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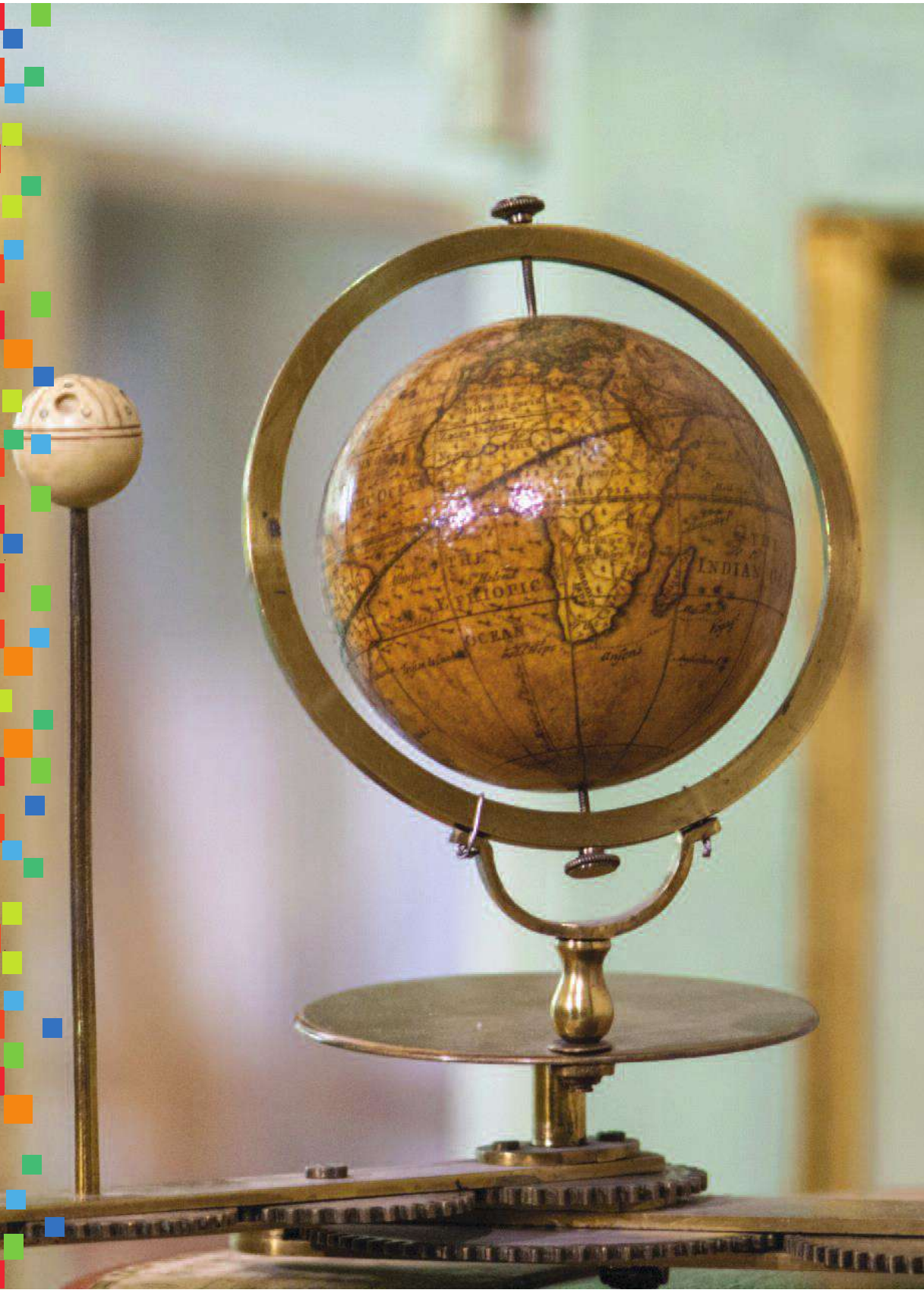

ALMA MATER STUDIORUM
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The Beauty and Pleasure of Understanding: Engaging with Contemporary Challenges Through Science Education (Proceedings of ESERA 2019)

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The Proceedings of ESERA 2019 is an electronic publication for revised and extended papers presented at the ESERA 2019 conference in Bologna, Italy during the 26-30 August, 2019. All papers in the eProceedings correspond to communications submitted and accepted for the ESERA 2019 conference. All proposals to the conference went through a double-blind review process by two or three reviewers prior to being accepted to the conference. A total of 1314 proposals (out of which 65 were symposia) were presented at the conference and in total 238 papers are included in the eProceedings.

