Designing teaching activities for kindergarten: student-teachers' proposals for the rainbow

KLEOPATRA PASKOU[1], ATHINA CHRISTINA KORNELAKI[2], GEORGE KALIAMPOS[3]

[1]*Department of Educational Sciences*
and Early Childhood Education
University of Patras
Greece
kpaskou@gmail.com

[2]*Early Childhood Education Department*
University of Ioannina
Greece
akornelaki@uoi.gr

[3]*Department of Education*
School of Education
University of Nicosia
Cyprus
kaliampos.g@unic.ac.cy

ABSTRACT
The present paper discusses a pathway to study pre-service teachers' actual knowledge through their designed teaching activities on topics of Natural Sciences. Its importance lies on the assessment of teachers' readiness and the effectiveness of their potential interventions. To this direction, a theoretical grid is proposed, which classifies teachers' activities into four theoretical frameworks (empiricist, Piagetian, socio-cognitive, socio-cultural). The research was implemented to 17 3rd year students – future preschool teachers from the Department of Educational Sciences and Early Childhood Education of the University of Patras in Greece. Students were asked to design teaching plans about the rainbow phenomenon and their texts were analyzed qualitatively using the aforementioned grid. The results showed that most of the students approached the topic in the empiricist framework intentionally or not. Their difficulty to apply the theoretical frameworks into practice indicates the strong influence prior experiences have on the teachers and raises questions about the formal education's effectiveness.

KEYWORDS
Theoretical frameworks, preschool teaching scientific activities, rainbow

RÉSUMÉ
Le présent article examine une méthode permettant d'étudier les connaissances réelles des enseignants en formation initiale par le biais d'activités d'enseignement conçues sur des sujets liés aux sciences naturelles. Son importance réside dans l'évaluation de l'état de préparation des enseignants et de l'efficacité de leurs interventions potentielles. Dans ce sens, une grille théorique est proposée, qui classe les activités des enseignants dans quatre cadres théoriques

(empiriste, piagétien, socio-cognitif, socio-culturel). La recherche a été menée auprès de 17 étudiants de troisième année - futurs enseignants de maternelle - du département des sciences de l'éducation et de l'éducation de la petite enfance de l'Université de Patras en Grèce. Les étudiants ont été invités à concevoir des plans d'enseignement sur le phénomène de l'arc-en-ciel et leurs textes ont été analysés qualitativement à l'aide de la grille susmentionnée. Les résultats ont montré que la plupart des étudiants ont abordé le sujet dans le cadre empirique, intentionnellement ou non. Leur difficulté à appliquer les cadres théoriques dans la pratique indique la forte influence des expériences antérieures sur les enseignants et soulève des questions quant à l'efficacité de l'éducation formelle.

MOTS-CLÉS
Cadres théoriques, activités scientifiques d'enseignement préscolaire, arc-en-ciel

INTRODUCTION

Introducing children of 3 to 8 years old in the study of materials and entities of the natural world, natural phenomena and concepts of Natural Sciences in general, has been the subject of various scientific fields such as Preschool Pedagogy, Cognitive and Developmental Psychology and Genetic Epistemology, Science Education. Thus, some research focuses on the difficulties of constructing natural entities, phenomena and concepts in young students' thinking (Fragkiadaki, 2020; Kaliampos et al., 2020; Pantidos, Herakleioti, & Chachlioutaki, 2017; Skopeliti, Thanopoulou, & Tsagkareli, 2018), the design or study of relevant modules of the curriculum (Adbo & Vidal Carulla, 2019; Ampartzaki, Kalogiannakis, & Papadakis, 2021), while other research focuses on issues concerning teachers, such as their knowledge, beliefs and practices (Draganoudi, Lavidas , & Kaliampos, 2021; Draganoudi et al., 2022; Kornelaki & Plakitsi, 2018; Vartuli, 1999; Zotti & Fragkiadaki, 2021). These research fields have a significant potential despite being still under development.

