Emergent science in preschool: The case of floating and sinking

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Abstract

This article studies an activity in a Swedish preschool setting where children's elaborations and understandings of floating and sinking are central. In a Swedish preschool context, it is advocated by the National Agency for Education (2016) that different forms of knowledge and ways of learning are used within the institutions to form a coherent whole. Based on a cultural-historical framework (Fleer, 2010; Hedegaard, 2012; Vygotsky, 1978, 1987), it is argued that if children are supported by a teacher, who mediates a cultural and historical, as well as institutional, perspective of knowledge, children may enhance their knowledge of science. Data was collected using a video-based technique called shadowing (Czarniawska 2007), and the overall study was framed within a case-study methodology. The analyzed activity show four children collaborating and exploring a range of aspects related to floating and sinking together with one teacher, acted out in a playful but focused manner. The results show that aspects such as the item, the fluid, and the way children handled the items to remove or add weight, were found important by the children. They used everyday language to talk about size, holes, weight, amount of water, and what changing preconditions would mean when different objects were placed in water. Their vocabularies were enhanced during the activity and seemed to foster emergent notions of density and Archimedes' principle, indicating that the language used has the potential to mediate the progress of both spontaneous and scientific concepts, where scientific concepts are understood as emergent.

Keywords

Floating and sinking; emergent science; preschool; children; learning

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Introduction

Science education is nowadays recognized as an important part of people's lives, providing skills as critical thinking, content knowledge, and possibilities for making informed decisions about environments and technical issues. Since 2010, the Swedish educational system has undergone reforms to increase and extend science and technology in society. The reforms consist of a general revision and efforts with specific focus on science and technology in the national curriculum for mandatory schools (National Agency for Education, 2011) as well as preschools (National Agency for Education, 2016). Swedish preschools have had steering documents since 1968, but received their first curriculum in 1998. The preschools are government funded and offer full-time daycare for children aged 1 up to 5/6 years and during 2013, 84% of Swedish children were enrolled. 53% of the staff have a three-year university degree and are titled as preschool teachers (förskollärare) or "teachers for the younger years" (lärare för yngre åldrar). The average child–adult ratio is 5.3 children per adult. Swedish preschools draw on democratic ideals found within the national curriculum (National Agency for Education, 2016), in which play, learning, care, and nurturing are viewed as equally important. This approach advocates that different forms of knowledge and ways of learning are used within the institutions to form a coherent whole. By adopting such a perspective, the contrasts between academic and social learning are toned down and social and cognitive knowledge are viewed as equally important (Williams, Sheridan, & Sandberg, 2014). This is enhanced by the awareness that both play and learning share the characteristics of playfulness, spontaneity and creativity (Vygotsky, 1995).

By drawing on such perspectives, the point of departure for this article evolves from research by Vygotsky (1978, 1987, 1995), who represents a cultural historical perspective, which highlights language, social environment, and the appropriation of tools as central. Development and learning in the area of science may be enhanced by the teacher[1], who mediates a cultural and historical, as well as an institutional, perspective of knowledge (Hedegaard, 2012). Regarding science and young children, the concept "emergent science" offers a perspective that highlights the importance of children's play and elaborations around topics related to science (Johnston, 2008, 2014). Further, it is acknowledged that young children can learn and develop their understandings of science (Sikder & Fleer, 2015; Sundberg et al., 2015). The aim of this article is to explore how children understand the concepts of "floating" and "sinking" in a Swedish preschool activity. The specific sequence is scrutinized by exploring children's expressions of their understandings of the phenomena. Of importance for this study are the opportunities provided for children to develop their current knowledge and whether their utterances are addressed and taken into consideration. Therefore, the research question is: *In what ways do children express and enhance their understanding of floating and sinking in an explorative and elaborative context?*

Research on science, floating, and sinking

Johnston (2014) argues that if young children are to develop their learning and understanding about science, possibilities for acquiring a variety of skills and abilities need to be included in their lives:

> Science is a practical and social endeavor, involving the development and use of a range of skills. Some of the skills are generic ones that are in use in other aspects of children's lives (e.g. observation, interpretation) whilst others are quite specific to enquiry in science and other related subjects (e.g. classification, handling variables). (p. 3)

