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The development of young children's science-related concept regarding "floating and sinking"*

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Abstract

The study based on the inspiration from Vygotsky's suggestion utilizing the developmental method to investigate qualitative changes of behaviors and analyze the developmental course of young children's science-related concepts will be presented in this paper. The inquiry-based science project presented is "floating and sinking" conducted by a group of 5-year-old children. Science activities from each group were audio - and video - taped for a period of one or two months. Semi-structured interviewing of children was conducted to verify current scientific thinking in relation to the science activities children experienced. According to the results, along with the progress of the project, qualitative changes of children's science-related inquiry behavior as well as conceptual development revealed. The results showed that discussion with the teacher and peers, as well as plenty of time and materials to investigate the phenomenon of "floating and sinking", were beneficial for young children's conceptual development.

Keywords: *concept of floating and sinking, the developmental method, young children*

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Introduction

Children acquire fundamental concepts through active interactions with the environment. As they explore their surroundings, they actively construct their own knowledge. Individual children are viewed as intellectual explorers, making their own discoveries and constructing knowledge (Sood, 1997; Landry & Forman, 1999; Bjorklund, 2000). Science is understood to be a process of active inquiry and a system of organizing and reporting discoveries. Rather than being viewed as the memorization of facts, science is seen as a way of thinking and working toward understanding the world. Oakes (1990) advocates that all students need to learn science skills such as observation and analysis that are part of a “less-is-more” curriculum that starts when children are very young.

Osborne and Wittrock (1985) identified two areas of interest in children’s construction of scientific meaning: (1) the conceptions of the natural and physical environment which children bring them to science lessons; (2) the impact of science lessons on those ideas. Since 1993, this focused attention on children’s construction of science has led to growing amount of research activity in Taiwan. However, science education in early childhood has received little attention from Taiwan’s general education community, because of teachers’ lacking of confidence in science knowledge and science teaching. Therefore, few researches have been directed towards science education for three-to-six-year-olds. Consequently, little is known about the development of young children’s conceptions of scientific phenomena, or how to teach science to this age group. It is timely that a study of young children’s conceptions of scientific phenomena and the conceptual development that occur during the investigation of science be conducted. Through such research it is possible to develop an understanding of how children acquire scientific ideas and also gain insights into better ways to teach science to this age group of children.

Recently, Chou (2002), applying the clinical interview method, draws our attention to the wealth of research conducted on young children’s views about living and non-living; speed; electric current; breathe; digestion; dissolving; evaporating; light; shadow; heat and temperature; air; and globe. The clinical interview method, including the method of interview about instances and interview about events, is frequently applied in researches on children’s conceptual development to explore children’s explanations for natural phenomena. This line of research indicates that children do have a variety of alternative scientific views which are difficult to modify once formed. However, researches applying clinical method are not able to investigate qualitative changes of children’s behavior development and analyze the developmental process of concepts.

In addition, an inspiration from the constructivist project- approach curriculum conducted by distinguished preschools in Reggio Emilia, Italy, was the implementation of “revisiting” (Forman, 1998). Revisiting is to review and think or discuss about past experiences, serves as a platform for further exploration of new ideas with the children (Forman & Fyfe, 1998). It promotes reflective thinking for both teacher and children, and provide supports for the children’s adaptation of their knowledge to the new situation and, more generally, to foster their conceptual understanding (Malaguzzi, 1998). Thus the revisiting method was adopted as one of the research method for the present study to gain more insights of children’s conceptual understanding about floating and sinking.

The purpose of this study was to investigate qualitative changes of children’s science-related inquiry behavior as well as conceptual development in natural settings, through observing and analyzing the documentation of the process of inquiry-based science project “floating and sinking” carried out by a group of 5-year-old young children in preschool setting.

This study investigated the following research questions: (1) What are the developmental changes of children’s understanding of floating and sinking through the exploratory activity participations? (2) How do children’s science-related inquiry behavior and conceptual development change qualitatively in natural settings?

