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# Contemporary teaching methods and science content knowledge in preschool education: searching for connections[1]

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**Abstract**

Teachers' difficulty in responding to changes of their teaching practice has been often attributed to insufficiency of content knowledge. The present study aims to investigate (a) the teaching strategies preschool teachers use to approach two science concepts (sinking/floating and evaporation), and (b) the influence of the content knowledge on the teaching strategies. Interviews to 20 teachers reveal that their teaching is more consistent with an "empirical" than a "contemporary" approach and that content knowledge is not the principal factor that influences teaching processes.


*Keywords:* preschool education, teachers' strategies, science education, curriculum implementation, science content knowledge;

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## 1. Introduction

Curriculum implementation has been an issue for many researchers. It has been indicated that in many cases there is a significant distance between the official curriculum of preschool education and the applied curriculum (Kallery & Psilos, 2002; Kavalari & Kakana, 2004). Teachers' difficulty in adopting new roles and styles has been attributed to various factors. When it comes to teaching science concepts, research has indicated the components that are responsible for the poor teaching of science concepts in preschool education. One of the most important components is that teachers often have insufficient content knowledge or alternative ideas about science topics (Lawrenz, 1986; Kruger & Summers, 1988; Kruger, 1990; Kallery & Psilos, 2001; Kallery, 2004). Other researchers have indicated that teachers show lack of confidence in approaching these topics (Harlen & Holroyd, 1997; Yoon & Onchwari, 2006) and they often doubt about the benefits of science teaching (Eshach & Fried, 2005).

Since year 2003, a new curriculum has been implemented in preschool education in Greece, the Cross-Thematic Curriculum Framework for Kindergarten (Greek Ministry of Education – Greek Pedagogical Institute, 2002), followed by the complementary Guide for the Kindergarten Teacher (Dafermou, Koulouri & Mpasagianni, 2006). The new curriculum is inspired by interdisciplinary pedagogy (see Eurybase Network, 2009) and proposes a holistic approach of the knowledge accompanied by detailed guidelines about the methodology teachers should follow to approach the teaching objects. It is an open and flexible curriculum and it proposes only a few examples for every teaching object which can help teachers design equivalent activities. Therefore, it enhances teacher's initiative and responsibility for the educational activities that will be finally performed in the classroom. In this context, teachers are assigned to invent, design and carry out activities that are in agreement with their classroom's developmental needs and interests.

The new curriculum integrates Science in the unit "Nature and Interaction" giving emphasis on the way young children learn and discover the world around them. The Teacher's Guide attempts to approach two indicative themes to illustrate the methodology teachers should follow to approach the themes that are appropriate to their classroom. One of the themes described in the Teacher's Guide is "Water" and some of the possible activities that can derive from this theme pertain to Science Teaching. In this context, the present study focuses on two science concepts, Sinking/Floating and Evaporation, which are not explicitly described in the Teacher's Guide. We found only two references, one for each concept, through the presentation of the theme "Water". These references are introductory questions to possible activities relative to the theme ("Put some snow in a cooking pot. What do you observe?" and "Put a pebble and a rubber toy in a basin with water. Do they float or sink?").

## 2. The study

The present study focuses on the content knowledge as a factor that influences teachers' methodological choices to teach Sinking/Floating and Evaporation. Therefore, it examines teachers' strategies searching for possible deviance points from the official guidelines of the current curriculum and tries to find connections with the content knowledge of science.

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### *2.1. Aim*

The aim of the study is to investigate (a) the teaching strategies teachers use to approach two science concepts (Sinking/floating and Evaporation), and (b) the influence of the content knowledge on the teaching strategies.

### *2.2. Hypotheses*

Our hypotheses are that (a) the teaching style will include many "traditional" features, and (b) there will be a positive correlation between the sufficiency of the content knowledge and the use of contemporary teaching strategies.

*2.3. Method*

*2.3.1. Sample*

The sample of the study consists of 20 preschool teachers working in public schools in Attica, Greece. They are all women, having from 2 to 29 years of working experience (mean = 11.4). Sixteen have graduated from Pedagogical Departments and four from a 2-year Pedagogical Academy.

