Kindergarten teachers' beliefs and practices towards elicitation in science teaching

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ABSTRACT

This study investigated a) how teachers view children's ideas in science, b) if and how they elicit young learners' thinking about natural phenomena and concepts, and c) what is the meaning and the purpose of elicitation for the teachers. A two-phase mixed-method was implemented with 15 kindergarten teachers including a) drafting a lesson plan for teaching a science concept, and b) in-depth interviews. The results indicated that although the participants value elicitation practices in early science for various and important reasons and state that they implement elicitation practices in their curriculum, they seem uncertain about how to incorporate the information they derive from elicitation in their science curriculum.

KEY WORDS

Early science teaching, children's ideas, elicitation, teachers' beliefs and practices

RÉSUMÉ

Cette étude a examiné a) comment les enseignants perçoivent les idées des enfants d'âge préscolaire concernant des phénomènes naturels et concepts scientifiques, b) si et comment ils recueillent leur idées et c) comment ils comprennent le sens et le but de ce processus pour l'enseignement des sciences naturelles. Une approche qualitative a été employée pour le recueil des données, qui s'est déroulé en deux phases, et 15 enseignantes de maternelle ont participé. Chaque enseignante a) a rédigé un plan de cours pour enseigner un phénomène naturel, et b) a participé à un entretien en profondeur. Les résultats montrent que les enseignantes apprécient la pratique de recueil d'idées pour enseigner des sujets de sciences naturelles à l'école maternelle et elles rapportent des raisons diverses et importantes. Elles ajoutent aussi qu'elles mettent en œuvre des pratiques variées pour recueillir les idées des enfants, mais elles semblent incertaines quant à la manière d'incorporer dans leur programme les informations qu'elles tirent de ce processus.

MOTS-CLÉS

Sciences naturelles, école maternelle, idées des enfants, recueil des idées, perspectives et pratiques

THEORETICAL FRAMEWORK

Children's ideas in science

While the research on young children's ideas in science is expanding, and it has been acknowledged that they are experiential learners, different approaches of science teaching and learning in early childhood are developed. What these approaches do undoubtedly share, is the assumption that the understanding of children's ideas for natural phenomena is crucial for science teaching, because their informal knowledge serve, among others, as a source of information for planning science activities, responsive to the needs of young learners (Hedges & Gullen, 2005; Ergazaki, Saltapida & Zogza, 2010; Papandreou & Terzi, 2011).

According to constructivism, children's ideas are individual constructs, which form conceptual models. Children use these models in order to understand the world around them. In the related literature, children's ideas are described as misconceptions, alternative or erroneous ideas, and obstacles, while they are characterized as robust, persistent and resistant to change through teaching (Allen, 2010). Drawing on this theoretical viewpoint, over the last forty years many researchers have studied individual understandings of various science concepts with the aim to identify specific levels through which children gradually construct conceptual models in science. For this purpose, different methodological tools have been implemented such as interviews and experimentations or drawing activities (e.g. Delserieys, Impedovo, Fragkiadaki & Kampeza, 2017; Christidou & Hatzinikita, 2006; Papandreou & Terzi, 2011). According to this view, the purpose of science teaching, should be to help children change, replace, or overcome their misconceptions (e.g. Allen, 2010; Kambouri, Briggs & Cassidy, 2011; Ravanis, Papandreou, Kampeza & Vellopoulou, 2013).

This line of research has produced important results for children's conceptual development related to various scientific concepts and phenomena, but another research perspective -based upon cultural-historical approach (Vygotsky, 1978)- stresses the importance on the way young children's scientific thinking develops (Fleer & Robbins, 2003; Robbins, 2005). This theoretical viewpoint acknowledges the individual, social and cultural aspects of children's learning and development. By actively participating in cultural and social activities, interacting with tools and artefacts, and familiarizing themselves with family stories and habits, children create a rich repertoire of knowledge (Fragkiadaki, Fleer & Ravanis, 2017; Robbins, 2005). For cultural-historical approach this everyday knowledge is not information which needs to be weakened and replaced by scientific knowledge (Ravanis, 2017); instead it comprises resources which are critical and indispensable for the learning of scientific concepts (Vygotsky, 1978). As Thulin and Redfors point out (2017), "the teacher needs to simultaneously take into account children's experiences and create links to the (new) science content in focus" (p. 511).

