 1986), today not least through digital tools and software applications (Nardi 2015). This study examines what tools and artefacts may afford interactions between children and their teacher, and what potential for scaffolding this might yield.

Learning in this interactional and relational perspective in preschool can be deictically unfolded in proximal interactions. In ‘gesture space’ (Streeck 2009; c.f. McNeill 1992) participants can jointly attend to phenomena, events and objects to try and reach an intersubjective understanding of what is at hand (Tomasello 2003). The view of joint communication here is based on the assumption of languaging, that language is actively used by participants in interaction (Linell 2016), in conjunction with other modes. In interaction, this can be accomplished by participants orienting their bodily posture towards the attentional foci, through language, and through gestures that might be coupled with resources in the environment in a complex of modes (cf. Goodwin 2007).

In the didactic situation, teachers can use external means as an ‘attentional anchor’ so that material, semiotic and imagined tools and artefacts are used as a scaffold in the development of children’s understanding of a concept (Abrahamson and Sánchez-García 2016). In these interactions, prior experiences are attuned with the concepts promoted in the context in which children act. Here language is key as it ‘combines individual experience and shared knowledge’, and develops upon and through children’s embodied experiences (Nelson 2007, 221). Thus science-oriented language use or languaging can be seen as a key indicator of conceptual development in the analysis.

Thus, in this study conceptual development is seen as a function of both scaffolding interactions and how these unfold over time. Figure 1 illustrates the main components of how, in the didactic situation, scaffolding interactions can amass into conceptual knowledge over the course of the science project.

The model in Figure 1 illustrates the fundamental relation between teachers, children and the use of external tools. Adults and children naturally interact through both languaging and doing things in relation to the external world with its tools and artefacts. The
analysis below examines how teachers use this relation with children pedagogically to scaffold their knowledge, which may over time develop towards an abstract or paradigmatic conceptual understanding.

**Methods**

The ethnographic data collection was organised together with the preschool teachers, parents and children, in accordance with ethical guidelines. The preschool department consisting of 22 children was tracked for seven weeks with visits at intervals on scheduled project days. The main tool for data collection was informed by visual approaches in ethnography (Pink 2015), and consisted of audio-visual observations and field notes. During the observational period, a wide range of activities related to spinning was observed and it should be noted that the science project took up considerable time during the weeks it ran, allowing the children to experience, reflect and communicate about spinning in various ways.

The selection of samples from the data for this paper was guided by Roth’s (2005) notion of ‘zooming’ and ‘focusing’. A way to capture both the larger sociocultural patterns of Swedish preschool, how the science project fits into this and at the same time ‘zooming’ in on detail in close analysis of didactical situations studied in-depth.

During initial analysis, all language and gestures in the data related to spinning in both formal and informal situations were coded in nVivo. Through this initial analysis, a shift during the seven weeks towards verbal language use, and more paradigmatic language use related to the concept of spinning among the children was noted. Informal interviews with teachers confirmed how this was in line with their views of the curriculum’s science goals.

Situations where digital tools are used have been purposely sampled for the interests of this paper’s aims. The examples, or *didactic situations*, should as such be viewed as focal situations, important for the science project where prior understanding is scaffolded into new potential understanding, and should be seen as important events that are amassed as conceptual development occurs over time.

The examples in focus have been sampled from two phases of the seven-week observational period, one early and one late phase. They have been analysed with an

![Figure 1. Visualisation of the theoretical model. A main outline of how didactical situations may lead to conceptual development over time.](image-url)
understanding of interactions as fundamentally multimodal. It is understood that actions are ‘environmentally coupled’ (Goodwin 2007), because actors combine linguistic and bodily modes, artefacts and properties of the environment around them to attain joint attention and possible co-construction of knowledge in interaction (cf. Tomasello 2003; Nelson 2007). In line with the theoretical model (Figure 1) it will be shown how teachers set up situations using the computer-projected screen to scaffold conceptual language and over time to move from narrative to more paradigmatic language (cf. Bruner 1986), which is also in accordance with the curriculum’s science goals. A multimodal transcription inspired by Goodwin (2007) has been used to highlight how language, bodily resources, and tools are combined to carry out these interactions.