THEORETICAL FRAMEWORK

In recent decades, there seems to be a growing interest in Educational Sciences in teachers' knowledge and their relationship with knowledge, teaching strategies and practices. Two broad trends are identified in this already broad field: the study of teachers' perceived knowledge, often recognized in the literature as opinions or beliefs, and the actual knowledge that reflects teachers' representations. As stated in the literature (Paskou, Kaliampos & Ravanis, 2021, p. 33). "Perceived knowledge-belief refers to the amount of convincing information in a particular orientation that someone has about a target issue (Tormala & Petty, 2007; Vellopoulou, & Ravanis, 2012). Actual knowledge-representation is a direct and clear awareness of certain parameters such as facts and their conditions of existence (Ergazaki & Zogza, 2012; Hindarti et al., 2021; Jelinek, 2021; Kambouri, 2016; Kampeza et al., 2016; Ravanis, 2020). Perceived knowledge thus falls under the metacognitive domain while actual knowledge under the cognitive domain (Dori & Avargil, 2015)".

In this context, the study of preschool teachers' actual knowledge on issues related to their practices when designing teaching activities on specific topics such as the thermal or electrical phenomena is considered of particular importance. The limited data in this area make relevant initiatives like the present necessary for various reasons. The main reason is that knowledge which extends to a wide range of concepts and phenomena but also to a certain depth, allows the systematic assessment of teachers' readiness and the effectiveness of potential

interventions. Furthermore, it allows the design of the formal education on a solid basis as well as the continuous training in Natural Sciences and a repertoire of successful teaching practices.

Of course, the use of a framework that allows us to systematically illuminate teachers' choices that will be documented in the research is an important matter. For the reason that creating systems for receiving research data, systems that can shed light on these practices beyond some subjective assessments are necessary. Such a theoretical grid has been proposed for many years (Ravanis, 1996) and is being developed and refined to this day (Ravanis, 2021). It is about a classification of teachers' and preschool students' practices as well as the educational activities' design and/or implementation in four distinct frameworks with different theoretical backgrounds and perspectives.

The first framework is characterized as empiricist and comes from the theoretical psychological and pedagogical currents, which recognize learning as a transfer of knowledge. Thus, it essentially supports a heterogeneous relationship, giving the teacher a central and guiding role and the student a passive-regional attitude. The second framework referred to as Piagetian is based on the central premise of Genetic Epistemology, in which the individual gradually begins to build his intelligence individually through interaction with the material world around him. Based on this hypothesis, important for learning is the ability of the child to interact autonomously with the materials of a designed environment and the systematic support of the teacher in this autonomous activity. The third framework, socio-cognitive, recognizes that children's approach to the concepts and phenomena of Natural Sciences is hindered by mental representations that are distant or at odds with school knowledge. Thus, the role of the teacher is to create the appropriate teaching conditions in which students actively overcome their difficulties and transform their original mental representations. Finally, the fourth framework, socio-cultural, is based on the hypothesis of the holistic development of the child, where the individual, mental, social and cultural dimensions are combined in an open perspective to create learning, communication and developmental perspectives. Here, young children and teachers create and share experiences and interact using each cultural tool.

This paper presents the results of research related to the analysis of students – future preschool teacher's written designs of teaching activities about the rainbow based on the model of the four aforementioned frameworks.

METHODOLOGY

Sample

The sample was selected through voluntary participation of 3rd year student – future preschool teachers who were enrolled in a course on the introduction of young Kindergarten students to Physical Sciences. Voluntary participation stems from the good self-image and confidence of participant's knowledge about the topic (Rosenthal & Rosnow, 1969). At the same time, according to Cohen, Manion & Morrison (2018) while convenient sampling may not result in generalisability to the rest of the population, yet it can act as a starting point for studying further and researching the topic. Along this line, having been informed through a detailed message about the objectives and topic of the research, 17 students – future preschool teachers agreed to be interviewed and design rainbow activities in a hypothetical Kindergarten context. Participants had no specific knowledge about the rainbow phenomenon from a physicist point of view. However, they had been systematically taught, within the course, the 4 distinct frameworks for developing teaching activities.

Data analysis

A qualitative approach was used in the analysis. In particular, the participants sent, via email, the texts of the proposed written activities to the researchers. These texts were collected and processed using content analysis (Cohen, Manion, & Morrison, 2018). The analysis focused on both the role of the teacher during the activities and the teaching subject as well as the role of the child during the development of the activities appeared in the texts. The analysis finally led to the classification of the texts into the four distinct theoretical frameworks mentioned above (empiricist, Piagetian, socio-cognitive, and socio-cultural) as well as their combinations.