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This acknowledges that the specific skills needed for developing scientific notions are something more than just observation and being in the world, even if the skills of observation are important in terms of focusing on specific aspects of the surrounding environments. Research on young children and science in preschools has also focused around areas such as the proficiency of observation and as a precursor for other skills such as classification and forming hypotheses (Johnston, 2009). That is, observations as such can be divided into categories such as affective, functional, social, and exploratory and are dependent on available resources, context, and interaction with peers and adults (Johnston, 2009). Further, the importance of making systematic observations in order to develop conceptual understandings of science has been central to the work of Russel and McGuigan (2013). They argue that opportunities for making systematic observations, with support from adults, give children a chance to draw conclusions from their explorations. Also, the teacher's role as aligning the focus for children's learning in science has been scrutinized. This is shown, for example, by Siry, Ziegler, and Max (2012), who claim that in order to enhance children's capacities and awareness of "doing science", teachers need to support children's use not only of investigation skills, but also the sharing of knowledge among peers and improving opportunities for children to go beyond everyday talk towards more scientific language.

During science activities, children's observations may challenge their previous expectations, leading children to wonder and develop interest in continuing their investigations (Andersson & Gullberg, 2014). In order to develop "scientific specific notions", Siry et al. (2012) suggest that by enhancing comparisons in different concrete situations, the use of words such as "although" (p. 333), initially derived from an everyday perspective, can be used in situations regarded as science activities and given a changed meaning. The word may become useful for describing and understanding occurring scientific phenomena during concrete elaborations such as when stating that an object may float although it contains water (Siry et al., 2012). The above-mentioned research implies that observations and the skills related to such activities are of importance for children in order to explore specific notions of science. What children are able to talk and reflect about becomes related to their experiences. Still, experiences resting on accessible resources need further maintenance to develop, such as time and teacher support in order to embrace aspects not immediately identifiable.

Research about young children and science has been conducted in different ways. For example, Piasta, Yeager, Pelatti, and Miller (2014) videotaped, categorized, and measured the time focused on the science and mathematical activities of children aged 3 to 5 years over 65 preschools in Ohio, USA. They concluded that the majority of these activities afforded a range of science activities mainly developing investigative and observational skills and the fostering of critical thinking. Content areas related to the physical world (as opposed to the living world) were only identifiable in half of the preschools; none of the preschools provided children with opportunities to learn about content such as water or air. The result was to some extent associated with teachers' experiences and level of education. Contrary to Piasta et al. (2014), a study by Tao, Oliver, and Venville (2011) showed that Chinese and Australian primary school children (n=255) had opportunities to learn about water and air. The Australian children had been taught since preschool compared to the Chinese children that had only just started to formally learn science. All children expressed similar conceptual understandings about weight, size, and the material, that is, that floating is related to lightness, a small size, and the material such as wood. This occurred even if the time they had been taught science differed and Tao et al. (2011) raises a critical reflection about whether science should be part of the preschool curriculum if it does not provide more advanced cognitive understandings. In relation to this

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reflection, it is worth mentioning that the importance of observations, allocated time, space, and teacher support should not be underestimated when providing science learning opportunities.

When focusing on floating and sinking, conceptual understanding may be enhanced during teaching in diverse ways, depending on different approaches. An intervention study with pre- and post-test of children's understandings by Havu-Nuutinen (2005) noted that children extended their understanding of concepts related to floating and sinking in a more multidimensional way when challenged by an approach to floating and sinking described as a "density approach" (i.e., including object's hollowness, shape, and size, not just mass and volume) rather than a "balanced forces" approach (i.e., only the weight of the object relative to the weight of the water). Havu-Nuutinen (2005) suggested that the "density approach" supported the process "to get rid of their 'weight-based model' and the children started to consider flotation as a phenomenon that depends on several physical properties. In later years these properties may help children to understand the concepts of volume and density" (p. 276). This was true even if, during the intervention, the children were unable to identify all such factors due to insufficient cognitive skills and inexperience. Further, in a qualitative study in a Swedish preschool, Pramling and Pramling Samuelsson (2001) focused on an authentic activity. The teacher interacted and encouraged a 3-year-old child to hypothesize, and test the hypotheses, about whether an object would sink or float when placed in a container of water. Supported by the teacher, the child used strategies such as interaction and engagement during the process of establishing understanding. The results show that the child utilizes the concepts even if he does not fully understand them. The activity serves as a frame for the evolving dialogue; it supports and enhances the child's thinking and reflection. The activity as such is considered important for the child's process of developing experiences of the concepts heavy/light and floating/sinking, and as a first step towards science (Pramling & Pramling Samuelsson, 2001).