*2.3.2. Procedure*

The data were collected through semi-structured interviews (average duration = 18 min.) and a questionnaire which was presented to them at the end of each interview. During the interview teachers were asked questions concerning their relation with science teaching and their feelings about their sufficiency on this subject. After that, they were asked to describe the way they usually chose to approach two science concepts, sinking/floating and evaporation.

At the end of the interview session, the teachers were given a questionnaire, with 14 questions concerning the content knowledge of these two science concepts. The questions concerned simple science issues that can be approached with young children in a preschool classroom.

## 3. The results

*3.1. Sample*

Seven of the participants are familiar only with the Cross - Thematic Curriculum; the rest based their teaching practice for many years on the old curriculum (Greek Ministry of Education – Greek Pedagogical Institute, 1991) and since 2003 they have been using the Cross - Thematic Curriculum.

*3.2. General aspects on science teaching*

None of the participants finds that the Science Education courses they took at University helped them enough to effectively approach science concepts in the classroom. Personal inquiry and exchange of ideas between colleagues is what helps most. Six mentioned that they feel a great deal of insecurity when dealing with science concepts; one of them had an extreme reaction (“I am very much afraid!”). Five teachers find that science concepts are difficult for the children to understand, the rest believe that it depends on the way the teachers present each concept to the children, and if it is appropriate then they can understand everything.

Nevertheless, they all approach science concepts in their classrooms. The most popular are: water cycle (20), melting/freezing (18), sinking/floating (18) and evaporation (18). All of the teachers agreed that they organize science teaching according to the current curriculum. Six mentioned that they have not discarded the old curriculum yet (“I get carried away”, “I use some ideas”, “I combine both”, “I cannot become totally detached”).

*3.3. Teaching Sinking/Floating*

Thirteen teachers approach the concept each year with their classroom, 5 of them only once and two have never approached the concept. Three teachers describe that the activity emerges by the children (these teachers insist on the fact that everything emerges from the children). The rest of them plan the activity as a part of a theme. This theme can be “Summer” (7), “Water and water cycle” (5), “Planting seeds” (2) or it can stem from different events and more than once during the school year (4).

Most of the teachers address questions to incite children's interest. One teacher was very clear; it is the children who pose the questions after having observed something and then we try to answer them all together (the same teacher insists that every topic emerges from the children). Eight begin the approach with a narration to introduce children to what they are about to do ("I start by giving children some basic theoretical stuff about summer", "we are going to do an experiment, children!"). In most cases (15) the procedure is the same: in a big basin full of water children put different materials gathered from inside or outside the classroom and observe the results. In other cases (3) the teacher puts in the water small boats made of different materials. The discussion that follows is about which materials sink and which float and finally they make a table to classify the materials they used during the experimentation.

### *3.4. Teaching Evaporation*

Evaporation is one of the most common science concepts, since 18 teachers approach it in their classrooms. One mentioned that she didn't have the chance to approach it yet and one that it confuses children, so she has decided not to approach it any more. All those who approach the concept connect it with the subject "Rain and water cycle" performing the same experiment that uses a cooking pot, something to warm the water and a plate to help the steam condenses into water again. This experiment almost never emerges from the children but it is an activity planned by the teacher.

Only six teachers mentioned that they ask children to make predictions, before performing the experiment. Most of them proceed to a discussion with the children after the demonstration. The procedure is strictly based on observation, due to safety problems. After the discussion the children mostly paint the "water cycle". Five of the teachers combine evaporation with melting/freezing, treating them as one concept, the concept of "water".

### *3.5. Analyzing teaching strategies*

The main purpose of the interviews was to reveal if the teaching strategies are based on the official guidelines, or they regress to "traditional" features that are in disagreement with the current curriculum. The thematic analysis of the interviews led us to formulate two basic categories that describe the teaching strategies:

I. "Empirical" approach

The term "empirical" reflects an approach, where children receive information through their senses. In this case, knowledge is simplified and the experiment is a plain demonstration, lacking systematic observation and reasonable conclusions. In this context, the teacher poses inappropriate questions and he or she is responsible to *transfer* knowledge and interpret the results (Ravanis, 1999). This approach also includes references to the piagetian theory, which gives emphasis on manipulation of materials, on developing reasoning skills (through grouping, sorting, comparing) and on previous children's ideas (Ravanis, 1999).