The research on children's thinking that draws upon the cultural-historical approach does not focus on specific elicitation practices. However, researchers stress the need to map children's experience on science and the way their thinking is developed in relation to their cultural and family environment, their interactions with peers and adults, as well as with the tools and artefacts they use (Fleer & Robbins, 2003; Fragkiadaki et al., 2017). Additionally, other researchers suggest that if we want to listen to every child's voice in the classroom context, we have to introduce different elicitation activities, as different children may prefer different means of communication (Papandreou & Terzi, 2011).

Teachers' views and practices

According to research findings, kindergarten teachers believe that science is a difficult learning area which they are not adequately trained to teach, and reason, they avoid teaching science or have feelings of discomfort when they do so (Hedges & Gullen, 2005; Howitt, 2007; Pendergast, Lieberman-Betz & Vail, 2017). Their science curriculum includes traditional or empirical approaches and consists of fragmentary activities lacking coherence (Kallery, Psillos & Tselfes, 2009). They prefer to provide correct answers to children's queries, instead of trying to understand and promote their scientific thinking (Kambouri, 2016; Kavalari, Kakana & Christidou, 2012).

However, little is known about early childhood teachers' beliefs and practices related to children's prior knowledge. Kallery et al. (2009) found out that preschool teachers do not base their interventions on children's ideas, while Kambouri's study (2016) showed, among others findings, that although kindergarten teachers recognize the importance of the elicitation process for teaching science, "they seldom have the time to identify children's preconceptions and tend to assume a certain base of knowledge" (p. 17). Nevertheless, this issue seems more complex and should be studied further.

Purpose of the study

The aim of this study was to contribute in understanding kindergarten teachers' views on the elicitation of children's ideas during science teaching and their related practices. Research questions were formulated as follows:

1. How Greek kindergarten teachers' view young children's ideas on scientific concepts and natural phenomena?
2. Do they implement elicitation practices in their science curriculum?
3. What is the meaning and the purpose of elicitation for them?

METHODOLOGICAL FRAMEWORK

Fifteen in-service kindergarten teachers participated in this study. Data were collected in two phases. First teachers were asked to make a short planning for teaching a science concept or topic in their classroom, while in the second phase, a semi-structured interview was conducted during which they were asked to describe in detail their planning and to answer a series of specific questions related to the research questions.

Data from both the transcriptions of the audio recorded interviews and the teachers' lesson plans were analyzed. The first phase of the thematic analysis (Braun & Clarke, 2006) applied in this study was to become familiar with the data. Then, during coding phase, features of the data, which were considered pertinent to the research questions, were identified. Furthermore, the original categories were reexamined and incorporated into overarching themes evident across the data. Finally, the themes were labeled, and a report was produced which involved representative examples of transcripts to illustrate elements of the themes.

FINDINGS

Findings from this study are presented in relation to each research question noted above. They are aggregated into the categories that emerged during the analysis and are illustrated with examples from the teacher's interviews.

How teachers' view young children's ideas on scientific concepts and natural phenomena

The analysis process elicited two key concepts evident across the data, which reflect teachers' perspective on children's scientific thinking, and have been labelled as "origin of children's ideas", and "features of children's ideas".

Origin of children's ideas

As the data analysis demonstrated, all the participants naturally referred to the origin of children's ideas, without been asked (Table 1). Family seems to be the main context which influences children's scientific understanding according to them (N=10).

TABLE 1

The origin of children's ideas in science

Context	Categories	Teachers	Examples	T
Family	Stimulus offered in their home environment	T1, T2, T3, T7, T11, T12, T14	*Stimuli that children get from home are a very important factor (T11)*	7
	Parent respond to children's queries	T3, T10, T13, T14	*...surely parents have addressed children's curiosity because children always ask 'why' about all sorts of things, let alone about the strange and mysterious world of science (T10)*	4
	Social and religious background	T15	*...it depends on the family's social background but also on their religious beliefs (T15)*	1
Community	Peers/friends	T15	*… children have some ideas from their interaction with other kids* (T15)	1
	Technological means	T1, T2, T3, T11	*Children hear things from television from videos (T2)* *The Internet and computers in general provide them with stimuli (T11)*	4
Natural environment & material world		T2, T4, T5, T6, T7, T8, T9, T15	*Because they are in the natural environment and children have already observed nature during early childhood(T5)*	8

Community has also an impact on the formation of children's ideas but only for five teachers. Surprisingly this category includes only peers and technological means such as the *internet, video, TV* and *computers*. For eight teachers, another important resource for the informal science knowledge that children bring to school, is their interaction with the natural environment.