The authors were asked to produce updated versions of their papers and take into account the discussion that took place after the presentation and the suggestions received from other participants at the conference. On the whole, the eProceedings presents a comprehensive overview of ongoing studies in Science Education Research in Europe and beyond. This book represents the current interests and areas of emphasis in the ESERA community at the end of 2019.

The eProceedings book contains eighteen parts that represent papers presented across 18 strands at the ESERA 2019 conference. The strand chairs for ESERA 2019

co-edited the corresponding part for each strand 1 to 18. All formats of presentation (single oral, interactive poster, ICT demonstration/workshop and symposium) used during the conference were eligible to be submitted to the eProceedings.

The co-editors carried out a review of the updated versions of the papers that were submitted after the conference at the end of 2019. ESERA, the editors and co-editors do not necessarily endorse or share the ideas and views presented in or implied by the papers included in this book.

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WITHIN THE PROCEEDINGS:

Part 7: Discourse and argumentation in science education

Part 8: Scientific literacy and socio scientific issues

Part 9: Environmental, health and outdoor science education

Part 10: Science curriculum and educational policy

Part 11: Evaluation and assessment of student learning and development)

Part 12: Cultural, social and gender issues in science and technology education

Part 13: Pre-service science teacher education

Part 14: In-service science teacher education, continued professional development

Part 15: Early years science education

Part 16: Science in the primary school

Part 17: Science teaching at the university level

Part 18: Methodological Issues in Science Education Research

PRESCHOOL TEACHER STUDENTS VIEWS'S INFLUENCE ON THEIR INTENTION TO USE TAUHGT INQUIRY METHODS

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In this research we investigated preschool teacher students' views that could possibly influence their intention to use inquiry methods, which they have been taught during a one-semester laboratory-type course, concerning concepts of science and their teaching methods. During this inquiry-based course, the teacher students (N=17) participated in several experiments concerning phenomena that are usually negotiated in the frame of preschool education, e.g., floating – sinking, magnets, air properties, etc. Moreover, the teacher students were explicitly taught the reasoning of the Control of Variables Strategy (CVS), as one of the course's goals was to provide understanding of aspects of the inquiry method. According to Ajzen & Fishbein's theory, our hypothesis was that teacher students' intention to use this taught method (CVS) in their classes as preschool teachers, depends also on teacher students' views about specific categories of social factors: (a) personal gains and losses, (b) important people that would approve or disapprove, and (c) personal features that would help or impede them. A six-task questionnaire was used to investigate teacher students' intention to use CVS method in their classes, at their first teaching year, focusing on the three aforementioned categories of social factors. Data were analyzed initially through a bottom-up approach, taking into account the answers of the teacher students, and afterwards using a K-means Cluster Analysis. The results have revealed three independent teaching professional profiles.

Keywords: teacher preparation, social interaction, inquiry-based teaching

INTRODUCTION

Current guidelines for effective instruction in science education suggest teaching both with and about the procedure scientists follow in their experimentation and scientific practices such as the Control of Variables Strategy (CVS), a method for designing and implementing fair experiments in order to test a variable's influence on a phenomenon (Chen & Klahr, 1999). Moreover, students of all ages confront difficulties with scientific reasoning pertained to CVS, such as hesitancy to make inferences from data, failure to realize that the value of a variable must be changed to test its impact and failure to recognize the need of controlling the rest of the variables (Boudreaux, Shaffer, Heron & McDermott, 2008; NRC, 2012).

There is evidence that explicit teaching of experimentation reasoning of the CVS method is necessary for a holistic understanding of the method (Lorch et al., 2010; Zoupidis, Strangas & Kariotoglou, 2017). Educating teachers such a way focuses on the expectation that they could spontaneously include such teaching approaches, when they will get started on their own teaching implementations. However, this expectation seems to be degraded when it is about teaching science content, because of preschool teachers' broader hesitant stance with regards

to science and its instruction (Andersson, Gullberg, Danielsson, Scantlebury, & Hussénius, 2019).

One of the most influential and popular conceptual frameworks for the study of human action is the theory of planned behavior (Ajzen & Fishbein, 2001; Ajzen, 2002). According to the planned behavior theory, human behavior is guided by three kinds of considerations: (a) beliefs about the likely consequences or other attributes of the behavior (personal gains or losses), (b) beliefs about the normative expectations of other people (important people that would approve or disapprove), and (c) beliefs about the presence of factors that may further or hinder performance of the behavior (personal features that would help or impede them from doing so). The first consideration, attitude beliefs, produces a favorable or unfavorable attitude towards the behavior. The second consideration, normative beliefs, result in perceived social pressure and the third consideration, control beliefs, give rise to the perceived ease or difficulty of performing the behavior (Ajzen, 2002). In combination, all three considerations lead to the formation of a behavioral intention, which is expected to be carried out when the opportunity arises.

