# Use of Mathematics and Science teaching materials: teachers' views

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## SUMMARY

*Research examining teachers' views on the use of instructional materials is limited. In particular, there is very limited research that investigates teachers' opinions not only about the educational materials provided to them, but also about the additional educational materials they seek and use. Also, research that compares teachers' views on the use of educational materials based on the subject they teach is particularly limited. This work aims to investigate and compare the views of primary school teachers on the use of Math and Science educational material. For the needs of the research, an electronic questionnaire was developed which was completed by 212 primary school teachers in Greece. The analysis of the data allowed to capture the opinions of primary school teachers regarding how they use the educational material provided to them, if they use additional educational material and (if so) how often and how they use it, what motivates them to seek new learning materials and where they look for them, but also the reasons they do not use additional learning materials. Also, their opinions on whether the actions they take when using educational materials affect their knowledge, beliefs, teaching practices and the learning outcomes of their students were recorded. In addition, differences were identified in teachers' opinions on the above issues based on the subject they teach (Mathematics, Natural Sciences).*

**KEY WORDS:** *use of educational materials, teachers' opinions, Mathematics, Natural Sciences.*

## INTRODUCTION

The rapid development of Mathematics and Natural Sciences especially during the last fifteen years and the important role they play in modern society, makes it necessary to build knowledge and cultivate

skills and attitudes to the students which will make them able to actively participate in the social becoming and effectively deal with the problems that will arise. Despite the importance attached to the education of students in Mathematics and Natural Sciences, learning outcomes are not considered satisfactory (OECD, 2017). It therefore follows that it is necessary to study the educational process related to Mathematics and Natural Sciences.

The study of the educational process mainly includes the students, the educational material, as well as the teachers. This work focuses on the relationship between teachers and educational materials. In particular, it focuses on teachers' perceptions of teachers' use of Mathematics and Science teaching materials.

Teachers engage in a multidimensional relationship with the educational materials they use as they organize the teaching they will implement in the classroom. Studying this relationship is important for two reasons. The first reason is related to the attempt to introduce innovations in the educational material. Every such attempt is "filtered" by the teachers. Studying the use of educational materials by teachers can "illuminate" issues related to how teachers perceive and understand any innovations involved with educational materials and how these enter into the context of the school classroom. The second reason is related to teachers. Understanding how teachers organize teaching, using educational materials, contributes to forming a more complete picture regarding the way teachers think and the teaching practices they adopt. The above can help design a more effective training material.

Although considerable research has been conducted on teachers' use of instructional materials, the need for further research in this area has been highlighted (Davis, Janssen, & Van Driel, 2016). The research that has been carried out has focused on the use of the educational material provided to teachers, while the research that has been carried out regarding the new (additional) educational material that teachers are looking for and finding is particularly limited (Casey, 2016). Also, there is limited research examining teachers' perceptions of the use of instructional materials (Davis, Choppin, McDuffie, & Drake, 2013).

Exploring teachers' perceptions of teaching and learning has been recognized as important. Teachers' perceptions usually influence their teaching practices (Duit, 1996; Isaacson, 2004; Ozkal, 2007; Pintrich, Marx, & Boyle, 1993; Savasci, 2006). How instructional materials are used appears to depend on teachers' perceptions of issues related to teaching and learning (Mellado, 1998; Tobin, Tippins, & Gallard, 1994). The choice of teaching methods and the general approach

of students also largely depends on teachers' perceptions
(Aguirre & Speer, 2000; Hashweh, 1996; Levitt, 2001).

In addition, the research that has been carried out on the use of educational materials has focused either only on its use during the teaching of Mathematics or only on its use during the teaching of Natural Sciences. There is particularly limited research comparing teachers' perceptions of the use of Mathematics and Science teaching materials.

The object of this research is to investigate and compare the views of primary school teachers on the use of educational materials in the teaching and learning of Mathematics and Natural Sciences. The topics explored relate to how teachers use the learning materials provided to them, whether they use additional learning materials and (if so) how often and how they use them, what motivates them to seek new learning materials and where they look for them, but and the reasons they do not use additional educational materials, as well as their views on whether the actions they take when using educational materials affect their knowledge, beliefs, teaching practices, and the learning outcomes of their students.

## Theoretical Framework

**The meaning and role of educational material in the educational process**
The educational material, i.e. the material used in the teaching practice and designed to serve specific educational purposes, can refer to Curriculum Material (CMS), the school teaching package, which is usually provided to teachers, and another, additional educational materials that are selected and/or designed by teachers to be integrated into the educational process.