Analysis

During the project the children are engaged in myriad activities where they somehow can experience or refine their understanding of spinning. As in the Fleer, Gomes, and March (2014) study, preschool provides different ways for children to experience concepts. The examples used in this paper should be seen as embedded within this project where the preschool provided continual experiences of spinning for the children.3

The analysis is divided into two main sections, one consisting of two examples from an early phase of the observational period and one section with an example from a late phase. The three examples presented highlight how the teacher scaffolds children’s communication by ‘anchoring’ attention to the external tool (cf. Abrahamson and Sánchez-García 2016), thus allowing the use of the affordances in these situations. The first two examples are centred on a projected photograph of former activity. The first example shows how attention is sustained by the teacher in interaction with the children and how the photograph promotes a narrative explanation of the past activity. The second example expands on how the children’s explanations are enacted through bodily modes, languaging and external tool use. It also shows how the attentiveness to all these modes of communication helps the teacher to expand the children’s explanations.

Since the analysis also aims to describe how the project develops over time, the third example, taken from later on in the project, displays a new range of paradigmatic language use by the children. The third example shows the teacher’s use of the semiotic universe of the animated series to get the children to display their knowledge in more abstract terms. In doing so, it illustrates the shift towards paradigmatic language terms that have developed over time during the project.

Early phase: examples 1 and 2

The following two examples, extracted from the same didactic situation during the early phase of the project, illustrate how embodied experiences of spinning that the children gather are turned into narrative explanations of the phenomena of spinning through the aid of digital images of former activities.

Example 1: narrative explanations with gestures of a past activity

A deep-rooted part of the local curricula in preschools in Sweden, even in urban areas, is to visit woods for outdoor activities. In this study, the teachers connect an outdoors activity
with the project by having the children bring artefacts to spin on different surfaces in the woods, and also to test the spinning properties of items found in the woods, such as cones and stones.

The teachers had documented one of these visits to the woods with a digital camera. Back at the preschool, photos are being projected on a large screen for the purpose of reflecting on spinning during the outdoors activity. On one of the images projected is a boy standing, ready to rotate and drop a wooden spinning top, made from a wooden board, onto another tree stump below him.

The use of a digital camera in the woods and the computer and picture-viewing application affords an external memory of the past activity. As such it also enables an interaction that supports narrative explanations (cf. Bruner 1986) of what the children did outdoors, how it happened, etc. The set-up also provides a resource for children to deictically interact in the gesture space (McNeill 1992) about the past activity and the phenomenon of spinning, to reflect and discuss it.

The setting is the playroom, and three children are sitting in front of the projection screen. The teacher operates the computer and is standing left of the camera position.

In Figure 2, two of the boys are focused on the pictures and one of them, Lucas, seems to be interacting with the screen and imitates the prospective motion of the boy in the photo, by twisting his own hand.

- The teacher addresses Axel, who is sitting to one side and seems less engaged – ‘Axel what do you think he will do with that board?’ This calls for attention (line 1).
Axel gazes at the teacher and responds ‘he will spin it’ (line 2).

The teacher counters with the question ‘in what way?’ (line 3).

Axel responds ‘on the road’ (line 4).

As this is unsatisfactory, the teacher prompts Axel by saying: ‘but look at how he stands and what he does’. She stresses ‘look’, and this coincides with Lucas, who has become increasingly involved with the screen, pointing to the spinning top of the boy in the picture (line 5).

Axel follows this up by walking towards the screen, and saying that ‘he will first take it up and then spin it down (...) throw it down’. The word spin is accompanied by the spinning gesture of his hand, and the ‘down’ is accentuated by a raised intonation, followed by the correction that he will ‘throw it down’ (line 6).