Taking an international perspective, researching authentic situations are not the common way to conduct science research in institutional settings. In relation to the above mentions studies, the current study takes a similar notion as done by Pramling and Pramling Samuelsson (2001). Thereby this article is filling a gap in a rather underrepresented research field all over the world, in regards to the teaching and learning of science and physical phenomena in early childhood. Here, it is done from a position where the children and teachers authentic work is seen from within the cultural and institutional framework in which it exists. The specific interest is on the children's enhancement of their understanding of floating and sinking although the conceptual content is not immediately identifiable. This is in line with Johnston (2014) who writes that a focus on science, as a part of a content area that is in the making, should not be taken for granted, highlighting that aspects such as reflection, communication, and joint activities are important aspects during the process of enhancing thinking. The emergence of learning science could be situated collaboratively, in play and during everyday activities, for example, when washing hands or eating, or during outdoor activities where children can encounter slippery ground due to mud, gravel, or ice (Larsson, 2013a). When undertaking this view on children's explorations the teacher's role is positioned as one who introduces children to a range of phenomenon and experiences in the area of science (Larsson, 2013b), and as one who develop and enhances scientific experiences, understandings, and language during concrete and elaborative circumstances (Johnston, 2014; Larsson, 2013b).

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Theoretical framework

Building knowledge through play is evident in a Vygotskian perspective on learning and development in the early years (Fleer, 2010). During childhood, children participate in different environments and encounter new aspects of themselves and the surrounding world. Hedegaard (2008, 2012) has constructed theoretical levels to show the dialectical and intertwined relationships among society, institution, and person concerning learning and development. *Society* entails cultural and historical traits and perspectives that have formed society. *Institution* is about participating in different institutions, for example the family, preschool, and school in practice. In the institution, *activity settings* occur, such as having lunch, circle time sessions, and so on. These are formed and performed according to the traditions in the specific institution. The level of *person* is, in the model, constituted by the children's perspectives, and understood in terms of their actions and communication (Hedegaard, 2008, 2012). The levels society, institution, and person are not separated, but instead tied together by dialectical relationships. Such relationships are expressed, for example, in children's expressions of diverse personal understandings about a science phenomena in activity; in turn, the sharing of these understandings has the power to influence the activity itself This is because the teacher, representing the institutional perspective, will use a professional attitude (advocated by the national curriculum) to alter and adjust to children's experiences. In the context of the current study, dialectical relationships imply that the institution is not static; it is directed by the society and affected by this. It also implies that the people in the institution affect the way the institution functions.

When children participate in activity settings, different features of the world are in focus; they encounter their environment and take part in shaping the activity. They also encounter new concepts for aspects of they already have an everyday understanding. From a theoretical perspective, regarding the development of concepts, Vygotsky (1987) suggested that it was important to develop the ability to master concepts related to different areas. This may be done by supporting the progress of everyday concepts, especially if the child is to develop and understand scientific concepts. Notably, Vygotsky writes,

> Like the formation of spontaneous concepts, *the formation of scientific concepts is not completed, but only begun at the moment when the child learns the first meanings and terms* that function as their carriers. This is the general law of development of word meaning. It applies equally to the development of spontaneous and scientific concepts. (emphasis in original, Vygotsky, 1987, p. 179)

This indicated that language has the potential to mediate the progress of both spontaneous (i.e., everyday) and scientific concepts. The understanding of what is essential in the development of concepts may vary across different countries and contexts. From a Swedish preschool perspective, an everyday understanding of floating and sinking could be expressed in terms of observable notions as heaviness, size, *or* material. A more scientifically accurate wording could combine such variables, even if the (scientific) term *density* is not required to be a part of the vocabulary. When embracing the perspective of viewing language, as well as the existing artefacts, as mediating tools (Vygotsky, 1987), it becomes important to look at existing conditions for learning. It becomes central to consider whether children are located in an environment that supports their knowledge and whether they have opportunities to express and enhance their understandings.

