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The Use of Outside Educational Materials in Mathematics and Science: Teachers' Conceptions

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Abstract

The research for teachers' conceptions of the outside educational materials, that they discover and use, is very limited. In addition, there is also particularly limited research comparing teachers' conceptions of the use of educational materials on the basis of the subject they teach. The present paper aims at investigating and comparing primary school teachers' conceptions of the use of outside educational materials in mathematics and science teaching. For the purposes of this research, an electronic questionnaire was developed and completed by 212 primary school teachers in Greece. Data analysis traced primary school teachers' conceptions of whether they use outside educational materials and, if they do, how frequently and in what way they use them, what motivates the teachers to discover outside educational materials and where they discover them, as well as the reasons why they might not use outside educational materials. Furthermore, the differences among teachers' conceptions of the above issues were detected on the basis of the subject they teach (mathematics, science).

Introduction

Teachers develop a multidimensional relationship with the educational materials they use while preparing their lesson plans. This relationship is particularly important to study. Understanding the way in which the teachers prepare and use educational materials in their lesson plans contributes to providing a more comprehensive picture of the practices they adopt and the opportunities for learning they offer to students, both of which being important factors for effective instructional design (Davis et al., 2016; Pareja Roblin et al., 2018).

Although significant research has been conducted on the conceptions and use of educational materials provided to the teachers (Davis et al., 2016), the research for teachers' conceptions of the outside educational materials, that they discover and use, is very limited (Casey, 2016; Davis et al., 2013). Teachers' conceptions refer to conscious or subconscious beliefs, understanding, meaning, mental images, and preferences of teachers (Leatham, 2006). The research for teachers' conceptions of the outside educational materials is considered important because teachers' conceptions affect their teaching practices (Savasci & Berlin, 2012) and the way in

which they use educational materials (Mellado, 1998; Tobin et al., 1994). Also, there is no comparative research for teachers' conceptions on the use of outside educational materials in different disciplines, such as mathematics and science. The above contemplations became the object of the specific research that investigates and compare Greek primary school teachers' conceptions of the use of outside educational materials in mathematics and science teaching.

Theoretical Framework

The Concept and the Role of Outside Educational Materials in the Teaching Process

Educational materials, i.e. materials designed for specific educational purposes, can be related to curriculum materials, such as school textbooks which are usually provided to teachers, as well as to outside educational materials selected and/or developed by the teachers for being incorporated in the teaching process. Curriculum materials, and especially school textbooks, prevail in the teaching practice, as they are often the sole means for mathematics and science teaching at school (Horsley et al., 2010; Karampelas et al., 2018; Weiss, 1997). In these cases, the teachers follow the textbook structure to their instructional design (Schmidt & Houang, 2014).

Outside educational materials and their role in the teaching process is reevaluated, after a period of controversy. Nowadays, they occupy a central part in research internationally, due to their positive outcomes on the teaching process and reveal their contribution not only to students' cognitive development but also to cultivating and improving social, emotional and various other abilities (Skoumpourdi, 2012). Outside educational materials can help the teaching and learning process (Howard et al., 1997; Meira, 1998), the deeper conceptual understanding of mathematics and science concepts (Arias et al., 2016; Neesam, 2005), the development of learning strategies, mathematical thinking and computational skills (Golafshani, 2013), the cooperation (Barone & Taylor, 1996), as well as the investigation of new ideas (Pimm, 1995). They cultivate critical thinking, creativity, positive attitude and self-confidence (Jacobs & Kusiak, 2006), they support communication (Domino, 2010), and they improve children's performance (Liggett, 2017; Swan & Marsall, 2010), including performance of children with special learning needs (Cass et al., 2003) as well as children with auditory (Nunes, 2012) and visual disorders (Koza & Skoumpourdi, 2012).

Although research outcomes reveal the contribution of outside educational materials to the teaching process, the teachers do not take it for granted. The majority of the teachers, although they acknowledge and theoretically support the significance of outside educational materials, do not systematically use them in practice nor do they incorporate them into the teaching process (Skoumpourdi, 2012). Moreover, there are also teachers who attribute a secondary role to outside educational materials and restrict their functionality only to the enrichment of teaching and entertainment, or even teachers who express their reservations about their use in teaching and learning (Moyer, 2001; Moyer & Jones, 2004). The study and the clarification of the relationship between the teachers and the outside educational materials are of particular research interest because they constitute the link between teaching practice and learning process, and they reveal both the opportunities for learning offered to the students, and the way knowledge is constructed in the classroom.

Factors Affecting the Use of Outside Educational Materials

Specific characteristics of the curriculum are factors affecting the use of outside educational materials in the teaching practice. For example, curricula based on models and adopting an approach to learning that is focused on the active engagement of students in the construction of significant ideas and concepts allow the use of outside educational materials more than conventional curricula do, which directly present the content and expect that the teacher can explicitly teach their students the skills, the concepts and the processes that constitute the purpose of the lesson (Stein et al., 2007). Furthermore, in case of an established curriculum, the teachers feel that their freedom to make changes and use outside educational materials is restricted (Davis et al., 2016).