Lucas and Elias start this scene with their attention on the task of discussing the spinning during a previous activity in the woods. The teacher calls for the attention of the disengaged child, Axel, by calling his name and asking a question. A short answer like ‘he will spin it’ seems unsatisfactory and the teacher asks a follow-up question, prompting a more correct answer. She seems dissatisfied with Axel’s answer ‘on the road’, and redirects Axel’s attention with the word ‘look’. This command is accomplished together with Lucas’s deictic pointing at the screen. Axel follows with a more specific answer that ‘he will first take it up and then spin it down’, and this description is supported by a spinning gesture accompanying the word ‘spin’, and then a change in intonation on the word ‘down’, and a self-correction that the boy in the image might even throw the spinning top down.

In this example, the digitally projected photographs have enabled the teacher to reflect on an activity with the children. In other words, the digital tool here affords a physical-virtual setting where past activities can be projected for the teacher and children to jointly attend to. Not only do they reflect on spinning in narrative terms (cf. Bruner 1986), the teacher in interaction with the children makes an effort to direct their attention to the former task for reflection. This can be seen as an example of attentional anchoring (Abrahamson and Sánchez-García 2016), where attention to the subject of spinning fits in with the educational goals. The guidance of the children’s attention to the image provides a way to scaffold a narrative explanation.

In interaction, this is accomplished by the use of both deictic and iconic gestures, and the teacher can together with the children (as when Lucas points to the screen for Axel), focus attention to the topic at hand. This shows how the interplay of different semiotic modes is used in the co-construction of explanations. The children use gesturing and change in intonation to describe the phenomenon of spinning that is projected before them. As such we can see the unfolding of their experiences and knowledge gathered during this project is being enacted here, in which language as one mode of use is enhanced by others. In the next example we will look at how children’s explanations expand by doing and languaging in the physical-virtual setting of this room.

Example 2: attentiveness to the doing in narrative explanations

Figure 3 is from the same session as the previous example and took place shortly after the previous transcription; it is therefore presented as a continuation. In this excerpt the
teacher directs follow-up questions to Lucas, who has been the most attentive of the children during the session.

In addition to what the digital tool afforded in the last example, this excerpt will illustrate how the physical affordances of the room, language, and bodily modes are used in combination by the children to describe how spinning objects may work and how the teacher’s attentiveness to these modes allows scaffolding towards more expansive explanations.

- In Figure 3, the teacher calls Lucas’s name, making him shift his attention from the screen to her, and then asks ‘how do you think he will do with that?’ (line 7).
- Lucas answers that the boy will ‘throw it away’, and prolongs the words ‘it’ and ‘away’ as he slides his hand across the screen (line 8).
- The teacher asks for further explanation with the words ‘in what way?’, and even suggests that Lucas may use his hands to explain (line 9).
- Elias addresses this and says spin, and then in a louder voice makes the sound ‘WOUP’ as he spins his body with his arm out (line 10).
- Lucas continues to explain that the boy in the picture ‘throws it away’; the away is clearly prolonged, and is followed by another shout, ‘AAH’ (line 11).
Lucas then follows up his gesture by depicting the boy’s throw, as he says ‘also follow it after like this’ and drops his hands down the screen and depicts it bouncing to the radiator in the room, as if the spinning top had come off the screen (line 12).

The teacher uses Lucas’s name to call for his attention specifically, as in Figure 2. Lucas’s first answer uses the strategy of prolonging words to make clear what he thinks is happening and he then slides his hands across the screen. He is coupling the explanation with a deictic use of the projected image. The teacher asks for a more explicit answer, and may have picked up on Lucas’s use of bodily modes in his explanations, as she suggests that Lucas may use gestures. Elias joins this conversation, and to show how forcefully it spins, he uses his whole body to describe this as he almost shouts. Lucas uses his first way of explanation by prolonging the word ‘away’ and also raises his voice on ‘AAH’, as the imagined spinning top is thrown away. He then continues to use his hands and in that way answers the teacher’s question by explaining how the spinning top would ‘follow’ and he shows that it would fall down the screen subject to the force of gravity. Then he continues with his hands below the picture and out from the projected screen and shows how it would bounce on to the radiator below.