Method

Vygotsky adopted the position of Blonsky, an older colleague in Psychology, that an understanding of complex mental functions requires developmental analysis, and proposed a method called “the developmental method” that allows researchers to investigate qualitative changes of human behavior development and analyze development of concepts. Therefore, it is necessary for investigating young children's concept development to carry out a long-term observation, tracing and analyzing the processes when they form their concept.

Inspired by the method proposed by Vygotsky, in the present study, the developmental method was utilized to investigate qualitative changes of young children's behaviors, analyze the developmental course of young children's science-related concept regarding floating and sinking, and documented young children's naïve ideas in natural setting

In addition, the present study is also a collaborative - teaching research, in which teachers and researchers are partners co-studying with children in natural settings, the research problems are based on practical issues found in teaching sites.

Participants

The children were from a kindergarten which was affiliated to a public elementary school, located in a middle socio-economic status community in Taipei county of Taiwan. A group of 5-year-old children participated, with each time 5-8 children variously. The children were those who stayed over for after-school care with permissions from their parents to participate in the study (the researchers spent much time to get acquainted with the children before the study started). The teacher, Jenny, who participated in this research and was one of the children's classroom teachers, led the activities. Jenny volunteered because of her interests and research background in children's science education, as her master thesis was related to this topic and was advised by the first author of this paper. In addition, one of her scientific teaching believes, was to give young children abundant opportunities to play and explore, in order to encourage children to learn through the play.

Setting

The activities were carried out in the children's classroom or in the outside corridor. Jenny would provide materials such as self-made pools, portable above ground pools, baskets, plastic storage boxes, containers and etc, for children to play "floating and sinking" activities. These activities were differing from children's day time program. However, Jenny later added some similar activities in day time, because the children who did not attend after school care program did not have chance to participate in this study were also very interested and wished to have opportunity to play.

The activities took place during children's after-school care time, lasted from 4:15 to 5:45 pm for 1 hour and 30 minutes, every Tuesday and Thursday with totally seven sessions in May and June. During the activities the researcher would videotape and take field notes.

Procedure

In every class, abundant time and various materials were provided by Jenny to encourage children to explore freely. Questions were also asked to stimulate children's observations and thoughts regarding to the phenomenon of floating and sinking. Note that the teacher did not give any answers or instructions to the children. After each activity, children were given a piece of paper (we called Small Discovery) and asked to express their related ideas through drawing the pictures.

The research included three parts: (a) Exploration and experimentation: at first, providing children plenty of time and materials to play and explore; (b) Making Prediction prior to exploration and experimentation: later, start asking children make predictions on objects' flotation and sinking to understand their prior knowledge about flotation and sinking, (c) Revisiting Activity: at the final section of the project, revisiting with children and interviewing their learning experiences with their drawings, sculpture, etc. and digital photos as well as videos taken during their participation in the experimental activities. These three parts were all audio-taped, videotaped and field-noted. The purpose of the revisiting was to verify the children's existing knowledge and experiences of floating and sinking. To help children reflect on their own thinking and on naïve explanations, the revisiting activity was constructed using an interactive approach. Children tried to explain what kind of objects float and sink and why, then tested the ability of objects to float in water and suggested reasons why they float. In addition, the children talked about experiences of their previous exploration and investigation regarding floating and sinking. Children's drawing on what they had learned from the experimental tasks was used to represent children's thoughts and complement the language expression, and used for revisiting the task.

Data Analysis

The analysis of the children's knowledge construction process is based on the documentation collected during the experimental activities as well as children's and teacher's conversations during the interactive phase. Video-tapes and audio-tapes were transcribed following the children's exploratory behaviors, verbal conversations and non-verbal episodes held during their investigation in the science activities. The data collected regarding the children's conceptual understanding of floating and sinking was analyzed.