Additionally, teachers' motives affect their decisions on whether they would use outside educational materials in teaching, as well as on the selection, the evaluation, and the integration of these materials to practice. Teachers use outside educational materials in cases where they want to enrich or replace the educational materials provided to them with the aim to make the lesson attractive and to boost students' active participation (Forbes, 2013). The teachers who intend to use outside materials should decide whether they will construct them by themselves or they will select them in a relevant source. The result of their search depends on their ability to discover, their knowledge of the available sources as well as on whether they have the intention to dedicate time and/or money in order to find outside educational materials.

Primary education teachers use a variety of approaches in order to search for outside educational materials, and they evaluate them positively when these materials meet their students' needs (e.g. materials attractive and appropriate for students' age) and are in accordance with the curricula, as well as when they incorporate familiar approaches (e.g. familiar examples). The outside educational materials that finally select is the one that requires minimum adaptation. Such materials usually include worksheets, questions to be discussed, games and newspaper articles (Casey, 2016; Recker et al., 2004; Webel et al., 2015).

The ways teachers use the outside educational materials are in accordance with their students' learning needs (Kesidou & Roseman, 2002; Recker et al., 2004; Son & Kim, 2015), with their own instructional goals (Brown, 2009; Drake & Sherin, 2006; Remillard, 2005), their teaching practice (Janssen et al., 2015), and their experience in educational materials (Sherin & Drake, 2009). They also take into consideration the alignment of outside educational materials to the curriculum (Casey, 2016; Davis et al., 2013; Webel et al., 2015) as well as with the general educational framework (Roehrig et al., 2007) and the opportunities offered online for easily finding, exchanging and evaluating a large amount of educational materials (Casey, 2016).

Frameworks for Using Outside Educational Materials

The systematic study of the complex relationship between educational materials and their use by the teachers has led the researchers to model it. Among others, the most known models/frameworks analyzing this relationship are Remillard's (2005) framework for the participatory teacher-curriculum relationship and the Curriculum Strategy Framework by Sherin and Drake (2009). However, the above models/frameworks do not

investigate the multidimensional relationship of teachers with the outside educational materials.

A model/framework that reflects elements of both relationships, i.e. the relationship between the teachers and the provided educational materials, and the relationship between the teachers and the outside educational materials, is the research framework by Casey (2016). This framework resulted as a need for consideration outside educational materials, due to the wide availability of them in a various source. This research framework represents linearly the teachers' decision-making process for using outside educational materials and the possible factors that affect it, in a sequence of four phases: motivation to consider outside materials, discovery of outside materials, evaluation of outside materials and preparation/adaptation of outside materials (Figure 1).

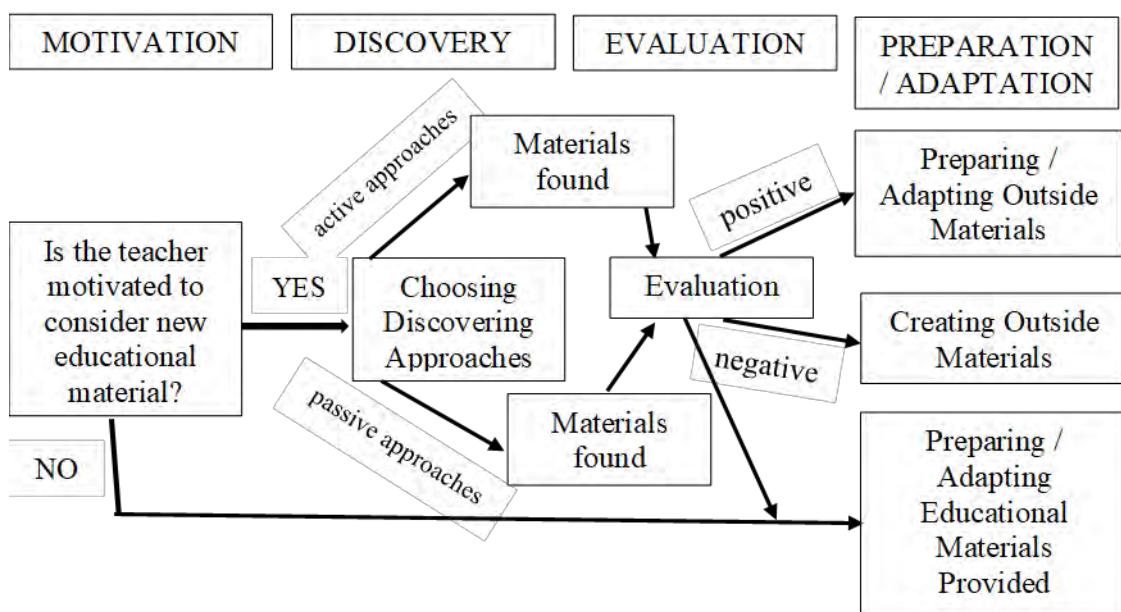


Figure 1. Teachers' Decisions on Outside Educational Materials and Possible Factors Affecting Them (Casey, 2016)