These explanations exemplify doing and languaging in children’s science communication. These multimodal explanations are environmentally coupled both in describing what happens in the virtual image and in being enacted in the physical room with the radiator. It should be noted that an attentional anchor can be material, semiotic, or even imagined (Abrahamson and Sánchez-García 2016), and as such the conceptual explanation is scaffolded by the photo and then enacted in the physical and imagined room (cf. Streeck 2009). As the boy is acting with his bodily and linguistic modes, he makes use of both the virtual and the physical properties that are situationally available to him, confirming findings by Siry, Ziegler, and Max (2012) that science in preschool is about ‘doing science’ as well as verbal discourse. When looking at this doing of science in detail, we can see how the teacher attends to the child’s embodied modes of communicating, and in turn requests more gestural explanations. In line with the dynamics of doing and languaging this is inherent in the teacher–child interaction in preschool, as studied by Goldin-Meadow (2003), and may manifest as conceptual development during the course of the project. The pedagogical goal for a project like this is to scaffold children to conceptual knowledge that is verbalised, i.e. paradigmatic language use. An example of what this can look like will be provided next.

**Late phase: example 3**

The third and last example is provided to show the pattern observed during the project that children used more verbal discourse related to spinning than in the earlier phase. The example illustrates how this is achieved with the familiar tool of the computer-projected screen and the use of the animated series as a mediating artefact.

**Example 3: developing paradigmatic language late in the science project**

In this final example, we will look at how a teacher uses a serial viewing session. The children are watching an episode of the Beyblade animated series streamed through YouTube. This is usually done as a leisure activity at the preschool. This time, however, the teacher is
using the external tool of the computer and the artefact of the serial in line with pedagogical goals. In this way, the serial becomes a didactic tool within this situation. It should be noted that this is at the end of the observation period and the project is in its later phase. With that background we can understand what the teacher requires of the children in relation to the aforementioned curricular science goals.

In the following example, the teacher uses a sequence which explains why one of the characters in the video series always wins its spinning top duels. It is reasoned that ‘a heavier blade [spinning top] is more stable’ (Figure 4). This paradigmatic explanation (Bruner 1986) seems to attract the children’s attention and the teacher goes on to use it. Thus, the digital tool and streamed video make it possible here for the teacher to focus the children’s attention on physical concepts related to spinning. The children’s use of conceptual language has been listed and printed in bold to the right of the transcript of Figure 5.

- The excerpt in Figure 5 starts out with the main sequence, which will be replayed by the teacher – saying ‘a heavier blade is more stable’ (line 1).
- The teacher is quick to pause the video and ask ‘why does that Beyblade win all the time?’ (line 2).
- Marco is the first child to come up with a suggested explanation, ‘cause he has really lots of Beyblade (.) his Beyblade spins really fast’, and to explicate that it spins ‘really fast’ he uses a gesture of both his hands moving spherically to accompany his words (line 3).
- The teacher’s prompt indicates that they, or he, have not understood (line 4).
- Alfredo gazes at and leans towards the teacher as he adds the conceptual word ‘heavier’ (line 5).
- The teacher follows this up with two questions: ‘and what happens when it gets heavier?’ and ‘what does it become?’ (line 6).
- Marco explains that ‘it stays there and fights’ (line 7),
- The explanation questioned by the teacher who asks ‘why?’ and replays the same sequence – ‘a heavier blade is more stable’ (line 8, 9).

**Figure 4.** This is a frame from the sequence of video that the children are watching on the projected screen. Here, the serial’s characters are doing an ‘analysis’ of why the evil characters spinning top is winning. This results in the explanation that a heavier spinning top is more stable. A sequence that the teacher and children notices and teacher continues to replay so the children can reflect on it.
Alfredo, once again, repeats the word ‘heavier’ (line 10).