The ESS and especially the school textbook dominates the teaching practice, often being the exclusive means for teaching Mathematics and Natural Sciences at school (Weiss, 1997). In these cases, the teacher works with his students on the issues included in the textbook and often follows its structure and pedagogical approach in his teaching design (Schmidt & Houang, 2014). Additional educational material and its role in the educational process, after a period of questioning,

has in recent years occupied a central position in research, the positive results of which have led to a reassessment of its importance (Skoumbourdi, 2012). Researchers, internationally, study the effect of the use of additional educational material in the educational process and highlight its contribution not only to the cognitive development of students, but also to the cultivation and development of social, emotional and various other abilities and skills such as facilitating teaching and learning

process (Howard, Perry, & Tracey, 1997; Meira, 1998), in deeper conceptual understanding of mathematical concepts (Neesam, 2005), in the development of strategies, mathematical thinking, computational skills (Golafshani, 2013), critical thinking and creativity, in cultivating a positive attitude and self-confidence (Jacobs & Kusiak, 2006), activating students by providing motivation for engaging in activities and for cooperation (Barone & Taylor, 1996), supporting communication (Domino, 2010), exploring new ideas (Pimm, 1995), in improving the performance of all children (Liggett, 2017; Swan & Marsall, 2010) including children from different cultural backgrounds (Stathopoulou, Skoubourdi & Kafoussi, 2009), but also special groups, such as children with special learning needs (Cass, Cates, Smith & Jackson, 2003; Sdrolias, 2005), as well as children with hearing impairment (Nunes, 2012) and visually impaired (Koza & Skoubourdi, 2012; Koza & Skoubourdi, 2018).

Although research results highlight the contribution of additional educational material to the educational process, for teachers its use to support teaching and learning is still not taken for granted. The teachers, in the majority of them, while recognizing and theoretically supporting the importance of additional educational material, do not systematically use it in practice, nor include it in the educational process after planning (Skubourdi, 2012). In addition, there are educators who assign it a secondary role, limiting its functionality only to the enrichment of teaching and the entertainment sector, or even educators who express their reservations about its use during teaching and learning (Moyer, 2001; Moyer & Jones, 2004).

**Relationship between teachers and educational materials**

The study and clarification of the relationship between teachers and educational materials, both the material provided to the teachers, as YPS, and the additional educational material that the teachers choose to use to plan and carry out their teaching, is of particular research interest because it is the connecting link between the Curriculum, the teaching practice and the learning process, highlighting the way knowledge is developed and communicated in the classrooms, as well as the learning opportunities offered to students.

Historically, there are three main trends in teachers' use of the educational materials provided to them (Brown, 2009; Davis et al., 2016). In the first extreme, the provided PCS is used/applied as is without any change, deviation or adjustment. His recommendations are strictly followed with the participation of the teachers to a very small extent, with their own planning. At the second extreme, teachers omit or minimize the use of ESS by developing their own teaching materials, through design from the ground up or through extensive adaptation actions. In the third trend, which constitutes one

intermediate state of the two previous extreme trends, teachers adapt, supplement, shape the PES in such a way that it fits their personality, but also supports the learning of their students.

The three trends in the use of PES influence and shape the ways in which teachers read/interpret PES for teaching, which are analyzed in (Brown, 2009; Davis et al., 2016): a. Extracting information from the educational material (draw on). Instructional materials and their particularities contribute to a range of teacher characteristics, such as knowledge, beliefs, and goals, and teachers, as active designers, influence instructional materials. b. Interpretation of the educational material (interpret). Instructional materials represent the topics and concepts to be taught, and teachers as creators of meaning make decisions about what their purpose is. c. Participation of the educational material in the educational process (participate). The learning material functions as an artifact or tool, and teachers work collaboratively with the learning material and participate in its design. In other terms, PES is used in teaching (Luna, 2007): a. as a guide: the PES is used step by step providing very specific information about what should be taught and in what way. b. as a resource: the PCS is only used for ideas and suggestions, but not for instructions. c. as support: the YS is treated as a supporter of teachers' learning not for content knowledge, but for ideas and suggestions about teaching and d. as a road map: the structure and order of the YS is followed as complementing the ideas, activities and content defined by the teacher. In the cases in which teachers decide not to use the YPS or supplement it for the teaching of Mathematics and Natural Sciences, they are led to the use of additional educational material. The reasons that lead teachers to use additional instructional materials relate to how to make science engaging and interesting to enhance engagement (Forbes, 2013), to finding effective ways to address the learning needs of their students (Kesidou & Roseman, 2002; Recker, Dorward, & Nelson, 2004; Son & Kim, 2015), by achieving their instructional goals (Brown, 2009; Drake & Sherin, 2006; Remillard, 2005), by matching existing instructional practice, and the cost (in time and resources) (Janssen, Westbroek, & Doyle, 2015), with their experience with PES (Sherin & Drake 2009), with the alignment of PES with the Curriculum, in cases where the Curriculum precedes in time from the development of the respective institutionalized PES (Casey, 2016; Davis et al., 2013; Webel, Krupa, & McManus, 2015), with school leadership, school planning and the parallel