The 1st phase represents the period of initial planning (of a lesson, a unit, or even of the entire school year), where the teachers examine the educational materials provided. The teachers deciding not to use outside educational materials omit the phases of discovery and evaluation and they just use and adapt the materials provided or construct their own materials (represented by the “no” line leading to the right side of the figure). In the 2nd phase, the teachers use a combination of approaches in order to discover outside materials (as recommended by the bended arrows). These approaches can be active (discovering mathematics coordinators for their schools, discovering on the Internet or discovering in their own libraries, sending requests to other teachers via social media) or passive (registering in newsletters on teaching mathematics, attending conferences, accepting references from colleagues). The ability of the teachers to discover outside educational materials also affects the materials that will be found and those that will further be discovered. In the 3rd phase, the teachers evaluate the materials in accordance with their instructional goals and other criteria significant for their needs in the specific period. Any materials negatively evaluated are not exploited and the teachers are led to return to the materials provided or construct their own materials. Any materials positively evaluated are

prepared and possibly adapted (in the 4th phase) before they are used in teaching. These last two phases (evaluation and preparation) describe decisions that are also taken while using the materials provided, whereas the first two phases (motivation and discovery) are only related to outside educational materials.

Although the possible combinations of teachers' processes for thinking and decision-making with regard to outside educational materials are not linear, this framework represents the process in a linear way. For example, the case in which the teachers will not find appropriate materials and may return to the phase of discovery and evaluation is not represented. The same happens with the case in which the teachers will negatively evaluate the materials they have found, they will realize that they do not have the time required to construct new materials, and they will finally return to the phase of discovery, etc. Although information is provided about external factors that could affect teachers' decisions throughout the teaching process, such as the subject, the curriculum, the years of previous experience in teaching, the alignment of the curriculum to the teacher's instructional goals, self-confidence in mathematics and science teaching as well as confidence to the curriculum, the framework does not exhaust all the aspects of teachers' decisions on outside educational materials.

Literature Review

The limited research recording teachers' conceptions of outside educational materials and their use in mathematics shows that the main reason that motivates teachers to search for outside educational materials is their positive contribution to the learning and teaching process (Marshall & Swan, 2008). Teachers think that the use of outside educational materials offers the children the opportunity, regardless of whether they learn in an audio, visual or kinesthetic way, to actively engage in the teaching process (Tran, 2015). However, the way they use them in the teaching practice seems to be empirically rather than theoretically documented (Skoumpourdi, 2012). Research also shows that every teacher perceives differently the effect the material has on learning and this also affects the way in which teachers use the material in practice. In other words, some teachers consider the engagement of the children, in the teaching process, a success, others that the children are having fun and others that the children are learning without realizing it. Thus, they use the material in different ways in order to discover what the students know or to explain difficult mathematical concepts (Tran, 2015).

The obstacles teachers encounter while using materials are the main reasons why they do not use or stop using them. The main obstacles that they report are the lack of equipment, the difficulty in preparing the materials, the lack of space required for using materials, and the cost (Tran, 2015). They are hesitant about using outside materials in teaching because they think that their use will make a big fuss in the classroom, the children will damage them, the cost of education will dramatically increase, that the concepts that will be developed as a result of the use of the materials will never become abstract (Jacobs & Kusiak, 2006; Szendrei, 1996). They argue that students frequently use the materials in a way that they do not evolve their actions into mental activity (Kilpatrick et al., 2001), that students' interpretations of the materials usually differ from the interpretation introduced by them (Baroody, 1989; Kilpatrick et al., 2001) and that students do not follow their instructions when they use the materials (Marshall & Swan, 2008). They also report that their lack of self-confidence and knowledge of the various uses of the materials, as well as the lack of time necessary for practice and preparation

make the use of the materials difficult during the teaching process (Golafshani, 2013). It is worth noting that in the cases that teachers had been trained on the materials used in the teaching practice, they all said that it helped them understand the true value of the materials and they are willing to use more materials in mathematics teaching (Tran, 2015).

All the above shows that, although the research, on outside educational materials, provides evidence on teachers' intentions of using them, on their motivation for discovering such materials as well as on the factors that have an inhibiting effect on their use, this kind of research is particularly limited. Furthermore, despite being one of the significant parameters of the relationship between teachers and educational materials, there is little evidence on where and how the teachers discover outside educational materials. In addition, the research comparing teachers' conceptions of the use of educational materials in mathematics and science is lacking. As a result, there is a necessity for conducting further research that systematically studies and compares teachers' conceptions of the use of outside educational materials in mathematics and science.