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Method

This research is framed as a case study (Cohen, Manion, & Morrison, 2007) and provides the opportunity to embrace and scrutinize a "real context, recognizing that a context is a powerful determination of both causes and effects" (p. 253). Case studies mostly comprise multiple sources constituting data, supporting the researcher in understanding the case and the contexts and the uniqueness of evolving actions and interactions, situations, and phenomena (Cohen et al., 2007). In this case study, video recordings formed the basis for transcripts of communication and actions. Together with minor additional field notes and researcher reflections, video data and transcriptions were the basis for the analysis.

Sample, setting and contextual information

When locating preschool settings with an explicit focus on physical phenomena, purposive sampling (Cohen et al., 2007) was found to be a suitable tool for data collection. Settings with such a focus are of interest since the connections to physics (i.e., physics in a wider understanding, not as a school subject) were, at the time of data production, newly integrated into the national curriculum for preschool (National Agency for Education, 2016) and found to be rarely occurring in preschools in Sweden (Persson, 2008). Science is highlighted in terms of supporting children in discerning, exploring, elaborating, discussing, and documenting phenomena and events in nature. Teachers were expected to develop children's understandings about simple chemical processes and physical phenomena. Three preschools in the west of Sweden were found to have such focus and two of these agreed to participate in the research project.

The particular preschool setting discussed in this article was situated in a multicultural area and functioned according to the national curriculum (National Agency for Education, 2016). The participating preschool had prior experience of focusing on science in terms of the solar system and prehistorical as well as contemporary animals. At the time of this research, they had an ongoing theme about boats, and during these activities, a focus on floating and sinking was highlighted. All activities were planned by the teachers in accordance to the intertwined perspective of play, learning, and care inherent in the Swedish preschool tradition. Important to emphasize is that the initial idea was derived from children's interest in such vessels. The teachers and their group of children agreed to have a researcher follow their work. The 18 children (of which 14 were part of the study) and the three teachers (two participating) were shadowed (Czarniawska, 2007) by the researcher carrying a video camera during ongoing activities. Data is drawn from a 45-minute session where a floating and sinking activity was conducted by one teacher, and four children: Samira (6.4 years), Tibelia (6.0 years), Akram (5.7 years), and Hakim (4.4 years). The activity took place inside during the morning while the other children were playing outside. The teacher had an educational bachelor degree focusing on children aged 1 to 6 years, and 18 years of teaching experience, but no specific education in science.

Analyzing data

Starting with verbatim transcripts from one video-recorded session, children's utterances about boats, floating, and sinking were highlighted and constituted the unit of analysis. By using a qualitative content analysis (Graneheim & Lundman, 2004) the wholeness of the activity and the communication is scrutinized in order to illuminate themes, subthemes, and latent and manifest content. That is, children's utterances are refined to a manifest content, which comprises descriptions close to the communication (see Table 1), for example, when a child answers that a

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stick floats since "there's holes in it" (line 180[2]). This was labeled as "weight"[3] (latent content) under subtheme and organized as theme (i) to float and/or to sink. In sum, the content analysis revealed three themes and six subthemes (see Table 1). Such analysis is used to reveal themes in children's everyday language and to complement the cultural historical perspective. The themes that emerged from the analysis showed areas that were essential to the activity. This article concentrates on (i) to float and/or to sink, comprising the subthemes item and fluid, and (ii) to change preconditions for floating and/or sinking, where the subthemes are Archimedes' principle and human impact. Theme (iii) differs in what is central in the elaborations and communication that takes place. It focuses on maintaining stability and emphasizes construction. Therefore, it is not included here.

Table 1
Results of content analysis

Focus	Theme	Subtheme	Latent content
Boats and other items that float and/or sink	(i) to float and/or to sink	Item	Weight, size, density and the object as such
		Fluid	Density and volume of water
	(ii) to change preconditions for floating and/or sinking	Archimedes' principle	Something that sinks can become floating and something that floats can sink
		Human impact	The way persons act in or have impact on the floating and/or sinking objects during the situation
	(iii)to load on something	*Stability*	*In which way and where weight is place*
		Construction	*The role of the construction regarding the ability to float.*

Ethics and aspects of credibility and dependability

This research follows the ethical guideline outlined by Swedish research council (2002), which states that information, consent, confidentiality, and how data is treated, must be part of the information to share with participants. This is done in terms of researcher introducing the project to parents, being available for questions and distributing written consent forms to parents of the children involved. The researcher spent time at the preschool before data production (Edwards, 2007), informing and getting children to know the person conducting the research. In settings with young children, additional ethical considerations are demanded (Dockett, Einarsdottir, & Perry, 2009; Farrell, 2005) since the children are dependent on the teachers in terms of which visitors will be let inside the setting. In this study, the researcher's previous experiences as a teacher made entry easier and the use of professional language was regarded as positive. During the leaving-phase, preparing children for the end of the process was of importance and as a final feature, the children were introduced to and shown parts of data that displayed themselves during the activities.