Features of children's ideas

In order to describe the children's ideas on natural phenomena, the participants referred to 11 specific attributes (Table 2). Their ideas were characterized mostly as erroneous, robust and resistant, and rarely as correct, based on experience, funny, unexplainable or magical, uncertain, original, animistic and theocratic beliefs. However, most answers blended together various features *(*e.g. T10: *They have some ideas but usually their ideas are incorrect…their ideas do not correspond with reality, they have their own beliefs … in their imagination).*

TABLE 2

Features of children's ideas

Features	**Examples**	**Teachers**	**T**
Misconceptions	*their ideas are incorrect, only experimentation can make them accept the correct ones* (T4)	T1, T2, T3, T4, T8, T9, T10, T14	8
Robust and resistant	*some children have unwavering ideas, and do not accept others' judgments* (T4)	T1, T4, T9, T11, T14, T15	6
Correct	*their views are usually correct, i.e. they know what is happening because they learn it from some books they read at home.* (T12)	T1, T12, T14	3
Based on experience	*they can discuss (or demonstrate) only of what they see, for example, they may say: when it rains, lightning strikes* (T7)	T2, T4, T7, T15	4
Funny	*Their ideas are funny, but for them this is their reality* (T10)	T10, T12	2
Unexplainable, magical or unrealistic	*… some others are unexplainable. For example, it rains because ... there is water in a storehouse and because a magician says: 'water go to earth', it rains* (T1)	T1, T12, T13	3
Original	*their answers … and their ideas can surprise you … are quite original*	T12	1
Uncertain	*…other kids are not sure and say, yes it can be done, maybe the other and later something else and so on.*	T4	1
Animistic	*For example, they may believe that the bubbles are crying because they read a fairy tale that the balloon is very disturbed*	T14	1
Theocratic	*Sometimes give explanations such as 'the God did that'*	T12	1

Teachers' elicitation practices in their science curriculum

Two main themes were evident across the data, which have been labelled as "spontaneous reference to elicitation practices" and "responses to related questions". The former was identified in teachers' lesson plans, while the latter in the way teachers answered to the researcher's questions related to elicitation practices.

In their lesson plan, 12 teachers spontaneously described how they indented to elicit children's ideas at the opening of their teaching and nine at the closure, while only two mentioned the monitoring of children's thinking throughout the activities (Table 3). In contrast, when teachers were asked whether they use elicitation practices in each of the three phases of science activities, all of them responded positively to the researcher. Also, it is worth mentioning that the teachers reported many different elicitation practices, especially in both the opening and the closuring of the activities, and, as the Tables 4, 5 and 6 show, some of them mentioned more than one practices.

TABLE 3

The elicitation of children's ideas in different phases of science lesson/activities

	Opening	**T**	**Throughout the activities**	**T**	**Closure**	**T**
Spontaneous reference to elicitation practices	T1, T2, T3, T5, T6, T7, T9, T10, T11, T12, T13, T14,	12	T6, T7	2	T1, T2, T3, T5, T6, T7, T9, T10, T11	9
Reference to elicitation practices as respond to related questions	T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11, T12, T13, T14, T15	15	T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11, T12, T13, T14, T15	15	T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11, T12, T13, T14, T15	15

TABLE 4

Elicitation practices at the opening of science activities

Elicitation practices	**Spontaneous reference to elicitation practices in lesson plans**	**T**	**Responses to related questions**	**T**
Discussion (questions)	T2, T5, T7, T10, T12	5	T1, T2, T4, T5, T7, T8, T9, T10, T12, T13, T14	12
Discussion (questions) & documentation, *"what we already know?"* routine	T3, T6, T10, T11, T13	5	T3, T6, T10, T11, T12, T14	6
Prediction or/and reasoning questions by using teaching material	T4, T7	2	T2, T4, T12	3
Narratives, puppet show, or dramatic play	T10, T14	2	T4, T5, T7, T10, T14	4
Art making (drawing, model making etc.)	T2, T10	2	T2, T4, T9, T10, T11, T14, T15	7
Games with rules		-	T4, T8, T9, T10, T11, T12, T14, T15	8
Observation & documentation of incidental events	T1, T9	2	T7, T9, T15	3

The most common elicitation practice at the opening of science activities that the teachers mentioned spontaneously, was a whole-class discussion with or without the documentation routin*e: "what we already know?",* while after the researcher's question they emphasized the use of discussions, artmaking and games with rules (Table 4). Discussions were also proposed spontaneously as an assessment technique at the closing of science activities, while after the researcher's prompt, teachers added the use of worksheets, art making and presentations of the new learning (Table 6). Finally, the strategy of observation of children's actions seems to be the most familiar practice the teachers use for eliciting children's thinking throughout science activities (N=13, Table 5).