More specifically, in the empiricist context were classified students' activities that suggest the teacher being at the centre of the activities, presenting and conducting demonstration experiments to confirm the concepts or phenomena presented in the class. Students passively watch the implementation of the experiments, and they are called to answer teacher's questions. The teaching subject in this perspective concern the approach of natural phenomena mainly by conducting experiments.

A number of activities were classified in the Piagetian context due to the fact that in those the teacher sets the desired goals of the activities, prepares and presents the materials, monitors students' actions and intervenes only when he deems it necessary. The young students in turn interact with the materials, plan what they will do with the materials given to them and finally, implement their plans by building knowledge. Like above, the teaching subject concern activities related to the phenomenon.

In the students' activities classified in the socio-cognitive context, the teacher acts as a mediator creating a sequence of activities which aims to create cognitive destabilization or conflict with the immediate result of overcoming the difficulties of students' experiential mental representations. Students reconstruct their mental representations having an active role in the designed environment suggested by the teacher. The teaching subject in this approach concerns activities that contribute to the destabilization of young students' mental representations.

Finally, in the students' activities classified in the socio-cultural context, the teacher appears to approach the natural world utilizing special pedagogical tools such as the symbolic play. Thus, students by engaging in symbolic play, give the objects a symbolic meaning and therefore the teaching subject in this approach is related to the structured play.

RESULTS

In this section the results obtained from the analysis of the students' teaching plans are presented. The results' frequencies are illustrated in Table 1. Moreover, for each of the four approaches representative examples are given using excerpts from the students' texts. In table 1 the frequencies of students' choices are depicted.

TABLE 1

Students' proposals' frequencies for each didactic approach

Theoretical frameworks	N	N%
Empiricist	12	58
Piagetian	1	6
Socio-cognitive	2	12
Socio-cultural	2	12
Empiricist and Socio-cognitive	1	6
Socio-cultural and Socio-cognitive	1	6

Empiricist approach

More than half of the students (58%) used in their texts teaching approaches that fall into the empiricist framework. In this context, all the students' activities in which the teacher appears to hold a central role in the implementation of the activities by asking questions to students were included. For example, "*I will ask questions such as: which colours constitute rainbow and how is rainbow constructed*" (Subject 9). Descriptions that suggest students being passive during the activities are also classified in this context. For example, "*students will follow teacher's guide*" (Subject 12, 14). Finally, in the empiricist context are classified descriptions that show that the rainbow phenomenon is made sensate to students by observing an experiment without their active participation to it. For example, "*students will attend an experiment*" (Subject 5).

Piagetian approach

In the theoretical perspective of the Piagetian framework, the activities of only one student are classified. Only in her activities the teacher seems to monitor students' actions and to intervene when needed while the students interact with the given materials "*I will be watching students to see how they operate and think, and I will encourage them to create constructs and act to the materials*" (Subject 15).

Socio-cognitive approach

In the texts of two students are illustrated teaching activities which are compatible with the socio-cognitive framework. In this approach, are included responses in which the teacher seems aware of students' mental representations. For example, "*Teacher will be informed about student's mental representations on rainbow through card depictions*" (Subject 13), "*Teacher will be informed about student's mental representations on rainbow through a story telling*" (Subject 17). In the socio-cognitive context the activities that showed that the rainbow phenomenon is approached with activities that utilize elements of the natural world are also classified. For example, "*the distinguish of rainbow will be with a natural and an artificial way of creating rainbow*" (Subject 13).

Socio-cultural approach

In the socio-cultural framework the teaching proposals of two students are included. In this approach, activities in which the teacher seems to approach the natural world using the symbolic play as a pedagogical tool are classified. For example, "*teacher will use music games to approach physical world from different paths*" (Subject 1), "*students sing a rainbow song that represents hope after rainstorm*" (Subject 8). Moreover, in this approach are classified the students' ideas in which they assume that the students will give some symbolic meaning to the objects. For example, "*students will create the rainbow with the colored strips on the cardboard*" (Subject 1), "*students will use objects with symbolic meaning. The circle yellow cardboard will be the sun, small grey cardboard will be rain drops, large grey cardboard will be cloud and colored strips will be rainbow*" (Subject 8).