The trustworthiness of qualitative research is often described in terms of concepts such as credibility, transferability, and dependability (Bryman, 2011; Graneheim & Lundman, 2004; Lincoln & Guba, 1985, 1989). Regarding credibility, the emphasis was on the choice of methods for the production of data that allowed making in-depth observations and selecting a unit of analysis from the material (Graneheim & Lundman, 2004). Researcher biases are avoided by, for instance, using a video camera, which contributes to "low-intrusion data" (Edwards, 2007, p. 129), that is, not to disturb participants in ongoing activities. Acknowledging that this study rests on a small sample size, transferability is not possible beyond the context. However, it may be

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possible to find similar situations by providing the reader with contextual aspects and empirical examples with respondent's voices (Bryman, 2011; Lincoln & Guba, 1985, 1989).

Findings

The findings show that children have opportunities to enhance their current understanding of floating and sinking due to their communication about the phenomena. The children also express notions of physics that are here understood as emergent science. This section is outlined according to the two themes: (i) to float and/or to sink with subthemes item and fluid, respectively; and (ii) to change preconditions for floating and/or sinking containing subtheme Archimedes' principle and human impact, respectively.

To float and/or to sink

In the first theme the children's utterances are related to the situation of testing their boats (which were found to have limited possibilities to float) and other objects. The utterances range from focusing on one aspect to focusing on two aspects when explaining what is happening. In the subtheme item, the expressions are on one aspect. For example, size or weight; the teacher repeatedly asks the children why different items stay afloat or sink:

141	Teacher:	Why don't they [the boats] float?
142	Tibelia:	They [the boats] are so small.

Before Samira tests her boat, the teacher asks her for a prediction of what will happen and afterwards for an explanation:

251	Teacher:	Ehhh… will this float or sink?	
252	Samira:	sink..	dropping the boat into the water
253	Teacher:	Try!..	
254	Samira:	FLOOAATTSs	releases the boat from 10 cm above the surface, it drops to the bottom before floating up!
255	Teacher:	Why does it float?	
256	Samira:	..because it is not so heavy…	takes the boat out of the water, holds it in her hand and estimates the weight
257	Samira:	heavy enough	
258	Teacher:	heavy enough	

Samira predicts that her boat will sink, but the opposite occurs. To the teacher's question, she answers that her boat was "not so heavy" (256) but changes the words into "it's heavy enough"[4] (257), highlighting one aspect: weight.

In the subtheme of fluid, another aspect beyond the item is included in children's utterances. It is connected to children who collectively combine two aspects: the size of a tub with the amount of water:

141	Teacher:	Why don't the boats float?	
142	Tibelia:	They [the boats] are so small..	
143	Teacher:	..are they too small..?	
144	Akram:	I know… we have such a large..	shows the size of the tub with his

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			hands, but is interrupted by Tibelia
145	Tibelia:	…and you have taken too much water [in the tub]..	interrupts Akram

Akram and Tibelia form an explanation together and collectively make reference to two aspects when explaining why the boats are sinking. Akram refers to the large tub (144) and Tibelia adds her understanding of the volume of the water having an impact on what happens (145). Later, Samira enhances her utterance and combines two different aspects—the weight and the fluid:

199	Teacher:	Akram… will it float or will it sink?	holds a coin in her hand
200	Samira:	I want…	
201	Akram:	…will it sink..?	reaches for the coin, holds it above the surface and drops it into the water. The coin sinks to the bottom and a noise is heard
202	Samira:	It was… it is … *very* heavy…	
203	Teacher:	Is it heavy?	
204	Samira:	..the water could not hold it…	said quietly, with her head turned away from the teacher

When rapidly sinking, the coin makes a sound when touching the bottom of the tub and Samira says that it is very heavy (202) and, importantly, she comments on the water's inability to hold the coin (204). This is uttered in a silent manner and is not commented upon (perhaps not heard) by the teacher or the children. Samira's comment implies that floating and sinking does not only depend on the item by recognizing and verbalizing both item and water.