initiatives in the area (Roehrig, Kruse, & Kern, 2007), but also with the possibilities offered by the internet to easily find, exchange and evaluate a wealth of educational material (Casey, 2016).

**Factors influencing teachers' decisions regarding the use of educational materials**

Regardless of whether teaching materials are provided to or chosen by teachers, teachers' decisions about their use in teaching are influenced and shaped by factors (teachers, teaching materials, educational context, etc.) that are activated and intertwined within in a specific educational context affecting the way in which the educational material will be used (Biggers, Forbes, & Zangori, 2013; Forbes & Davis, 2010; Moyer, 2001; Stein, Remillard & Smith, 2007). The factors that concern the teachers themselves are related to their knowledge (general pedagogies, special pedagogies, content, for teaching and learning the subject, for the material, for the students, for the Curriculum, etc.), with their beliefs (about their identity and role as teachers, about the way they perceive teaching and learning, about educational materials), with their experiences and memories (about learning Mathematics as children, about the perspectives themselves as learners, even their interactions with family members around Mathematics and/or their experiences of their own children) and influence their professional identity as well as the use and adaptation of educational materials and contribute to the differentiation of its use (Levitt, 2001; Drake & Sherin, 2006; Remillard, 2005).

The research shows the positive correlation between knowledge of the subject, its teaching, the PES and the quality of the teaching. Teachers with confidence in their understanding of science subject matter were more likely to adapt the materials provided and more able to do so (Nicol & Crespo, 2006). A teacher with strong knowledge about teaching Mathematics was able to adapt an ambiguous PES math task, while no importance was given to this task by the teacher with low knowledge about teaching Mathematics (Hill & Charalambous, 2012). Strong knowledge about teaching Mathematics supported teachers in using mathematical language accurately and helped them avoid mathematical errors when using innovative PES (Sleep & Eskelson, 2012). This knowledge was necessary for them to be able to develop the multiple representations and promote the multiple solution methods proposed by the PES.

Educators only use ESS if it is consistent with their views of the content of the subject matter and how it should be taught (Blake, 2002; Duffee & Aikenhead, 1992; Gess-Newsome, 1999; Luna , 2007). Basic education teachers in the US, because they did not believe that inquiry should be assessed

abilities of students, they did not adapt the PES to assess these abilities (Beyer & Davis, 2012). Other educators valued the idea of inquiry because it was relevant to their goals of providing hands-on experiences to children, but also to spark student interest rather than engage students in authentic science practice (Forbes, 2013). US K-12 educators who lacked an adequate understanding of the scientific practice of reasoning and argumentation rarely incorporated it into their teaching (Arias, Davis, Marino, Kademian, & Palincsar, 2016; Beyer & Davis, 2008; Zangori, Forbes, & Biggers, 2013). Prospective teachers did not use educational materials to teach Natural Sciences because they believed that specialized equipment was required, an opinion which reveals a lack of pedagogical content knowledge on the one hand and a disconnection of the subject from everyday life on the other (Levitt, 2001; Luna, 2007). In research where teachers used educational materials emphasizing, when teaching the mathematical concept, the result rather than the process, it appeared that its use hindered rather than helped learning (Puchner et al., 2008).

When PES does not match teachers' knowledge and beliefs then teachers reduce its cognitive demands (Davis et al., 2016; Remillard, 2005; Stein et al., 2007). In Mathematics they did not insist on interpretation-construction even though it was the main goal of the PES. In Science, despite being given a toolbox of materials, they did not seem to adopt innovative practices, but continued to rely on the textbook or worksheets. Teachers who reported greater use of the toolkit also reported greater use of innovative practices such as argumentation, data analysis, and group work. Of course, the learning results differed because teaching was involved in addition to PES, but they were more optimistic for Physics than for Mathematics.