Results

The results of this study revealed that the understandings of floating and sinking phenomena for the 5-year-old children was followed by a trend described as below: In the beginning, the children were free-play with the materials, not concerning about the floating or sinking phenomena. They turned into play quickly and enjoyed using the given materials in their own imaginative ways, however, giving non-relevant and non-scientific explanation, *I'm cooking*, and then relate objects' physical characteristics and properties to floating and sinking. Gradually, children use their own words to describe the phenomenon of floating and sinking, and moving from considering one property of the object toward considering more than one property of the object in relation to their judgments of the phenomenon of floating and sinking. Finally, few children discover the causes for the flotation (properties of the materials), and express their understanding of the phenomenon of floating and sinking.

The characteristics of children's development in relation to understanding of floating and sinking phenomenon are described as follows:

1. Children enjoy free exploration of materials, giving non-relevant and non-scientific explanations regarding floating and sinking

The children free played in the plastic swimming pool and explored objects provided by the teacher. All children took initiative in playing these authentic objects (sponges, steel pot, plastic bottle and plastic bears …) in the floating and sinking play. Some stirred with the spoon in the pot and invited others to join their cooking activities, some pretended to prepare for lemonade by filling in the jar with water and plastic bears. These children did not mention any physical properties of objects or the responses were non-relevant to the phenomenon of floating and sinking. However, some children did express their prior knowledge regarding floating and sinking (as the excerpt cited below). At this point, children did not mention any physical properties of objects or the responses were non-relevant to the phenomenon of floating and sinking.

Teacher : What are you doing?
Mary : (stir the spoon in the pot) Cooking.
Justin : (pour water into the pot) Cook like this. (Insert hands into the water) Stirring .
Teacher : What happen to those plastic bears when we put them into the water?
Julia : They will float.

(WG Class Observation 12-Swimming Pool)

The understanding of children’s prior knowledge at the beginning of the project is thought to be essential to inquiry-based science education. It is hoped to provide provides teachers and researchers information for further curriculum planning. von Glasersfeld (1989) and Resnick (1987) caution that if we as educators do not take children’s prior knowledge into consideration, it is likely that the message we think we are sending will not be the message received. The emphasis in science education is not as much on children discovering everything by themselves as it is on relating new knowledge both to previously learned knowledge and to experiential phenomena so that children can build a consistent picture of the physical world.

2. Children describe the phenomena of floating and sinking with their own words

After the first free exploration time, children started to notice the phenomena of floating and sinking; moreover, they tried to explain it with their own words (non-scientifically).

During testing, children provided various explanations for 'floating' and 'sinking'. A child described the phenomena of flotation as roaming around like water. Some children were still not familiar with the related words and misused the word "sink" to describe the phenomena of flotation, or misused the word "float" to describe the phenomena of sinking.

Teacher : What happen to those plastic bears when we put them into the water?
Mary : They float.
Andy : They sink (Andy misused the word "sink").
They are roaming around as water.
(WG class observation 14-Plastic Container)

In the beginning of the project, children started using the word "float" and "sink", while most of them did not get the meaning and the concept of floating and sinking. However, children did try to describe the phenomena of floating and sinking with their own words. This finding is in line with what Havu-Nuutinen (2005) reports that "many words in science are used in an alternative way to everyday language". Children frequently interpret scientific words in terms of their everyday meaning. Conversely words used in everyday discourse may facilitate alternative understandings.

3. Children relate objects' properties to the causes for the floating and sinking

At this point, as suggested by the teacher, before the experimental activity, children predicted and tested the phenomena of objects to float and sink in water, then suggested reasons why they float. Afterwards, Children had access to objects varying in size, weight and material, with which to experiment. The causes for the floating and sinking as well as different properties of the testing objects were reasoned about during children's investigation in the phenomena of floating and sinking. The properties children had mentioned including - shape, material, size, hardness, weight and absorbent.