RATIONALE

Following the trends described in introduction, preschool education teacher students in the focal University usually follow a science laboratory lesson, during which the teacher students have the opportunity to design and implement several experiments concerning phenomena that are usually negotiated in the frame of preschool education, e.g., floating – sinking, magnets, air properties, etc. In parallel, the teacher students are explicitly taught aspects of the experimentation reasoning, such as the CVS method. The results of this approach concerning the understanding of the method have been proved to be positive (Zoupidis, Strangas & Kariotoglou, 2017).

Following though Ajzen & Fishbein's (2001) (A-F) framework, we hypothesized that the intention of the preschool teacher students to use the taught CVS method when they design and implement teaching scenarios for science education issues is influenced by social factors such as personal gains and losses (attitude beliefs), important people that would approve or disapprove (normative beliefs), and personal features that would help or impede them (control beliefs), from using the CVS method. In short, we think that the question, if and how preschool teacher students would use CVS method in their classes, is still an open question and that an answer to this question, even in a primary level, would be convenient in the sense that it could influence our teaching practices (Andersson & Gullberg, 2014).

METHOD

This research has been realized during a university, laboratory-type and inquiry-based course in the frame of the preschool science education. The participants were seventeen second grade teacher students. During the course, the teacher students participated in several inquiry-based experiments concerning phenomena that are usually negotiated in the frame of preschool education, e.g., floating – sinking, magnets, air properties, etc., investigating, among other

issues, the variables that could influence those phenomena. Moreover, the teacher students were explicitly taught the reasoning of the Control of Variables Strategy (CVS), as one of the course's goals was to provide understanding of aspects of the inquiry method. For instance, the teacher students had the opportunity to deal with both unconfounded and confounded experiments and to justify their choices during the activities (Figures 1 and 2).

- We sink an object into the water. A colleague claims that « the shape influences floating or sinking of an object, that is cylinder-spape objects sink and sphere-shape objects float». The following four experiments were realized.

	Experiment 1		*Experiment 2*		*Experiment 3*		*Experiment 4*	
Variable	Test1	Test2	Test1	Test2	Test1	Test2	Test1	Test2
Weight	10 g	10 g	10 g	10 g	10 g	100 g	10 g	10 g
Material	foam	iron	foam	foam	foam	iron	foam	iron
Shape	sphere	sphere	sphere	rod	sphere	rod	sphere	rod

Which of the above experiments you think is or are fair to test this claim?
Please justify your answer:
.....
.....

Why did you exclude the rest of the experiments?
.....
.....
.....

Figure 1. The teacher students are prompted to characterise experiments (fair or unfair) and justify their choices.

« You have in front of you two magnets (bar magnet and horseshoe magnet).
Weigh them on the electronic balance.
The large magnet weighs .....
The small magnet weighs .....
Approach them now to the heap of the clips. Which one attracts more clips? »

Please, propose a change in order the experiment to become fair.
.....
.....
.....
Execute the experiment.

Figure 2. The teacher students are prompted to find the error in the experiment and propose a change in order that the experiment becomes fair.

A six-task questionnaire was used to investigate teacher students' intention to use CVS method in their classes, at their first teaching year, focusing on the three aforementioned categories of social factors. Specifically, attitude beliefs were investigated asking the teacher students about what their personal gains and losses would be if they used the CVS method in their classes, the first year that they would teach. Respectively, teacher students' normative beliefs were investigated asking them the reasons that specific for them important third people would

approve or disapprove their teaching choices. Last but not least, teacher students' control beliefs were investigated, asking them to provide their personal features that could help or impede them from successfully implementing such a teaching approach.

Data analysis followed a bottom-up approach (Strauss & Corbin, 1994) taking into account teacher students' answers, so that categories of teacher students' beliefs would be revealed. Afterwards, data were analyzed using K-means Cluster Analysis, scale 1,0 (1: the category is present, 0: the category is absent), which was implemented to partition the teacher students into clusters that present behavioral intention similarity.

RESULTS

The categories of teacher students' beliefs that were revealed from the bottom-up analysis of their answers to the six-task questionnaire are presented in Table 1.