Purpose and Research Questions

The present research paper is included in the wider field of studies investigating teachers' conceptions of the use of educational materials. The purpose of this paper is to investigate and compare primary school teachers' conceptions of the use of outside mathematics and science educational materials. In particular, the present paper aims at answering the following research questions:

Research Question 1: What are primary school teachers' conceptions of whether they use outside mathematics and science educational materials and (if yes) how frequently and how they use them and in what way these conceptions differentiate on the basis of the subject (mathematics, science) they teach?

Research Question 2: What are primary school teachers' conceptions of the reasons that motivate them to discover or not discover outside mathematics and science educational materials and how these conceptions differentiate on the basis of the subject (mathematics, science) they teach?

Research Question 3: What are primary school teachers' conceptions of the sources where they discover outside mathematics and science educational materials and how these conceptions differentiate on the basis of the subject (mathematics, science) they teach?

Methodology

Research Process and Sample

The present quantitative research was conducted in the school year 2017-2018 in two phases. The first phase (pilot study) included the development of the data collection tool (questionnaire). At first, the questionnaire was handed out to ten primary school teachers. Then a brief collective discussion was held with the teachers, when comments and remarks were made. In addition, the questionnaire was also given to two researchers (Mathematics Education researcher and Science Education researcher) so that its internal validity could be verified and any deficiencies or vague points could be corrected. Then the questionnaire of the main research was developed on the basis of the remarks and the deficiencies detected during its implementation in the pilot

study so that it could respond to the aims of the research and could be comprehended by the teachers. In the second phase (main research), the questionnaire was electronically completed by primary school teachers, whose answers were then analyzed. The main research involved 212 public primary school teachers, including 74 men and 138 women. The average age of the participants was 44.2 years and their average teaching experience in the classroom was 19.2 years.

Data Collection

The research tool for data collection was the questionnaire in electronic format. The final questionnaire included two parts with a total of 12 questions that investigated teachers' conceptions of the use of outside educational materials. These questions were formulated for the needs of the research on the basis of the research questions and the relevant research literature on the use of educational materials by the teachers (Casey, 2016; Davis et al., 2016). These questions were preceded by the definitions of the following terms: "educational materials", "educational materials provided" and "outside educational materials". Questions 1-6 referred to teachers' decisions on mathematics educational materials and questions 7-12 referred to teachers' decisions on science educational materials in school year 2017-2018.

Questions 1 and 7 investigated primary school teachers' conceptions of whether they have used outside educational materials apart from those provided in mathematics and science, respectively. The teachers could choose between two answers (Yes, No). Questions 2 and 8 investigated primary school teachers' conceptions of how frequently they have used outside educational materials in mathematics and science, respectively. The teachers could choose among five answers (in almost every lesson, several times a week, almost one time per week, two or three times per month, less than 2-3 times per year).

Questions 3 and 9 investigated primary school teachers' conceptions of the reasons that motivate the teachers to discover outside mathematics and science educational materials, respectively. The teachers were presented with five reasons (reducing the time required for the preparation of the lesson, offering the students additional activities for clarifying the concepts, arousing their curiosity, offering the students additional opportunities for active engagement in the teaching process, offering the students additional activities for practice). Moreover, the teachers were asked to record any additional reasons. The teachers could choose how frequently they use outside educational materials in teaching for each of the above reasons. They had five choices (never for this reason, rarely for this reason, sometimes for this reason, frequently for this reason, almost always for this reason).

Questions 4 and 10 investigated primary school teachers' conceptions of the reasons why they do not use outside educational materials in mathematics and science, respectively. The teachers were presented with six reasons (they cover my students' needs, they are in line with my teaching style, there is no time for adaptation, the instructions provided to me leave no room for the adaptation, the conceptions of my instructional coordinator are against the adaptation, my peers are against the adaptation). The teachers were also asked to record additional reasons and were presented with five choices, as it happened in questions 3 and 9.

Questions 5 and 11 investigated primary school teachers' conceptions of where they discover outside mathematics and science educational materials, respectively. The teachers were presented with nine possible sources of educational material (my archives, another teacher, an instructional coordinator, a friend that has studied mathematics or science education, minutes of congresses, scientific journals, known webpages or blogs, through an online search engine). The teachers were also asked to record additional sources they use. The teachers could choose how frequently they use each of the above sources in order to discover outside educational materials for teaching. The teachers had five choices (I have never used his source, I have rarely used this source, I sometimes use this source, I frequently use this source, I almost always use this source).