The teacher re-uses the video’s explanation ‘it’s heavier and because of that it becomes more stable’, then she gets Michail’s attention, by using his name. As he gazes up at her from his spinning top, she asks ‘what does stable mean then?’ (line 11).

Michail repeats the word ‘stable’, then pauses and says that it means that ‘it’s heavier’ (line 12).

Theo, who has been sitting silently in a corner, constructing his spinning top, then looks up and adds to the answer that ‘when Beyblades are heavier then they have more force’ (line 13).

The teacher sounds satisfied with this answer: ‘yes you could say that they get more force (.) if they are heavy then they don’t break as easily’ (line 14). The children thereafter continue to watch the video.
The teacher wants the children to understand the concept that a heavier spinning top is more stable, as the character in the video sequence explains. She uses the pause button on YouTube and the interface to replay the sequence. She turns the video’s explanation into a question for the children, a question that Marco tries to answer by saying that it is spinning really fast, and using an iconic gesture, as he has been observed doing throughout the project. However, this is at the end of the project. The explanation that it is just ‘spinning fast’ and a gesture is not a satisfactory answer for the teacher. Alfredo notices the conceptual word ‘heavier’ from the video series, and imitates it for the teacher. In return, she continues to ask why it happens and what it will become. Marco explains that the Beyblade will stay and fight, but the teacher requires another level of explanation. She replays the sequence again, and once again Alfredo answers that it’s heavier. The teacher reformulates the video’s explanation, and then turns to Michail to ask what stable means. Michail repeats the word, and thinks for a while, and then gives the same explanation, that it is heavier. The teacher is not given time to question this answer as Theo continues to elaborate that when Beyblades are heavier they have more force.

Throughout the example, the children use conceptual language, either through imitating the video or using concepts unheard in this session (‘fast’, ‘force’). The children’s explanations move towards increased abstraction, from an explanation that the spinning top is ‘really fast’ and gesturing, to the use of the concept ‘force’. The explanation provided by the children in this example evolves into it being stable when it’s heavier, and when it’s heavier it has more force. It seems that the video, used actively by the teacher, affords an opportunity for her and the children to talk about concepts that are relevant in the Beyblade universe with sustained interest. It can be viewed as an example of how children’s interest and the pedagogical goals meet (cf. Siry and Kremer 2011). What unfolds is the use of the video as an attentional anchor (Abrahamson and Sánchez-García 2016) in another semiotic world than their own. When the children are attentive, a didactic situation can unfold where the teacher can further the dialogue, and successively make them reflect on the animated series in more conceptually conscious terms.

Discussion

This paper has been based on an assumption that teachers may scaffold conceptual language for preschool children by interacting with them in the use of external tools (Vygotsky 1978; Hutchins 1995). Throughout the examples, the external tools and artefacts presented are used by the teacher as attentional anchors (cf. Abrahamson and Sánchez-García 2016) for the topic. This can be a way to harness the semiotic worlds of the children and, as with Siry and Kremer (2011), be viewed as alignments of children’s interests and educational aims, here creating affordances for conceptual development.

As the project progresses, there is a move towards increased abstraction or paradigmatic explanations, as in Peterson’s (2009) study. The interactions involved in this scaffolding are shown to be complex as they blend the children’s playful and tacit knowledge about spinning with dialogues using more abstract concepts. This confirms the conclusions of researchers such as Lemke (1990) and Siry, Ziegler, and Max (2012) that preschool science discourse is as much about doing as talking. A key component of the interactions is the use of gesture and bodily resources by children to approach the concepts (cf. Roth and Lawless 2002; Goldin-Meadow 2003). The multimodal nature of science
learning and the use of language and bodily modes are present in all of the examples, and this is reminiscent of Hvit Lindstrand’s (2015) study of spinning. Here, however, the teacher may intentionally interact to afford development of paradigmatic explanations over time, thus combining ‘individual experience and shared knowledge’ (Nelson 2007, 221) in pursuit of children’s conceptual language use and development.