To change preconditions and/or the ability to float

In the second theme the teacher alters her focus from being curious about why things float or sink to giving children a problem to solve. First, she clearly invites the children to be active and to give suggestions for how the activity could progress. For example, she asks about the possibility of preventing a set of glass-stones from sinking, something which is related to the subtheme Archimedes' principle:

298	Teacher:	..if I don't want.. If I would like to place these stones [in the water] but I do not want them to sink. What could I do then?	holding several glass-stones in her hand above the surface
299	Tibelia:	..take them all and put them..	
300	Teacher:	But they sunk if I took them all .. could I place them onto something perhaps?	
301	Hakim and Samira:	..yeess..	
302	Teacher:	On what?	
303	Samira:	The lid	pointing at the jar where the glass-stones are kept

The children are quick to find, and add, something that floats, and they support each other when showing the teacher the lid. The lid is made of plastic, about 10 cm in diameter and has a low edge. It is placed in the tub and the teacher asks children to place glass-stones on it. Akram and

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Hakim place several glass-stones, while at the same time giggling and looking at the lid. The excitement is obvious:

317	Samira:	Sccaarryyy..	
318	Akram:	It.. is.. a ghoosstt.. there..	Hakim places the 7th stone but touches the lid, resulting in the lid letting in water and sinks
319	Teacher:	Oh, what happened now?	Tibelia quickly puts her hand in the water and places a glass-stone on the sinking lid
320	Samira:	..when Hakim placed it.. then it didn't work..	
321	Teacher:	Why	
322	Samira:	..because..	
323	Tibelia:	Because it was so heavy	interrupts Samira
324	Teacher:	It became too heavy	
325	Samira:	..to many..	
326	Teacher:	mmm	reaches for the lid, pours the water out and take the glass-stones in her hand

The children are focused on the situation, and at the same time talking and sharing the moment, looking at each other and smiling. When placing stones, one by one, the lid eventually sinks and the teacher poses questions directing the children's attention to what is going on (319). When answering, the children rely on concepts they used earlier, such as heaviness (323). In addition, Samira's alteration of Tibelia's word "heavy" into "many" (325) indicates that Samira has identified the number of glass-stones as an important variable and reason for the lid sinking. The utterance also enhances the available everyday vocabulary. The analysis show that the alteration of weight into number makes the distinction about reducing or increasing weight more easily defined. In scientific terms, the increased weight can lead to the lid sinking due to the imbalance between the buoyancy and the weight of the item (the lid).

In children's terms, floating can be re-established by reducing heaviness. In the next part they use a jar made out of aluminum. It is 10 cm in diameter and has an edge that is 7 cm high and is loaded with many glass-stones:

442	Teacher:	Oh, it sinks. How can we do it so the boat will continue to stay high up in the water?	the boat (i.e., jar) is floating with the edge just above the surface
443	Children:	I knooww	
444	Samira:	Take out some of them	points at the glass-stones
445	Teacher:	Yes, and then	
446	Akram:	Take some out?	takes some out and places them on the table
447	Teacher:	You took out some of them [Akram]. Let's see if this will work. Just take some at each time.. There's still too many, isn't it?	the teacher pours out water and Samira removes more glass-stones
448	Akram:	4,5,6..	counting his stones
449	Teacher:	Akram! How… is it floating better now do you think?	the children look at the jar and giggle – the edge of the jar is further up from the surface now
450	Akram:	yeess!	

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When the children say that one could take out some glass-stones, this is here understood in scientific terms, as a reduction of weight is needed if the boat should stay afloat. It implies_that the relation between the weight of the item and the buoyancy can be altered. If done in favor of the item, it is prevented from sinking (in this situation). The numbers once again become important for children; numbers are defined as "take out some of them" (444) and the jar is saved from taking in water. The elaboration and problem-solving situation makes the children interact and support one another in their actions, framed by excitement and playfulness when sharing the same focus.

Later, they try to force a piece of wood to sink by placing a lot of glass-stones on it:

577	Teacher:	What… how.. why can we place so many glass-stones on this one without it sinking?
578	Hakim:	..because they are all wet?..
579	Samira:	Because this one is even larger?
580	Teacher:	But why is it that [larger]?
581	Samira:	Since it contains a lot of air..
582	Teacher:	So much air?.. aha..
583	Tibelia:	Yes, it has so much air..