4. Children consider only one property of the object in relation to their judgments

During testing, the children were pleased to see some predictions confirmed. However, when the paper clip sank, a typical comment was, *It's light but it isn't floating*. They were surprised when the wood floated. *I thought the wood would drop to the bottom and it did but then it floated*. The children tried to explain why one 'light' object floated but not another. *The marbles sank. Maybe it's because they are big. I think the bottle sank because it had water in it*. Children started changing non-relevant justifications to considering one property of the object in relation to their judgments. However, the children based their arguments on everyday experience, for instance, *I have sunk a wooden chess once*, the explanations had been heard from the adult, *my dad told me*, or the flotation occurred because the object is made to float or to sink, *it will float, because it must float*. Gradually, some of these justifications had almost disappeared. These changes showed that children began to consider floating and sinking more accurately in terms of the event itself. Consequently, the reasons why the object sinks or floats were not judged based on their previous life experiences, but the object in this particular context was seen as more significant.

Children started using one property (weight or size) to predict objects' floating and sinking. The justifications are based only on the weight or the size of the object. The child stated their arguments only for weight or size, even though some of them seemed to understand that it is not the only reason. The weight and size were mentioned, but not put together; in particular, size of the object was used to explain the heaviness of an object.

5. Children consider more than one property of the object in relation to their judgments

Some older children predicted sponge's floating as filling with air; others predicted sponge's sinking as filling with water. Children did not accept others' prediction until they saw the truth, then children tried to find reasons for their observation. The teacher guided the child to find a relevant description and helped the child to notice that ‘air’ is not enough of an explanation. Teacher-child interactions, in which the reasons for the floating and sinking had been thought through, improved the children’s abilities to think causally about the phenomena and to reorganize their own ideas. Gradually, those properties were combined with some other relevant features, while children were asked to describe the results from the experiment and explain why this happened.

6. Children try to investigate the causes for the flotation, although not scientifically

In the beginning, children mostly explained the flotation using the weight of the object. After experiment, however, many responses were provided including the idea that the *‘the object is not waterproof’* and *‘the weight of the object is too much’*. To find out the causes for the flotation, some children even linked their answers to the water. When children revisited the project with the researcher, water and not water-proof object was the element that was seen as essential reasons for sinking. First, the objects were seen to be too heavy for water to hold up. Second, the objects were not waterproof. Third, the children regard water inside the objects as a critical feature for sinking. In these cases the weight of the object became excessive.

Teacher : What happen to this plasticine boat, when I put it into the water?
Vince : It will sink if you touch it.
Leon : I have an idea to make plasticine boat sink.
Teacher : What is it?
Leon : Make it round.
Teacher : Why your plasticine boat has a hole in it?
Leon : So that it will sink. (the plasticine boat sinks.)

(WG class observation 15-Plasticine Boat)

During revisiting, children explained how to get a plasticine ball to float and used the justifications in which understanding of the shape of the object became clear. However, the reason why this particular shape affects floating or sinking was not fully understood.

7. Children reveal the understanding of how they came to have the knowledge

Revisiting activity is a tool for connecting prior experience to further learning. A child saw the photos of floating and sinking project where he put a marble into the water and it sank, another child put small Styrofoam ball into the water and it floated. While viewing, he took other child’s perspective and indicated, *small one used to float*. He revealed that he was able to use the viewing experience to communicate that he now saw something he did not know before--that size is not the only justification. Thus, revisiting activity generates new hypotheses and ideas for extending learning, making connections, and constructing new understandings.

Teacher : What kind of object can fall into the bottom of the water?
Vince : Small one.
Teacher : Like small Styrofoam ball?
(Teacher put it into the water and it float.)
Vince : Weird. It used to be sinking.
(Vince pressed the Styrofoam ball to the bottom of the water.)
Teacher : How do you know the thing is going to float or sink?
Vince : I tested and found out whether it will float or not.
Vince : I tested and checked they will be heavy or light, big or little.
(WG class revisiting－with Vince)

Discussion

According to this study, analysis of the children’s conceptual development process is important in terms of developing appropriate teaching methods and supporting the children’s knowledge construction. However, the process of conceptual development seems to be varying and context dependent.