Teachers use the affordances (Gibson 1986) offered by the tools in didactic situations that strive towards the curriculum’s goals. The tools are used not only as mediators of the concepts but also for their interactional possibilities, and provide a space where children can bodily enact their knowledge in front of the image on the screen. This is done in multimodal ways that illustrate how interactions unfold in the ‘gesture space’, as conceptualised by Streeck (2009). It can here be noted, as with Danielsson’s (2016) study, that different modes can potentiate new ways for phenomena to be explained.

While affording learning opportunities for the children, the use of the screen in these cases seems to require continuous effort by the teacher to anchor the children’s attention (cf. Abrahamson and Sánchez-García 2016), perhaps requiring the ‘sciencing attitude’ of an engaged teacher (Fleer, Gomes, and March 2014). Moreover, this confirms the need for a capable social mediator when using the screen for learning (Roseberry, Hirsh-Pasek, and Golinkoff 2014), as the artefacts and tools do not drive development themselves, but might be used in a didactical way, in relation with a knowledgeable adult. This study offers support for the view that this effort provides opportunities for a supportive environment for children that may scaffold science learning.

Indeed, the situations under study in this paper are only a part of the experiences children have with the concept of spinning, as also shown by Samuelsson (2018). Edwards et al. (2017) contemplate how the digital tools only equate to a part of the total experiences children encounter during their day. Moreover, if artefacts and tools play an important role in science learning and reasoning, as claimed by Schoultz, Säljö, and Wyndhamn (2001), we may stress the importance of how such external means are used in interaction and in relation with the learners’ current knowledge, experience and abilities.

Considering the pros and cons afforded by the tool and application studied, in other cases it might also be critical for practitioners to be conscious of the learning opportunities afforded by a specific tool, application, and the content – and how to use them in the didactic situation. This is a necessary pedagogical reflection in a more digitalised world (cf. Palaiologou 2016), and this study might offer some hints on how science learning might be organised in a preschool context encompassing both physical and digital tools.

Conclusions

This study has explored ways that conceptual development for preschool children might be scaffolded. This relies on a fundamental interrelation between embodied doing, languaging, and the use of external artefacts and tools. Importantly, this study has shown how this interrelation might unfold over the course of a science project and how children’s experiences might be expressed and refined through the use of multiple modes in developing ways with the intentional efforts of adults.

The use of digital tools in early childhood practices will probably continue to be a topic of concern in the years to come (cf. Palaiologou 2016; Edwards et al. 2017). This study has illustrated what such tools afforded for a science project within a certain context. While it
is clear that digital tools have potential in their use for conceptual development in early childhood, it is not evident that they are the prime resource for learning in preschools. They are nonetheless tools amongst others to use with children’s developing knowledge in a contemporary preschool. Digital tools can, together with other means of pedagogical interaction, provide experiences that are added to over the course of time, scaffolded, and further amassed to provide more conceptually conscious ways for children to view their world.

Notes

1. The official name of the science project was: ‘Beyblades and the centrifugal force’, as presented at teacher-parent conferences and to the municipality. It should be noted, however, that centrifugal* occurs only once in the corpus of recorded and collected data, when a PowerPoint slide aimed at parents and the municipality officials is displayed. It should be noted that the phenomenon most present is centripetal force. However, since the word spinning is used throughout the project by children and the teachers in interaction with children, it is also used throughout this paper.

2. The ethical guidelines of The Swedish Research Council (2011) have been followed in regards to the written consent of participant parents, teachers and confidentiality in handling of data. In addition to this, the children themselves have been informed and repeatedly asked to reconfirm their participation during the project to ensure the study was ethically sound from a child perspective.

3. For results regarding other activities during the project, see Samuelsson (2018).

Disclosure statement

No potential conflict of interest was reported by the author.

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References