The piece of wood did not sink as the jar did earlier and this opened an opportunity for learning, searching for explanations, as the item was wet or larger than previously tested items. Samira comments on the size (579) and says that it is filled with air (581), which is confirmed by Tibelia (582). This implies that children relate the presence of air inside the piece of wood as one explanation why this item can carry more glass-stones without sinking.

This second theme also comprises the subtheme named "human impact". That is, during the activity it is evident that the children explore that the way an object is held, placed, and released in fluid can affect what happens. For example, touching a floating object can cause it to sink, as when Tibelia threw her boat into the water and it sank fast. The teacher urges her to place it differently at the surface, and when following the teacher's suggestion, it sinks more slowly to the bottom. When the teacher directs the children's awareness about how to handle boats or items when placing them in water, she is, in scientific terms, implying that the force used when placing the boat may cause the boat to be filled with water, that is, to gain weight and thereby sink.

Discussion

This study draws on an authentic activity in one Swedish preschool. The aim was to study the way children's understandings of floating and sinking were expressed and enhanced in such an activity. The studied preschool setting embraced a culture where science was a possible area of study (Larsson, 2013b; Sikder & Fleer, 2015; Sundberg et al., 2015). The analysis of the activity reveals that the children are focused, talk, and share the moment and interact in a positive and constructive manner. From a cultural-historical perspective, learning and development are seen as connected to the context and culture where different aspects dialectically influence each other (Hedegaard, 2008, 2012; Vygotsky, 1998). According to the qualitative content analysis (Graneheim & Lundman, 2004), it became evident that aspects such as the item´s characteristics and the fluid were found important to discuss. The framing enabled activities such as removing or adding weight, and the conversations among the children supported their cooperation and mutual engagement. This supports the findings by Andersson and Gullberg (2014) who highlight that what children are able to talk and reflect about becomes related to their experiences, and that

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observation activities are of importance for children to explore specific notions of science (Siry et al., 2012).

The children use everyday language to talk and they also identified that they can change and influence the course of event—something which first floats can be managed so that it sinks, through concrete changes in external conditions. Communication about such phenomena leads to possibilities to establish understandings of concept as floating and sinking. During the activity, children expressed a range of important observable characteristics through the use of everyday concepts (Vygotsky, 1987) related to size, holes, weight, amount of water, and what changing preconditions would mean when different objects were placed in the water. These findings are comparable with Chinese and Australian children expressing their conceptual knowledge about similar physical phenomena (Tao et al., 2011). In this study, children mainly connected floating and sinking to one aspect, but as shown previously, children also related this to several aspects. For example when intuitively saying that the coin sunk because "it was… it is … very heavy" (Samira, line 202) and "the water could not hold it…" (Samira, line 204). From an emergent science perspective, this is understood as conceptual awareness, a knowledge of something abstract, that is, that the water has a force, an up-thrust, something that did not occur in the Tao et al. (2011) study. The conversations during the activity had a function for children's learning and development (Vygotsky, 1987) when altering and together defining floating and sinking in a collaborative manner. That is, the children's evolving scientific skills were dependent on the context and resources, peers, and adults. However Tao et al. (2011) stated "simply being exposed to scientific facts and information, or exploring and playing with scientific equipment, is not enough to bring about the conceptual understandings of science…" (p. 896). The introduction of science concepts in playful activities, like the one highlighted in this article, can extend their exploring, observational, communicative and conceptual skills. Here it became a key factor for approaching the pathway towards knowledge in, and about, science.

The findings show that both the teacher and one of the children consider the item and the fluid to be of prominence, which may imply that the teacher implicitly takes what Havu-Nuutinen (2005) described partly as a balanced forces approach, that is, focusing on weight. One of the children (Samira) seemed to have, by herself, combined the weight of the object relative to the up-thrust of the water and makes it explicit. The findings show, when adopting the perspective that early explorations are important for the emergence of scientific understandings (Johnston, 2014), that the activity seemed to foster emergent notions of density and Archimedes' principle. Samiras comment was done in a context where there was a combination of active exploration and the teacher's genuine interest in supporting such actions. The children were participating and actively contributed to the way the activity evolves by putting in more items or suggesting how to change preconditions for floating and sinking. At the same time, the teacher listened to children's reasoning and maintaining the initial focus of the activity, even if all utterances were not met. The children's knowledge is expressed on a person level and the activity is enacted on the activity setting level, where the teacher represents the institutional perspective, working in line with a curricular and societal perspective (Hedegaard, 2008, 2012). Viewed from a dialectical perspective, the children's possibilities to alter and place additional items in to the activity reveals that their actions and utterances are given opportunities to modify both the activity setting and the teacher's arrangements on an institutional level.