Children’s understanding of floating and sinking

In this study, children demonstrate patterns in their judgments which are similar to the findings of Kohn (1993) that objects much more or much less dense than water are more accurately judged than objects with densities closer to the density of water.

Weight and volume are found to “interfere” in these judgments in systematic ways for the children.

Besides, similar to the findings of Halford (1986), most of children’s judgments are based on the size-weight illusion. Finally, older 5-year-old children are sensitive to substance, with good accuracy in their judgments for objects made of metal. As the children are asked to judge whether the objects would sink or float when placed in water, younger children’s errors are connected to size or weight, this finding is different from the research finding of Kohn & Landau (1987).

Some type of naïve ideas are gradually resolved along with the progress of the project and moved toward more scientific-oriented concepts. However, to ensure that this understanding is accurate, teachers need to know what the children think and why they think it. As educators, we can reveal young children’s naïve ideas and help them unravel their false ideas, as well as provide children with the opportunity and support to develop accurate scientific understanding.

The importance of free exploration, peer interaction as well as teacher - child interaction and the revisiting experience in supporting understanding

According to the findings of the present study, young children enjoy and benefit from free exploratory play, though sometimes the play is not conceptually oriented. Having plenty of time playing in the swimming pool with the objects, children discover the characteristics and properties of objects, and get to understand the phenomena of floating and sinking.

Through peer interaction and teacher - child interaction, children notice that others’ ideas are different from theirs. When exploring together, children support each other conceptually and their verbal skills are improved. These all demonstrate the significance of social interaction. As Butts (1993) emphasizes in his study that hands-on experience is not enough for children. They need cooperation with peers and assistance from teachers to develop the concept of floating and sinking.

Through the teacher’s questioning, the object was considered deeply and the children were guided to justify their explanations. Cognitively, the social interaction demanded several thinking skills; for example, reasoning, and consequently promoted the process of conceptual development. During the social interaction, Vygotsky’s (1978) view about the zone of proximal development can be easily identified in use. Vygotsky’s (1978) assertion about the importance of language in the learning process is also proved in this study. Havu-Nuutinen (2005) also mentioned that to facilitate conceptual change, collaborative discussions that encourage the children to synthesize their views and draw relationships of causes and effects, compare and summarize is seen as important.

The revisiting experience becomes a part of learning in this study. Revisiting activity provides a way for children to review their previous experiences and extend their thinking. When the children noticed that their way of thinking is not as the same as others or the fact or their previous ones, the conceptual change may occur in their conceptual structure.

Conclusion

“The developmental method” used in this study allows researchers to investigate qualitative changes of children’s behavior and conceptual development. The findings of this study are useful for research and teaching site. However, further studies are to be conducted to get more evidences regarding the developmental trend of floating and sinking concepts of young children. The “revisiting” process implemented in the study is found to be an activity effective for young children to reflect on their own thinking and make progress through the experience. It is a tool for connecting prior experience to further learning. Revisiting truly help children generates new hypotheses and ideas for extending learning, making connections, and constructing new understandings.

In addition, providing appropriate and various materials for children to explore and observe objects’ physical characteristics, as well as providing chances for young children to freely explore with objects in order to meet children’s physical and psychological needs, is also found to be essential for young children’s science-related concepts to develop.

By the end of the project, most of the children remained in describing phenomenon of “floating and sinking” stage, and only a few 5- year-old children reached the stage of reasoning. For preschool children, describing phenomenon or event is a significant thinking skill. Thus for the children’s conceptual developmental process, the discussions held with teacher and peers, as well as plenty of time to investigate the phenomenon of “floating and sinking” seemed to be the most significant.

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