TABLE 5

Elicitation practices throughout science activities

Elicitation practices	Spontaneous reference to elicitation practices in lesson plans	T	Responses to related questions	T
Discussion (questions)			T3, T9, T11, T14	4
Experiment & prediction questions	T6, T7	2		
Puppet show			T4	1
Art making (drawing)			T4, T15	2
Observation & documentation of children's actions	T6	1	T1, T2, T4, T5, T6, T7, T8, T9, T10, T11, T12, T14, T15	13

TABLE 6.

Elicitation practices at the closing of science activities

Elicitation practices	Spontaneous reference to elicitation practices in lesson plans	T	Responses to related questions	T
Discussion (questions)	T6, T7, T9, T11,	4	T1, T2, T4, T5, T6, T8, T10, T12, T15	9
Worksheets	T6, T11	2	T4, T6, T9, T11, T13	5
Artmaking (drawing, model making, journals, posters)	T2, T10	2	T2, T8, T14 T15	4
Puppet show or dramatic play			T8 T3, T13	3
Oral presentation with or without posters	T5	1	T5, T11, T14, T15	4
Discussion (questions) & *"what we have learned"* routine	T3	1	T3, T11	2
Games with rules	T1	1	T8, T15	2
Observation & documentation of incidental events			T7, T9	2
Parents questionnaire			T11	1

The meaning and the purpose of elicitation practices

Through the data analysis, five reasons for eliciting children's ideas were revealed. As demonstrated in Table 7, the teachers' main intention is to plan appropriate science activities or their future science curriculum (T4*: …. This way, I can define later on what goals I am setting and which direction I am following concerning my teaching practice*). Teachers' statements (N=10) about the role of elicitation for assessing children's learning before or after an activity, were quite explicit. They reported that children's ideas help them to identify misunderstandings and obstacles, achievements, and new learning outcomes (T2: [I use their ideas] *In order to identify their progress, their comprehension of the phenomenon, how well they have overcome any possible cognitive thinking obstacles. To observe their progress)* and what knowledge they bring from their home (T12: *you will be able to learn a lot of things about their home, their environment, the way they work with their parents).* From the other side, only five teachers reported that they assess teaching effectiveness (T13: *[their ideas] help me see what I did right or what I did wrong, what I could have changed… I think that children's ideas can work as feedback for the teacher),* while others (N=4) expressed their aim to increase children's interest for the science activities through elicitation Only one teacher thinks of elicitation as a means for allowing children to share their previous experience.

TABLE 7
Why teachers elicit children's ideas

Teachers' intentions	Teachers	T
Plan science activities		
1. Identify objectives	T3, T4, T7, T9, T10, T15	6
2. Identify both the context and the structure of the activities	T1, T2, T6, T7, T8, T10, T14, T15	8
3. Plan future science programs	T5, T10, T12, T13, T14, T15	6
Assess children's learning		
1. Identify obstacles, misconceptions, lack of knowledge or difficulties	T1, T2, T3, T4, T6, T8, T10	7
2. Accomplishments, achievements, changes in thinking	T1, T4, T6, T11, T12, T13	6
3. Identify influence from family's members	T1, T12	2
Assess teaching effectiveness	T3, T7, T10, T13, T15	5
Increase children's interest	T2, T5, T11, T12	4
Support the sharing of experience	T6	1

DISCUSSION

In this section, by summarizing the main findings of this study and reviewing the perspectives of the participants, we address the research questions and look for the theoretical assumptions these teachers share.

Their views about the origin of children' ideas reflect points from the sociocultural paradigm and are supported by previous researches which have evidenced the family background as the main source of children's informal science knowledge (e.g. Sikder & Fleer, 2015). However, most teachers seem to overlook cultural resources, which also influence children's knowledge (Hedges, Gullen & Jordan, 2011).

From the other side, some teachers consider the children's interaction with the natural environment as the only influential factor for the formation of their ideas, a view that seems to be based on a constructivist perspective. Their views on the features of children's ideas also seem to emerge from the same perspective, as most teachers described them as misconceptions, robust and resistant (Kambouri, 2016). Other characterizations, like funny, magical and unexplained ideas, imply that children's thinking is naïve and immature, reflecting a more traditional and romantic view of the young child.