II. "Contemporary" approach

The term "contemporary" characterizes an approach that is based on children's predictions. In this case, experiment and observation are systematic and guide children to test their predictions and come to conclusions by discussing and recording their opinions. The teacher's role is to facilitate children's investigations by providing the appropriate equipment and embedding processes that facilitate learning (cooperative learning, symbolic representations, language etc.) (Ravanis, 1999). Table 1 shows the number of references to each category for each science concept.

Table 1. References to the two categories from the descriptions of the approach of the two science concepts.

| Concept | "Empirical" | "Contemporary" |
|---|---|---|
| Sinking/Floating | 63 | 10 |
| Evaporation | 34 | 8 |
| Total | 97 | 18 |

In the description of the participants' teaching processes we encounter more references that pertain to an "empirical" approach. "Empirical" references are highly increased in the case of Sinking/Floating.

### *3.6. Content knowledge*

The overall score on the content knowledge of the two science concepts that we examined was 5.09 (scale 1 – 10). The score on Sinking/floating was 4.17 and on Evaporation 6.02. Considering the content of the questions which concerned simple science issues we evaluate these scores as low.

The main interest of the present study is to have a penetrating view and to find possible connections between a specific score on content knowledge with specific teaching processes. Table 2 contains the findings for each participant. The number of references to features of each teaching strategy ("empirical" and "contemporary") as well as each participant's score on the content knowledge of sinking/floating and evaporation are presented.

Table 2. References to the two teaching strategies and content knowledge score.

| | **"Empirical" (number of references)** | **"Contemporary" (number of references)** | **Content knowledge (scale 1-10)** | **"Empirical" (number of references)** | **"Contemporary" (number of references)** | **Content knowledge (scale 1-10)** |
|---|---|---|---|---|---|---|
| | Sinking/Floating | | | Evaporation | | |
| 1 | 4 | | 5.7 | | | 2.8 |
| 2 | 5 | 1 | 7.1 | 2 | 1 | 4.2 |
| 3 | | | 7.1 | 2 | | 7.1 |
| 4 | 3 | 2 | 2.8 | 2 | | 4.2 |
| 5 | 4 | 1 | 1.4 | 3 | | 8.5 |
| 6 | 4 | | 2.8 | 2 | | 7.1 |
| 7 | 6 | | 2.8 | 1 | 2 | 7.1 |
| 8 | 1 | | 10 | 2 | | 10 |
| 9 | 2 | | 4.2 | 2 | | 2.8 |
| 10 | 1 | 2 | 2.8 | 1 | | 4.2 |
| 11 | 1 | | 1.4 | 3 | | 2.8 |
| 12 | 4 | | 7.1 | 1 | | 10 |
| 13 | | | 0 | | 2 | 5.7 |
| 14 | 5 | 1 | 7.1 | 2 | 1 | 4.2 |
| 15 | 3 | 2 | 2.8 | 2 | | 4.2 |
| 16 | 4 | 1 | 1.4 | 3 | | 8.5 |
| 17 | 4 | | 2.8 | 2 | | 7.1 |
| 18 | 6 | | 2.8 | 1 | 2 | 7.1 |
| 19 | 2 | | 4.2 | 2 | | 2.8 |
| 20 | 4 | | 7.1 | 1 | | 10 |

As we see in the table there are 7 participants who explicitly referred to the "contemporary" approach when describing teaching Sinking/Floating. These participants have a low score on the content knowledge of this concept (mean 3.6). There are 7 participants with a high content knowledge score (5.7 – 10.0) on this concept; five of them gave only "empirical" references.

When it comes to Evaporation, five teachers give "contemporary" references and these teachers have a moderate score on the content knowledge (mean 5.6). There are 10 participants who have a high score (7.1 – 10.0) in the content knowledge of evaporation; eight of them gave only "empirical" references.

## 4. Discussion

The present research cannot claim that there is an immediate connection between the teaching strategies and the content knowledge. It seems that the teaching practice to approach Sinking/Floating and Evaporation is so well established, that it is not significantly affected by the content knowledge of these science concepts. One must have an inclusive look by examining and combining all the components that are reflected on the teaching practice, such as teachers' attitudes, beliefs and perceptions which can all lead to inappropriate teaching choices. The authors intend to extend the present study by performing observations in order to have a more detailed view on the way these two science concepts are approached in preschool classrooms.

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