The temperament of teachers, their teaching goals and their beliefs about the very characteristics of the educational material are directly related to which elements of it they highlight and which practices they adopt. Educators who adopted traditional approaches were less in agreement with the PES reforms, without this meaning that they did not also implement some of the modern reforms (Levitt, 2001). Teachers who adopted the view that the main purpose of using educational materials is to entertain or reward used educational materials in such a way, downplaying their role and thus not helping their students to connect the use of materials with learning Mathematics and meaningful exploration and construction of mathematical concepts (Moyer & Jones, 2004). The secondary school teachers who took part in the research expressed their anxiety about their inexperience in using the materials and from their comments it appeared that they used them for reward, to change the routine, to enable the student to understand abstract concepts, for enrichment of teaching or just for fun.

Teachers' motivations influence their decisions about additional instructional materials. Motivations to: (a) integrate additional material into their teaching, (b) select it, (c) evaluate it, but also (d) how they prepare/adapt it for use, e) how they use it , as well as other particular factors related to their decisions to use it (Casey, 2016). Educators who intend to use supplemental materials should take the time to decide whether to create them themselves or seek them from a source. Depending on their search skills, their knowledge of the available sources, and whether or not they are willing to pay to find it, the outcome of their search is also affected.

Primary teachers used a variety of approaches to searching for potentially useful teaching materials and positively evaluated those that aligned with meeting their reasons for engaging with it (Casey, 2016). The approaches they used to search and evaluate resulted in the selection of additional materials that required minimal customization. These materials were worksheets, discussion questions, games, but also newspaper articles. However, there were cases of teachers who, although they engaged in the search, evaluation and adaptation for use in the teaching practice, did not lead to the expected results due to deficiencies in their knowledge of teaching with educational materials. Similar were the results of research in which positive evaluations of Internet materials by teachers of large elementary and middle school classes were based on various criteria such as alignment with the needs of their students (e.g., age-appropriate and engaging). and with Curricula, containing familiar approaches (such as familiar examples) and requiring minimal adaptation (Recker et al., 2004; Webel et al., 2015).

Also, the function, structure and special characteristics of the educational material as well as the respective educational context are factors that influence the way it is used in the teaching practice. For example, Standards-Based Curricula that adopt an approach to learning that focuses on actively engaging students in the construction of important ideas and concepts allow for the use of additional instructional materials more than conventional Curricula, which directly present content and they expect the teacher to explicitly teach students the skills, concepts, and processes that are the goal of the lesson (Stein et al., 2007). Furthermore, when the Curriculum is institutionalized teachers feel limited freedom to make changes (Davis et al., 2016).

In supportive educational contexts, the degree of exploratory orientation of the PES is a predictive indicator for how exploratory oriented the teachers' instructional planning will be (Beyer & Davis, 2012; Forbes, 2013). Prospective teachers who were trying to

turn lesson plans into exploratory did so successfully. However, how exploratory the final lesson plans were was largely dependent on the degree of inquiry that the initial plans incorporated (Forbes & Davis, 2010). Educators who had taught at other times based on the inquiry approach observed higher than average learning outcomes (Kanter & Konstantopoulos, 2010). Other factors that shape teachers' decision-making about the use of

instructional materials are ecological and context-related factors, which for Mathematics (Stein et al., 2007) are mainly available time, local culture, as well as the amount and types of professional support provided to teachers.

**Effects of using instructional materials**

The practices adopted by teachers, when using the PES and the support for learning to use it, influence and shape their knowledge and beliefs, as shown in research on Natural Sciences. In a study (Schneider & Krajcik, 2002), on three middle school teachers in the USA, the special role played by PES in the development of teachers' pedagogical content knowledge for the specific subject was highlighted. The same was recorded in a study with three secondary school teachers in the Netherlands (Coenders, Terlouw, Dijkstra, & Pieters, 2010). Beyer and Davis (2012) found that the pedagogical content knowledge of 24 US elementary teacher candidates and pedagogical design competence, i.e. teachers' ability to create instructional scenarios, developed through experiences that included the use of PES and support for learning to use it. Interaction with PES can shape teachers' content knowledge and views of the science lesson, as shown in a longitudinal study of 22 Australian secondary teachers (Arzi & White, 2008). The use of PES caused changes in the beliefs and knowledge of a second high school teacher in the USA regarding the inquiry pedagogical approach in natural sciences, but also the teaching with a more student-centered orientation (Dias, Eick, & Brantley-Dias, 2011). Also, in a study (Wyner, 2013), of 36 secondary school teachers in the US, it was found that teachers who implemented inquiry-based PES in science more readily adopted the use of this approach in their teaching.

In another research (Schneider, 2013) it was found that PES can be useful in developing teachers' knowledge about their students. The learning outcomes of students in specific science practices differed and were influenced by the respective educational context and by the way the PES was interpreted and applied by the teachers (McNeill & Krajcik, 2008).