Questions 6 and 12 investigated primary school teachers' conceptions of how they have used outside educational materials in teaching mathematics and science, respectively. The teachers could choose between two choices related to the different ways outside educational materials are used (not adapted, adapted). The questionnaire was in electronic format and was sent to the teachers via the directorates of primary education of the country. Teachers' answers to the questions of the questionnaire constituted the research data.

Data Analysis

The statistical processing of the research data aimed at presenting the frequencies of the answers (in absolute numbers and percentage distribution) and the correlations resulting from recording the similarities and the differences among the basic variables of the sample. The investigation for the existence of a statistically significant difference among teachers' conceptions of: (a) whether they have used outside educational materials or how they use outside educational materials in the subject they teach (mathematics, science) used McNemar test, and (b) the remaining issues to be investigated (the reasons motivating the teachers to discover or not discover outside educational materials, the sources where they discover outside educational materials) and the subject they teach (mathematics, science) used Wilcoxon Signed Ranks test (Zwick et al., 1982).

Results

Teachers' Conceptions of Whether They Use outside Mathematics and Science Educational Materials and (if yes) How frequently and How They Use Them

As to whether primary school teachers have used outside mathematics and science educational materials, it has been noted that almost nine out of ten teachers state that they have used outside mathematics educational materials and almost seven out of ten teachers state that they have used outside science educational materials. Comparing teachers' conceptions when they teach mathematics with their conceptions when they teach science with regard to whether they have used outside educational materials, it was found that the percentage of teachers stating that they have used outside mathematics educational materials is higher (90.4%) than the percentage of teachers stating that they have used outside science educational materials (72.1%). By contrast, the percentage of teachers stating that they have not used outside science educational materials is higher (27.9%) than the percentage of teachers stating that they have used outside mathematics educational materials (9.6%). According to McNemar test, it is found that there is also a statistically significant difference between their conceptions of

whether they have used outside educational materials in the subject they teach (mathematics, science), $\chi^2(1)=25.412, p<0.001$.

With regard to how frequently primary school teachers use outside mathematics and science educational materials, it was found that 64% of them state that they use outside mathematics educational materials several times per week or in almost every lesson, while only 31.7% of them state that they use outside educational materials 2 or 3 times per month or less than 2 or 3 times per year. Also, 44.1% of the teachers state that they use outside science educational materials several times per week or in almost every lesson, while only 29.6% of them state that they use outside science educational materials 2 or 3 times per month or less than 2 or 3 times per year. Comparing teachers' conceptions when they teach mathematics with their conceptions when they teach science with regard to this issue, Wilcoxon Signed Ranks test showed that outside educational materials are used more frequently when the teachers teach mathematics ($Mdn=4$) than when they teach science ($Mdn=3$), $Z=-4.208, p<0.001$.

With regard to how frequently primary school teachers use outside mathematics and science educational materials, it was found that most teachers make adaptations to them (97.9% of the teachers in mathematics and 98% of the teachers in science). McNemar test showed that their conceptions are not significantly different with regard to the subject they teach (mathematics, science), $\chi^2(1)=0, p=1$.

Teachers' Conceptions of the Reasons Motivating Them to Discover Outside Mathematics and Science Educational Materials

With regard to teachers' conceptions of the reasons motivating them to discover outside mathematics and science educational materials, it was found that more than seven out of ten teachers state that providing the students with additional activities for clarifying the concepts, arousing students' curiosity, providing the students with opportunities to actively participate in the teaching process and providing the students with activities for further practice are reasons that frequently or almost always motivate them to discover outside educational materials. It was also found that for most teachers the limited time for the preparation of the lessons is not a reason that frequently motivates them to discover outside educational materials.

In two of the above reasons, teachers' conceptions differ significantly on the basis of the subject they teach (mathematics, science). In particular, Wilcoxon Signed Ranks test showed that any additional activities for clarifying the concepts are reasons for discovering outside educational materials more frequently when the teachers teach mathematics ($Mdn=4$) rather than when they teach science ($Mdn=3.5$), $Z=-2.124, p=0.037$, while arousing students' curiosity is another reason for discovering outside educational materials more frequently when the teachers teach science ($Mdn=4$) rather than when they teach mathematics ($Mdn=3$), $Z=-4.242, p<0.001$. As for the three remaining reasons (providing the students with opportunities to actively participate in the teaching process, providing the students with activities for further practice, reducing time for the preparation of the lessons), it was found that teachers' conceptions are not significantly different with regard to the subject they teach ($Z=-1.601$ and $p=0.122$, $Z=-1.60$ and $p=0.109$, $Z=-0.290$ and $p=0.785$, respectively).

Teachers' Conceptions of the Reasons Why They do not consider the Use of outside Mathematics and Science Educational Materials

As for the reasons why the teachers do not use outside mathematics and science educational materials, it was found that the conceptions that school textbooks provided cover students' needs or are in line with the teacher's teaching style or there is no time for changes because the entire curriculum has to be taught are reasons why the teachers do not consider the use of outside educational materials. It was also found that the conceptions of the instructional coordinator, the conceptions of their peers, and the instructions provided by a central organization (Ministry of Education) are not significant reasons why they do not consider using outside mathematics and science educational materials.