In contrast with Kambouri's findings (2016), in this study the majority of the participating teachers spontaneously claimed that they implement elicitation practices in both the opening and closing of their science activities; this practice might reflect their understanding of elicitation as an important component of science teaching. What is more interesting in the present study is the variety of elicitation strategies the teachers reported, though the list was notably increased after asking teachers to propose ways for supporting the taciturn children to express their ideas.

Teachers mentioned various activities, which are common in the kindergarten curriculum. Except discussions and questions, which are the most common practices for eliciting children's ideas, they reported both the *"what we already know?"* and the *"what we learned?"* routines, which imply that their science curriculum incorporates approaches like the inquiry-based learning and practices like the use of the KWL chart (Smolleck & Nordgren, 2014). The variety of elicitation practices (Tables 4, 5 & 6) might be interpreted as the teachers' endeavor to enable children to express their knowledge and experience, and as an indication of the importance they attribute to the process of elicitation of children's ideas. From the other side, their lesson plans showed that they do not propose different practices in conjunction (e.g. a drawing activity and a game with rules), and when they suggest more than one practice, they rarely have the explicit purpose to empower all the children to express their ideas, as the literature suggests (Papandreou & Terzi, 2011). Furthermore, the lack of elicitation practices during the science activities may suggest that the participating teachers are unaware of the importance of documenting children's thinking as it evolves through their participation in science-related interactions and material manipulation, which may mean that they consider learning rather as an automatic change from a starting point to an endpoint and not as an ongoing and dialectical process.

Participants seemed also unsure of how to use the data derived from elicitation activities, though they report a series of reasons for justifying the importance of elicitation in early childhood science. Although most of them claimed that they use elicitation in order to formulate the objectives and the structure of the science activities, in their lesson plans they did not actually describe how the children's ideas could contribute to the activities they presented afterwards. These teachers, as well as those who value elicitation as a means to motivate children to participate in science activities and share their experience with each other, seem to use elicitation simply as an introduction to the next activity. As Larkin (2012, p. 946) points out, "from this perspective, a teacher did not necessarily need to do anything with the ideas once they were elicited; the act of eliciting them was a purpose in itself".

Likewise, not all of the teachers who valued elicitation as an assessing tool seemed sure of what to do with the children's ideas and the changes in their thinking. Only the teachers who focused on children's obstacles and misconceptions (e.g., T8, T10) made some specific, though traditional, suggestions for the following steps of their instruction like T8: "*Hence, if I observe that they keep having erroneous ideas or misconceptions, this means that something is wrong, and I will repeat an activity, I will pose questions again and I will repeat the points*".

Generally, most of the participants seem to understand the role of elicitation in science learning through a traditional perspective as they emphasize elicitation mostly as a tool for them, i.e., to provide them information to plan new activities and assess children's progress along with their own efficiency. However, very few seem to consider that elicitation also serves children's learning as it allows self-assessment processes to take place when children share their thinking with their peers and/or compare their current and previous ideas.

CONCLUSIONS

Contemporary research has provided evidence of the broad prior knowledge and experience children bring to school; it has showed that teachers should be aware of and build on this prior knowledge (Hedges & Gullen, 2005). It is also stressed that, teachers' knowledge and beliefs impact on the science curriculum offered to children (Kallery et al., 2009; Thulin & Redfors, 2017). In line with this viewpoint, the present study aimed to investigate early childhood teachers' views and practices on children's ideas in science. By highlighting the main findings of this small exploratory study discussed above, we can assume that the participants waver among different theoretical assumptions for both young children's thinking and science teaching in early childhood. In general, they consider children as experiential learners and acknowledge both their everyday knowledge on natural phenomena and the influential factors for this knowledge, though partially. However, it does not emerge from the findings that these teachers are aware of the richness of the children's prior knowledge or that they explicitly consider them as competent learners. It is also noteworthy that they value both science teaching and elicitation practices in early childhood for various and important reasons but, as it is demonstrated they remain uncertain of how to incorporate the information they collect from elicitation in their science curriculum. These beliefs and practices might have important consequences on children's science learning, since research in early science cited in this paper, suggests that a lack of emphasis on children's prior knowledge may limit learning and teaching opportunities.

The aspect of kindergarten teachers' professional profile demonstrated by this study generates thoughts for both their initial education and their professional development. It would be challenging for example, to re-consider a) the content of their education (enriching it with pedagogical approaches that value elicitation of children's ideas in early childhood science education), and b) strategies that allow teachers to reflect on their views about young children and their thinking, the meaning of the information they receive from the elicitation process and the ways they could use it for developing children's science knowledge and experience.

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