From the little recorded research results on how the characteristics of teachers influence the practices they adopt when using the YPS in Mathematics, it appeared that when using the material, teachers' feelings of self-efficacy and self-confidence develop, as stress during the teaching process is reduced. during instruction (Vinson, 2001), the role of teachers is redefined and non-traditional teaching approaches to knowledge construction are adopted, giving control of learning to students (Moyer & Jones, 2004). It has also recorded a change in the opinions of Greek special and general education teachers after the use of educational materials

(Goumas, 2017). A positive attitude towards the daily inclusion of materials for teaching mathematical concepts was developed and the reference to inhibiting factors, other than limited teaching time, which seems to be the main barrier to the daily use of materials, was reduced. Also, the teachers of the general class recognized the improvement of the performance of students with learning difficulties and the change of their behavior in the learning process. The teachers of the inclusion classes reported that with the help of the material they were able to approach mathematical concepts in a more engaging and creative way and that their students represented mathematical processes more easily.

**Frameworks for using educational**
**materials** Researchers have proposed frameworks/models for studying the complex relationship between teachers and educational materials, which affects the use of educational materials in the teaching practice.

***a. Remillard's participatory model (2005)***
Remillard (2005), captured the relationship between teacher, context and provided PES, through the participatory model she proposes. In her model (Figure 1), the circle on the left characterizes the abilities, skills and knowledge that the teacher brings to this relationship in order to interpret, evaluate and adapt the PES, influenced of course by the characteristics of the materials themselves, which are presented in the circle right, but also from the frame. On the other hand, educational materials contribute through their specific characteristics, influencing in turn the teacher's relationship with the Curriculum. For example, the teacher brings pedagogical content knowledge and subject matter knowledge to the use of ESS, but also aspects of his identity and beliefs about his students. On the other hand, the PES represents ideas and topics in specific ways and has a specific form and structure. These features of the PES also affect how it is used in teaching practice. This relationship provides the teacher with opportunities for personal learning as he organizes and implements his teaching plans in harmony with his Curriculum type and adoption policy (Brown, 2009).

**Figure** 1: Remillard's (2005) participatory model


***b. Sherin and Drake's (2009) framework of PES strategies*** The way in which PES is translated into teaching is determined by a very complex system of factors, as described above, which includes the materials, the students and the rest of the educational environment, at the center of which are teachers, who act as interpreters and evaluators of ESS and classroom events using a variety of strategies. In other words, teachers adopt a variety of attitudes when 'using' PES. Sherin and Drake (2009), focusing on teachers' strategies when using the curriculum, propose a framework (the curriculum strategy framework) which takes the form of a 3X3 table (Table 1) and describes three processes, reading, assessment and the adaptation in relation to three moments of time. Reading refers to how teachers read the curriculum. The ways in which teachers read CPD can vary significantly both in terms of timing reading in relation to teaching and in terms of where they focus while reading (Remillard 1999 & 2000). The evaluation concerns how the teachers evaluate the PES before, during and after its use. These positions may differ, both in where teachers choose to focus in assessment and in the dimensions on which they base that assessment. Finally, adaptation concerns how teachers adapt the PES. Adaptation can include both structural changes, such as omitting, adding or replacing an activity, as well as changes in

context of activities, such as changing terminology or structure. In the simplest case, a teacher may tend to adapt the PES by simply omitting parts of a lesson, while in another case the teacher may be innovative and make significant and creative changes and/or additions to the PES. Vertically the table describes when these processes take place: what teachers do before teaching in order to prepare, what positions they adopt during teaching and what they do after teaching, reflecting what has happened in the previous stages.

**Table** 1: Sherin and Drake's (2009) framework of strategies for using the HMS

| | Study | Evaluate | Adapt |
|---|---|---|---|
| **Before teaching the** | | | |
| **During teaching** | | | |
| **After teaching** | | | |

The framework of ICT use strategies does not fully address the issue of teachers' use of ICT as it leaves unanswered questions about how teacher knowledge affects ICT use and what is the relationship between a teacher's strategy when using ICT PES and the effectiveness of its teaching. For example, a teacher may tend to create new materials, but there may be no indication of whether these creations focus on substantive or superficial aspects of a lesson, and whether or not they are aligned with the objectives of the Curriculum and the purpose of the lesson (Sherin & Drake, 2009).