Comparing teachers' conceptions of the above issue, Wilcoxon Signed Ranks test showed that there are no significant differences according to the subject they teach (school textbooks cover students' needs: $Z=-0.728$, $p=0.494$, school textbooks are in line with the teacher's teaching style: $Z=-1.534$, $p=0.136$, the limited teaching time is hardly sufficient: $Z=-0.044$, $p=0.884$, the instructions provided: $Z=-0.715$, $p=0.525$, the instructional coordinator: $Z=-1.130$, $p=0.295$ and the opinions of the other teachers $Z=-1.660$, $p=0.121$).

Teachers' Conceptions of Where They Discover Outside Mathematics and Science Educational Materials

As to where primary school teachers discover outside mathematics and science educational materials, it was found that more than six out of ten teachers state that they consider their archives, known webpages or teachers' blogs and search engines to be the sources they frequently or almost always visit in order to discover educational material. By contrast, most teachers (more than eight out of ten) do not consider other teachers, their instructional coordinator, a friend of theirs who has studied mathematics or science education, conference proceedings, scientific journals and organization's repositories to be the sources they frequently or almost always refer to in order to discover educational material.

Comparing teachers' conceptions of how often primary school teachers discover outside mathematics and science educational materials in specific sources, Wilcoxon Signed Ranks test showed that teachers more frequently discover outside educational materials in their archives when they teach mathematics ($Mdn=3.5$) rather than when they teach science ($Mdn=3$), $Z=-3.628$, $p<0.001$; in other teachers when they teach mathematics ($Mdn=2.5$) rather than when they teach science ($Mdn=2$), $Z=-2.488$, $p=0.012$; in an instructional coordinator when they teach science ($Mdn=1.5$) rather than when they teach mathematics ($Mdn=1$), $Z=-2.168$, $p=0.034$, and in search engines when they teach science ($Mdn=3.5$) rather than when they teach mathematics ($Mdn=3$), $Z=-2.957$, $p=0.003$. As for the five remaining sources examined, it was found that teachers' conceptions do not differ significantly with regard to how frequently the teachers discover outside educational materials according to the subject they teach (a friend who has studied mathematics education or science education: $Z=-1.119$, $p=0.284$, conference proceedings: $Z=-0.746$, $p=0.456$, scientific journals: $Z=-1.298$, $p=0.196$, known webpages or teachers' blogs: $Z=-1.278$, $p=0.209$ and organization repositories: $Z=-0.348$, $p=0.738$).

Discussion and Conclusions

As to whether primary school teachers have used outside mathematics and science educational materials, apart from those provided (school textbooks), it was found that most teachers have used outside educational materials. This tendency of the teachers to use outside educational materials, may be attributed to reasons related to the fact that the students are provided with more opportunities and are therefore helped with the learning process, as found in Casey's (2016) paper but also in the present paper. As to how frequently primary school teachers use outside mathematics and science educational materials, apart from those provided, it was found that most teachers use outside educational materials at least once a week. It was also found that there are differences in these conceptions of theirs on the basis of the subject they teach. When they teach mathematics, they tend to use outside educational materials more frequently than when they teach science. This tendency of primary school teachers may be attributed to the fact that the Greek educational system dedicates more teaching hours per week to mathematics than to science and to the fact that primary school is more focused on teaching linguistics and mathematics than on teaching science. Furthermore, the above difference may also be due to the fact that mathematics is a separate subject in all primary school grades and science is a separate subject only in the last two grades of primary school, while in the other grades, science is part of a broader subject called "environmental studies".

With regard to the way primary school teachers use outside mathematics and science educational materials, it was found that almost all the teachers stated that they make adaptations to them. Furthermore, there were no significant differences in teachers' conceptions on the basis of the subject they teach (mathematics, science). This tendency of the teachers to make adaptations to the outside educational materials they discover and find may be attributed to the fact that several sources including outside educational materials are not exclusively intended for primary education and, as a result, the teachers make adaptations to the educational materials they find. The above findings are in line with the findings of other research papers that focus on the ways in which the educational materials provided are used by the teachers (Beyer & Davis, 2012; Brown, 2009; Drake & Sherin, 2006, 2009; Forbes, 2013; Lloyd et al., 2017; Remillard, 1999; Roehrig et al., 2007).