From a societal perspective, it is of importance in a Swedish context that "learning should be based, not only on the interaction between adults and children, but also on what children learn from each other" (National Agency for Education, 2016**,** p. 6). When viewed on a society level (Hedegaard, 2012), conceptual understandings of science as such are not required by Swedish

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preschoolers. Instead, observation is an important skill to develop (Andersson & Gullberg, 2014; Johnston, 2009; Russel & McGuigan, 2013) and will call upon more focused inquiry. In this study, for example, observations enhanced the identification of a larger piece of wood being able to carry more weight since, as the children said; it contained air (line 581). These, and similar expressions in this study, are interpreted and understood as emergent science. Depending on the teacher's positioning as a co-constructor and as a facilitator for pathways towards science, emergent science became possible through adult-child mediation and cooperation. The teacher, as representative of the institution, was both leading and following the children's suggestions and giving support when they encountered different challenging phenomena. The teacher was interacting and directed the children's attention to specific aspects of floating and sinking that she wanted them to discern in the evolving situations.

From an institutional and societal perspective (Hedegaard, 2012) finding align with the Swedish curricular demands of creating a coherent whole where children are able to communicate, to observe and to reflect and to learn, work and play together. Similarly, a study by Larsson (2013b) found that when teachers initiate and support play and learning about sound (as a physical phenomenon), they can contribute to children's learning about concepts, which from a physics perspective, is considered as abstract. Playful atmospheres and embedded communication and interaction have shown to be of importance for learning (Pramling Samuelsson, Sommer, & Hundeide, 2011). During the floating and sinking activity it may seem as though the teacher's "why is it floating" question was the overarching way to communicate, though, this was an explorative and elaborative activity where children had a large impact on the communication and the progress of the activity. Acknowledging that asking questions is a traditional and established way of trying to grasp children's perspective (Pramling Samuelsson et al., 2011), this can be done in different ways. However, when the teacher's communicative stance changed towards posing problem-solving activities, children further increased their activity, and their utterances became more refined and developed. This concurs with Russel and McGuigan (2013), who highlight the importance of teachers supporting children's communication in order to be able to draw conclusions based on their explorations and investigations.

Conclusion and implications for practice

For practice, this implies that the concept of emergent science provides novel opportunities for thinking about science education in preschool. The children, as a group of learners, can support each other during explorative and elaborative activities, not only in understanding what is going on but also enhancing the way activities are enacted, according to their experiences and their current understandings. On an institutional level, for teachers, these findings highlight the importance of being sensitive, and to take an active part in investigations, observations, and discussions, in order to support children's cognitive and cooperative skills. However, the "why" question needs to be problematized in relation to the activity and the different kinds of communication it may offer in a situated practice. The focused observations supported children's experiences and enhanced their understandings of floating and sinking during the activity. As being a case study and reflecting one activity, the long-term gains of the activity are difficult to predict. Further, the absence of pre- and post-test may to some readers be a limitation of the study; still, the aim was not to record conceptual change. As shown in this particular study, providing opportunities to develop children's investigative skills and emergent scientific knowledge be done may advantageously without accessing or grading young children's cognitive abilities. The study proposed that, by being observant of children's concepts on everyday levels and when appropriate, link to scientific, potential levels, teachers can introduce children to a

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scientific language, including concepts as, force, buoyancy (up-thrust), gravity, density or Archimedes' principle.

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[1] Here, the term "teacher" refers to staff working with children aged 1–6 years.
[2] This example is not included in the article
[3] Weight is used when relating to something being measured in Newton (N). Mass is used when being measured in kilo (kg). Heavy/heaviness is used when children relate to weight and mass.
[4] The Swedish words are "lagom tung".

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with phenomena associated with physics. Concept as play, emergent science, every-day and scientific concepts are of importance, together with the opportunities for learning enhanced by the teachers in such settings.

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