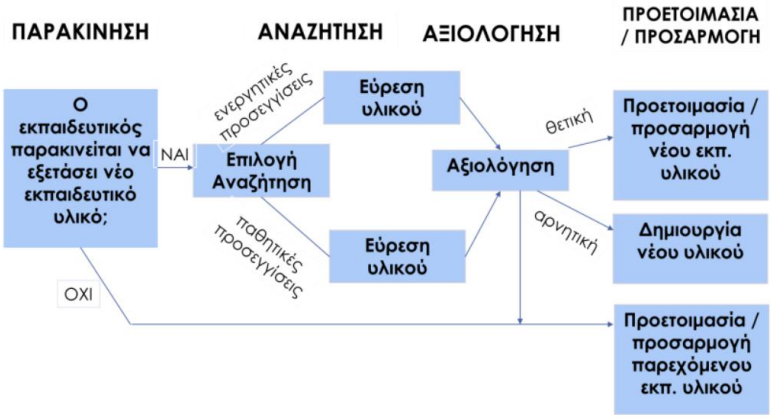
***c. Casey's (2016) Research Framework for Additional Educational Materials*** The wide availability of educational materials in various sources highlights the need to develop both effective approaches to searching for high-quality materials and skills to evaluate potentially suitable educational materials (Casey, 2016). Because teachers may save time by finding ready-made material and often material that has been evaluated and revised, but they may waste valuable time in this search.

In this direction, Casey (2016) proposes a research framework that linearly represents the decision-making process of teachers for the use of additional educational material and the possible factors that influence it, in a sequence of four phases: the examination, the search, the evaluation and preparation/adaptation of additional materials (Figure 2). The 1st phase

represents the time period of the initial planning (of a lesson, a unit or even the whole school year), where teachers consider the PES. Teachers who decide not to use additional materials skip the search and evaluation phases and simply use and adapt the materials provided or create their own materials (represented by the "no" line leading to the right side of the image in light gray ). In phase 2 , teachers use a combination of approaches to discover additional materials (as indicated by the curved arrows) which can be actionable (finding Maths coordinators for their school, searching online or in their own libraries, sending requests to others teachers through social media) and passive approaches (subscribing to newsletters about teaching Mathematics, attending conferences, accepting recommendations from colleagues.) Teachers' searching ability, that is, how they use the approaches, also affects what materials are found ( gray boxes) and which materials remain to be searched (light colored boxes). In phase 3 , teachers evaluate the materials according to their teaching objectives and other criteria relevant to their needs at that particular time. Negatively rated materials are not used, leading teachers to revert to the default provided materials or spend time creating their own materials. Positively evaluated materials are prepared and possibly adapted (in phase 4) before being used in teaching. These last two phases (evaluation and preparation) describe decisions that also take place during the use of the provided materials, while the first two phases (motivation and search) concern only the additional educational materials.

This framework does not represent all possible combinations of teachers' thinking and decision-making processes about additional learning materials, which are not linear, but it does represent the process linearly. For example, it does not represent the case in which teachers will have difficulty finding suitable materials and may return to the search and evaluation phase, nor the case in which teachers will negatively evaluate the materials they have found, decide to create new materials , they will find that they do not have the necessary time and may go back to the search phase, etc. Also, the framework does not exhaust all aspects of teachers' decisions about additional material. It does not include information about Curriculum creators, students and teacher communities, but provides information on external factors that can influence teachers' decisions throughout the process, such as district, Curriculum, years of teaching experience, but also experience with the Curriculum, the alignment of the Curriculum with the teaching goals of the teacher, the confidence in teaching Mathematics, as well as the belief in the autonomy of the Curriculum.

**Figure** 2: Research framework of teachers' decisions about supplementary instructional materials and possible factors influencing them (Casey, 2016).




## LITERATURE REVIEW

From the recordings of teachers' opinions it appears that most recognize the important role of educational materials in the educational process. They mention specific educational materials and their characteristics, but the way they use them is empirical. For example, primary school teachers, whose years of service did not exceed five, while they knew and mentioned specific materials such as the number line and the abacus, as well as their different types, but also the various possibilities they may offer in the educational process , in practice they were not often used even according to the theoretical data (Skoumbourdi, 2008a & 2008b). In a survey to determine the role and use of mathematics materials for children from four to twelve years of age, as well as

teachers' beliefs about its effectiveness in increasing mathematical understanding, it appeared that teachers believed that educational materials are a visual help and that it involves children in the learning process in a pleasant way by offering them motivation (Marshall & Swan, 2008). Also, many teachers emphasized that educational materials help children to understand concepts, encourage oral communication, improve motor skills, provide opportunities for cooperative learning, but also help them to introduce new concepts, to make abstract concepts easier to understand , as well as understand students' thinking through its manipulation. The main obstacles that