As to primary school teachers' conceptions of what motivates them to discover outside mathematics and science educational materials, it was found that the reasons that frequently motivate most teachers to discover outside educational materials are related to the fact that the students are provided with additional activities for clarifying the concepts and actively participating in the teaching process as well as for arousing their curiosity. For two of these reasons (providing additional activities for clarifying the concepts, arousing students' curiosity), there is a statistically significant difference between mathematics and science. When the teachers teach mathematics, they more frequently tend to discover outside materials in order to offer the students additional activities and help them clarify the concepts as compared to the cases when they teach science. This tendency of the teachers may be attributed to the fact that more teaching hours are dedicated to mathematics than to science as well as to the fact that, as already mentioned, primary school gives more emphasis on teaching linguistics and mathematics than on teaching science. By contrast, when the teachers teach science, they more frequently tend to discover outside materials in order to arouse their students' curiosity as compared to the cases when they teach

mathematics. It is easier to find educational materials arousing students' curiosity in science (e.g. an experiment whose outcome is different from what the students had predicted) than in mathematics.

As regards the reasons why the teachers do not use outside mathematics and science educational materials, it was found that the conceptions of the instructional coordinator and the conceptions of their peers are not significant reasons for which they do not consider the use of outside mathematics and science educational materials. As to the other reasons, it was found that the conceptions according to which school textbooks provided cover the students' need are in line with the teacher's teaching style or there is no time for changes because the entire curriculum has to be taught are reasons why the use of outside educational materials is not considered. It was also found that their conceptions of the reasons why the teachers do not use outside educational materials on the basis of the subject they teach (mathematics, science) are not significantly different. Nondifferentiation among their conceptions may be attributed to the fact that primary school teachers, to the extent they teach all the subjects and they are not specialized in teaching a specific subject, hold similar conceptions of the reasons why they do not use outside educational materials when they teach mathematics and when they teach science.

When it comes to where primary school teachers discover outside mathematics and science educational materials, it was found that most teachers consider their archives, known webpages or teachers' blogs and search engines to be the sources where they frequently discover educational materials. By contrast, most teachers did not consider other teachers, the instructional coordinator, a friend who has studied mathematics or science education, conference proceedings, scientific journals and organization's repositories to be the sources where they frequently discover educational materials. These findings are in accordance with research results that show that the teachers use the Internet mainly in order to find outside educational materials (Davis et al., 2013; Recker et al., 2004; Webel et al., 2015). This tendency of the teachers may be attributed to the wealth of educational materials that can be found on the Internet but also to the increased opportunities, especially in recent years, for Internet access both from schools (Parsad & Jones, 2005) and from teachers' houses (Horrigan, 2012). It was also found that there are significant differences on the basis of the subject (mathematics, science) among teachers' conceptions of where they frequently discover outside educational materials. When the teachers teach mathematics, they tend more frequently to discover outside educational materials in their archives and in other teachers as compared to when they teach science. It is possible that the teachers have created for mathematics an archive with outside educational materials that is more complete as compared to the respective archive they have created for science and therefore they turn to it when they teach. By contrast, when the teachers teach science, they tend to discover outside educational materials on the Internet through search engines more frequently than when they teach mathematics. To the extent that teachers' archives do not include sufficient outside science educational materials, it is possible that they will decide to search on the Internet.

Figure 2 shows, according to teachers' conceptions, their decisions on educational materials, as they resulted from the present paper. The presentation of teachers' conceptions is organized in four phases (Casey, 2016): motivation to consider, discovery, evaluation and preparation/adaptation.