Approaches' combination

There are two teaching plans which are classified in two approaches simultaneously. In particular, one student (subject 2) used the Piagetian and the socio-cognitive framework and another student (subject 6) used the socio-cultural and the socio-cognitive framework. For example, student 2 in her teaching plans presents the teacher in both the Piagetian and the socio-cognitive context "*teacher let the student create and discover everything and tried to guide the child without giving a ready answer*". Student 6 presents the teacher and the teaching subject using elements from both the socio-cultural and the socio-cognitive context "*teacher acts as a mediator and tries to reformulate children's pre-existing knowledge that rainbow is a solid*

object you can touch, not a visual phenomenon and approaches physical world with different paths. The teaching object is a flashlight, transparent bowl with water, mirror and a song regarding rainbow".

Finally, it is worth noting that about one third (1/3) of the students in the beginning claim that they will follow a specific approach but based on the results of the analysis of students' texts, they end up not to. For example, student 11 while claiming that her teaching plans will be designed according to the Piagetian approach "*I will use Piagetian strategy*", eventually she follows the empiricist approach by situating the teacher in the center of the activities and the students passively following teacher's instructions "*teacher is in the center of activities and students follow teacher's guide*". In addition, student 4 while she also claims that her teaching plans will be designed according to the Piagetian approach "*I will use Piagetian strategy*", she ends up following the empiricist approach assigning to herself the role of explaining how the rainbow is created and to students the role of passively following her instructions "*I will explain the way rainbow is constructed and students will follow teacher's guide passively*".

Students 7 and 10 in their teaching plans claim that the teacher will ask students questions in order to be informed about their mental representations using a socio-cognitive approach "*Teacher will ask questions: where does light come from, where do we find light, where does light exists in the class*" (Subject 7), "*Teacher will explore children's mental representations of the rainbow showing a picture of a rainbow and asking questions: what is it, how is rainbow formed?*" (Subject 10). However, students' responses are not taken into account when designing the activities and the students follow the teachers' instructions using the empiricist approach "*Students will follow teacher's guide*" (Subject 7, 10).

Finally, student 14 in her teaching plans claims that the teacher will narrate a story about the rainbow phenomenon using the socio-cultural approach "*story telling about a rainbow fairy*". However, the sequence of her activities is approached with the empiricist way since the students follow the teachers' instructions "*Students will follow teacher's guide*".

DISCUSSION

According to the results, the students – future preschool teachers tend to approach the rainbow phenomenon mostly in the empiricist framework according to their teaching plans. In their texts they present mainly demonstration experiments that confirm a theory or concept, placing the teacher in the center of the activities and expecting from the students to passively follow the teacher's instructions and/or answer to his/her questions.

The fact that the university students are motivated to use a specific theoretical framework when designing their activities and end up following the empiricist framework, shows a potential difficulty in applying the theory into practice. The latter can be related to their prior experiences and the ways they were taught about the phenomenon or Natural Sciences in general (absence of exemplary teachings, lack of class experience) (Kornelaki & Plakitsi, 2018). Offering university students an innovative curriculum in science education and teaching them how to use it has proved insufficient because students tend to revisit the way they were taught when they will be asked to teach science themselves, a cycle that demands divergent emphasis on pedagogy (Pringle, 2006). This result is also consistent with the literature according to which teachers tend to adopt passive pedagogical approaches due to the lack of confidence and self-efficacy (McDonald et al., 2021) as well as the unpreparedness they feel graduating from the university (Kornelaki & Plakitsi, 2018; Slavin et al., 2014).

The theoretical grid used for the classification of the university students' teaching plans into four distinct frameworks, the empiricist, the Piagetian, the socio-cognitive and the socio-

cultural (Ravanis, 2017) served sufficiently the purpose of the research. Moreover, its use shed light to the university students' choices regarding their practices in teaching science and allowed us to document them in a quantifiable manner. The results of the current research provide valuable insights about the university curriculum on science education and raise questions in relation to its effectiveness. It can constitute the spur for meaningful reflection on the educational process and lead to proposals for more satisfactory outcomes.

It should be noted that the present study can only offer indications since its length does not allow us to generalize its results. In the future, it is suggested to be implemented to a representative sample of the population and to be assessed on different scientific phenomena beyond the rainbow phenomenon.

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