teachers face in using the material are the lack of equipment, the difficulty of organizing the material, the lack of time and space required to use the material, the cost, and that the children do not follow their instructions when using it. In research investigating the beliefs of

secondary school teachers about the use of educational materials in teaching Mathematics, as well as its influence on learning and the factors that facilitate or hinder its use, it was found that teachers showed more interest in using materials after teaching (Golafshani, 2013). Educators argued that the use of materials, both before and after instruction, plays a crucial role in students' learning of concepts. At the same time, they mentioned obstacles, which made it difficult to use material during teaching. More specifically, before teaching some difficulties they mentioned were lack of confidence and lack of time to practice. After the teaching it was seen that the teachers felt more confident, which was also due to the training they had followed. However, they still felt that they lacked time to prepare and lacked knowledge about the variety of use of materials. On the other hand, the factors teachers thought would help teaching did not differ before and after teaching. These factors were the effective use of equipment, its availability, appropriate training and administrative support.

In another study, which investigated primary school teachers' beliefs about instructional materials and how they influence their use in the classroom, it appeared that teachers consider instructional materials an important tool for learning Mathematics (Tran, 2015). An important role in these opinions seems to have been played by the fact that while the teachers as students had not been in contact with educational materials, their participation in trainings organized by the school councils on how to use the materials helped them to understand the value of. Although the way they used them and the lessons that used them were different, the teachers felt that the use of the material strengthened the learning and understanding of mathematical concepts. In addition, they considered that by using them, the children had the opportunity to be actively involved in the teaching and it was also a way to include children who do not learn in an auditory way, but in a visual or kinesthetic way. Each teacher perceived differently the influence that the use of the material had on learning. That is, one considered the children's involvement in the teaching process a success, the other that the children were having a good time and the third that the children were learning without realizing it. Also, the way they used them differed. One used the material to find out what the students knew while the other used it to explain difficult math concepts like fractions. Finally, all teachers seemed willing to use more and more materials when teaching Mathematics

however, also highlighting the obstacles they faced, which were related to the lack of time and available resources.

Prospective and active teachers, of Rhodes, attach great value to the use of additional educational material for the teaching of Mathematics, especially in small classes (Kalafata, Skoubourdi, & Chrysanthi, 2016). In their answers, most teachers indicated that the educational material should be used every week or more often, throughout the school year to meet cognitive and teaching needs. Although teachers appeared to be convinced that the materials should be used to support the teaching of Mathematics, they were not always able to suggest specific materials and activities within which to fit them, although all the activities they suggested involved the use of material. The materials they mentioned were mostly existing, which led the researchers to conclude that they might be trying to include materials that are familiar to the children from their everyday lives. Specialized materials were mentioned mainly by the prospective teachers who had attended a relevant course.

Similar results were obtained by a research (Hatzinikolaou, 2018) for the investigation of the opinions of the teachers, of Rhodes, on the importance of tangible material as an element of student autonomy in the teaching of Mathematics. From the results it appeared that the view that tangible materials contribute to the effectiveness of teaching Mathematics prevails with teachers reporting that they use a wide variety of tangible materials at least once a week. The criteria by which the specific teachers chose the tangible material was based, to a large extent, on its relevance to the teaching objectives and the mathematical concept they wished to teach and they considered that its selection and use should be based on the wider theoretical framework of the teaching of Mathematics. They also agreed that the material should promote self-activity and student involvement, be appropriate to the students' cognitive level, but also take into account the needs and interests of the students. The material they reported using for teaching was both digital and physical. The majority of the teachers considered that the use of tangible material is a factor of mathematical autonomy, but without providing information about the teaching approaches they adopted when carrying out activities using materials. They argued that depending on the age of the students the tangible material can be used in a different way and in a different type of activity. The practical difficulties they mentioned were the lack of tangible material in schools, the lack of proper training in its use, lost teaching hours and insufficient time, which discourage its inclusion in the mathematics classroom. There was also a small percentage of teachers who stated that they do not include any additional material in the teaching of Mathematics.