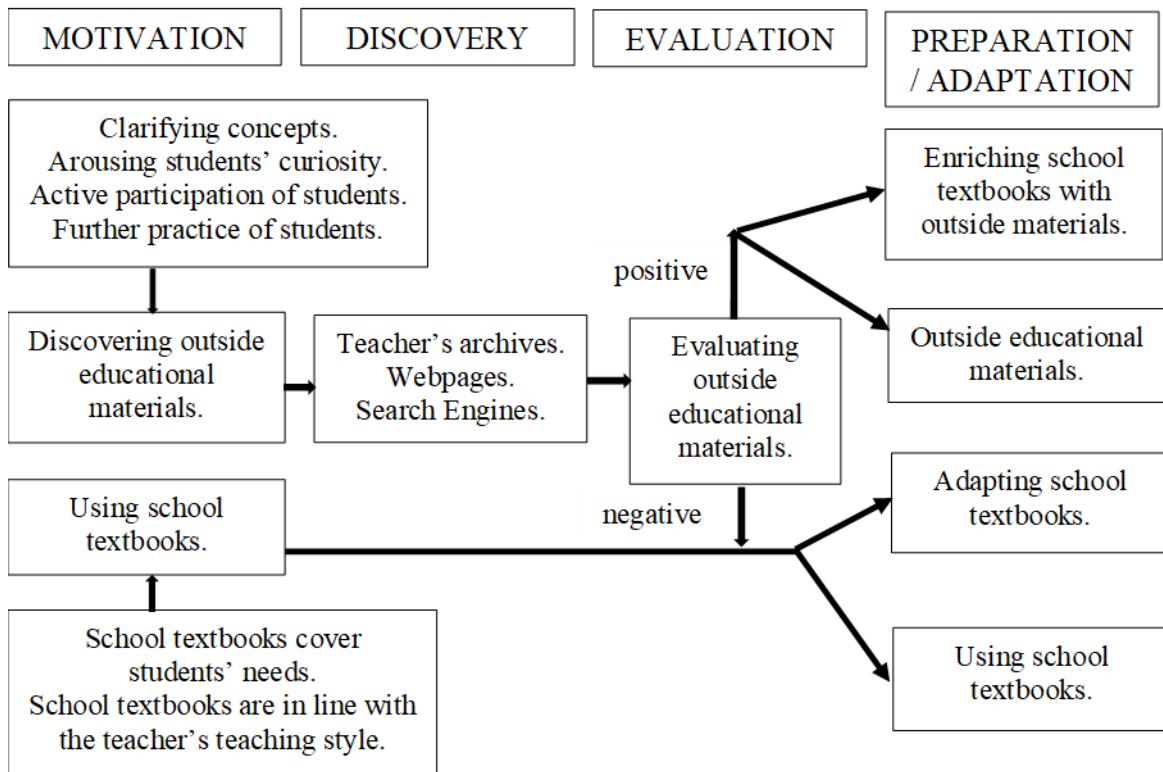


Figure 2. Primary School Teachers' Decisions on Mathematics and Science Educational Materials

The phase of motivation to consider is related to the reasons that urge the teachers to exclusively use the educational materials they are provided with or search for outside educational materials. In case the teachers consider that the educational materials they are provided with meet the needs of their teachers or are in line with their teaching style, then they are content with their use in order to prepare their teaching. But if the teachers consider that the educational materials they are provided with are not sufficient for adequately clarifying the concepts to their students, arousing their curiosity, actively engaging them in the teaching process or providing their students with opportunities for further practice, then they decide to discover outside educational materials. The phase of discovery is related to the sources to which the teachers turn in order to find outside educational materials. These sources are mainly the teacher's archive, known webpages containing educational material or online search engines. Mainly through these sources the teachers trace and collect educational materials.

The phase of evaluation is related to the process in which the new educational material is judged by the teachers. The result of this judgment is critical for preparing their teaching. The judgment can be either positive or negative. The phase of teaching preparation/adaptation is related to teachers' decisions on the use of educational materials. In case the evaluation of outside educational materials is positive, the teachers prepare their teaching mainly on the basis of the educational materials provided and enrich it with outside educational materials or they do not use the educational materials provided and prepare their teaching on the basis of outside educational materials. In case the evaluation of outside educational materials is negative, the teachers prepare their teaching mainly on the basis of the educational materials provided, which they either adapt or not adapt. However, it should be noted that because only a specific number of primary school teachers participated in the research, the findings are subject to the restrictions of the sample. Moreover, the research was conducted only with the use of

questionnaires. The interview or the combination of a questionnaire with an interview would allow a deeper investigation into teachers' conceptions of issues related to the use of mathematics and science educational materials.

Despite the above restrictions, the present paper contributes to the research on the use the teachers make of mathematics and science educational materials, as its findings shed light on aspects of this issue that had not been investigated, especially regarding the use of outside educational materials, on the one hand, and, on the other hand, the comparison of teachers' conceptions of the use of outside educational materials among mathematics and science. Previous research had mainly been focused on the use the teachers had made of educational materials provided and had left other significant aspects of teachers' decisions unexplored.

The present paper showed that most primary school teachers use outside educational materials, apart from those provided, for specific reasons and they search for them in specific sources. In addition, the research that had been conducted on the use of educational materials had been focused on a specific subject. The present paper carried out a comparative study on teachers' conceptions of the use of educational material in two subjects (mathematics, science) and found both similarities and differences.

Nevertheless, the present paper is focused on investigating primary school teachers' conceptions. Secondary school teachers' conceptions of the use of mathematics and science educational materials should also be investigated and they should be contrasted with the respective conceptions of primary school teachers. Also, the present paper was centered exclusively around the study of teachers' conceptions of the use of mathematics and science educational materials. The study on the use of educational materials in the classroom (during the teaching process) and the comparison of teachers' practices and their conceptions are considered necessary. Finally, the way in which the interactions between the teachers and their students, their peers, the instructional coordinators and the principals affect their decisions on the use of educational materials and the way in which they contribute to changing their knowledge, aims and teaching practices should be investigated. The study of these proposals within the framework of teaching mathematics and science will play a part in better understanding the learning process and teachers' practices (with regard to the use of educational materials) and will also contribute to more effectively supporting both the teachers, with regard to the use of educational materials, and those involved in developing curricula and educational materials for teaching mathematics and science.

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