Table 1. The categories of teacher students' beliefs in the three relatively differentiated clusters.

	Cluster1 (17 teacher students)
1. Personal gains	a. Understanding of science, b. Enhance teaching skills, c. Pleasant / efficient classroom climate, d. Satisfaction for helping children
2. Personal losses	a. Time to make them understand, b. Loosing self-confidence lead to frustration or/and discouragement
3. Important thirds approve due to	a. Children's improvement (Parents), b. Understanding of method's importance (Colleagues), c. Emphasis on my strengths and abilities (Relatives), d. My professional development (Relatives)
4. Important thirds disapprove due to	a. Dangerous and excessive method for this age range, b. Not understand method's importance (Colleagues)
5. Personal features that help	a. Patience and perseverance, b. Being methodical, c. Critical thinking / research glance
6. Personal features that impede	a. Classroom management skills, b. Self-management skills

Cluster Analysis was implemented to the data that revealed from the qualitative analysis of the teacher students' answers. The teacher students were partitioned into three relatively differentiated clusters (Table 2). So, according A-F analysis framework, three teaching professional profiles, each corresponding to one of the three clusters, have been revealed.

Table 2. The categories of teacher students' beliefs in the three relatively differentiated clusters.

	Cluster1 (6 teacher students)	Cluster2 (5 teacher students)	Cluster3 (6 teacher students)
1. Personal gains	1a, 1b*	1b, 1c	1a, 1d
2. Personal losses	-	2a	2b
3. Important thirds approve	3a, 3b	3a, 3b	3c, 3d
4. Important thirds disapprove	-	4a	4b
5. Personal features that help	5a	5a, 5b, 5c	5a
6. Personal features that impede	6a	6b	6b

*categories from Table 1

Specifically, six out of seventeen teacher students (cluster1) advocate that the use of the CVS method helps both the teacher and the children to understand science. It also enhances teachers' teaching skills. The method offers recognition from important thirds due to children's improvement and teacher's knowledge and succeeds only through patience and perseverance until the children understand. On the other hand, it has a risk in terms of classroom management.

Five out of seventeen teacher students (cluster2) advocate that CVS method can provide pleasant and efficient classroom climate and also enhances teachers' teaching skills. The method offers recognition from important thirds due to children's improvement and teacher's knowledge. It succeeds through patience and perseverance, being methodic, but also through critical thinking and research glance on the part of the teacher. On the other hand, it takes time to make the children understand, has a risk in terms of self-management issues and could be accused from important thirds that do not know the method for involving the children in dangerous and excessive activities.

Finally, six out of seventeen teacher students (cluster3) advocate that the use of the CVS method helps both the teacher and the children to understand science and provides satisfaction for helping children. The method offers recognition from important thirds due to teacher's abilities and professional development. It succeeds only through patience and perseverance until the children understand. On the other hand, issues of losing self-confidence could appear or important thirds that do not know the method could disapprove the teacher.

DISCUSSION AND IMPLICATIONS

The aim of this research was to investigate teacher students' intention to use CVS method in their classes, at their first teaching year. So, there is a need to connect teacher students' beliefs about social factors (attitude, normative and control beliefs) to their beliefs concerning the use of the CVS method, which they have been taught during the laboratory course. To realize this connection, we use the following analysis framework: (a) their beliefs about their personal gains and losses reveal the direction that teacher students appreciate that the method can get them, (b) the content of important thirds attitude towards the use of the method reveals the positive results or the possible resistance that will show up as a consequence of the use of the method, and (c) from their beliefs about personal features that could further or hinder the use

of the method we can recognize the aspects of the method that teacher students appreciate as crucial to its success.

The results have revealed three independent teaching professional profiles. Teacher students that belong in the first profile approach the innovative method as it could simply be implemented in a traditional teaching environment like any other method, without challenging the class. Teacher students belonging in the second profile appreciate the method, recognize and very possibly would strive to provoke traditional teaching environment implementing the method. Finally, teacher students that belong in the third profile perceive the method within a framework that they have the total responsibility of its successful implementation. Each teacher students profile provides important information that could lead to useful teaching implications.

Specifically, the teaching implications that arise from the above analysis are that apart from understanding the CVS method, teacher students should also be helped: a) to distinguish this method from other traditional ones, emphasizing its procedural character, b) to take the risk of sacrificing teaching time in order to succeed introducing such an innovative method, and c) to consent that passing to their students responsibilities to implement the innovation would be pleasant and fruitful for the teaching and learning procedure.

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