The intention of including educational material for the teaching of Mathematics and Natural Sciences is not the same among primary school teachers

with research results diverging. Desli and Dimitriou (2014) conducted research on the views of prospective kindergarten teachers and teachers on teaching Mathematics and Science. Teacher candidates and pre-service teachers stated that the most important approaches to effective teaching and learning of Mathematics are developing a positive attitude towards Mathematics and focusing on students' prior knowledge, while the least important was the use of experiments and materials. Regarding the approaches they consider most important for the effective teaching of Natural Sciences, the prospective teachers and kindergarten teachers chose the integration of knowledge in everyday life situations and the use of experiments and materials, while less important was the selection of appropriate activities, for prospective teachers and the knowledge of the interdisciplinary approach for prospective kindergarten teachers. The researchers conclude that there are differences not only in the teaching strategies that prospective teachers are likely to use in the future, but also in the intention to integrate educational materials with Science having the advantage over Mathematics by both groups of prospective teachers. Similar were the results in a survey (Karakatsani, 2017) related to teachers' beliefs about Mathematics and

Science, in which teachers described the use of materials as necessary for the Science lesson, while the same did not happen for Mathematics . The teachers stated that they use educational materials because they believe that they lead to learning and that they are a motivation to participate in the educational process. In a survey to investigate the opinions of prospective and current primary education teachers in Greece, regarding the use of educational material

during teaching, it appeared that students and teachers have a positive attitude towards the use of material in the field of Mathematics, but also in Physics Sciences, mainly to meet cognitive needs and provide motivation in order to activate children's interest and engage them in the process of exploration (Chrysogelou, 2018). Next is the role assigned to the material in achieving teaching, communication and social goals. The important place of the material in teaching was also shown by the frequency with which the material is suggested to be used. The majority of the sample claimed to use educational material at least once a week and even daily. Teachers and students were not sure that the use of educational materials is hindered by factors such as long preparation hours and inadequate training in the use of materials. The educational materials suggested by the teachers for teaching Mathematics were software programs, worksheets and the textbook. They also talked about cubes, sticks, abacus and abacus. On the other hand, kindergarten teachers and student kindergarten teachers appeared to refer to a greater range of materials. In addition to the above, the Montessori material was also suggested, the map, the tangram, etc.

Therefore, it could be assumed that the lower the school grade, the greater the range of materials used for teaching. Accordingly, for the teaching of Natural Sciences, mainly cultural-type materials were proposed by all. That is, scales, thermometers, magnifying glasses. Also, everyday objects and games were proposed, while the proposals for the teaching of Natural Sciences were mainly through experimental activities, simulation programs, while the student teachers were also mentioned in the school textbook. It appeared that although they all had a positive attitude towards the use of materials in education, they were unable to articulate a specific example from a topic of their choice. It was observed that even the few who did go into the process of reporting a Maths activity were not context based.

A lead in the intention to include additional educational materials for the teaching of Mathematics is reflected in the responses of active special education teachers who stated that they consider the presence of material in Mathematics more imperative than in Natural Sciences (Agnandi & Skoubourdi, 2018). They appeared to be aware of the role of materials in mathematics education and were able to suggest activities in context with specialized materials, while the same was not the case for Science, where they found it difficult to recommend specially designed materials. This is probably justified by the fact that approximately half of the participants worked in special schools and integration departments, in which the teaching of Natural Sciences to students with special educational needs is not foreseen. The special education teachers claimed that the use of materials is crucial to achieve the lesson objectives related to skills and knowledge and necessary to enrich their teaching in Mathematics, but also to implement reinforcement and extension activities in the Science lesson. The materials that the teachers mentioned that they included in the teaching of Mathematics were mainly specialized mathematical material, while the same was not the case for Natural Sciences. The materials that were captured were mainly existing, that is, everyday objects that are not related to the education of Natural Sciences. So, at this point, the inability of special education teachers to propose specially designed material for Natural Sciences is identified. Of course, there were also answers from teachers who mentioned specialized material, but claimed that they do not use it, because it is absent from the school units in which they occasionally work. Special education teachers reported using instructional materials more than once a week to introduce Math and Science concepts. The main criterion for selecting or designing materials, reported by teachers, was based on the particular—idiosyncratic, in many cases—interests of students with special educational needs. The most important obstacles they recorded that they encounter when using the material are the distraction of the students from

the mathematical activity, the inability to connect mathematical/physical concepts with specific materials, the lack of interest in the materials, their poor treatment and the necessity to readjust them to the particularities of the students. Additional difficulties faced by the parallel support teachers concern the management of teaching time, the lack of appropriate materials from the school unit and the availability of space.

Other reasons why teachers are reluctant to use additional learning materials for teaching are because they feel that using them will create a commotion in the classroom, children will destroy them, the cost of education will increase too much, and that the concepts they will be developed using materials they will never become abstract (Jacobs & Kusiak, 2006; Szendrei, 1996). They argue that many times students use the materials in the way they have been taught and do not develop their actions into mental activity (Kilpatrick, Swafford, & Findell, 2001). They also report that children's interpretations of materials often differ from the interpretation introduced by teachers (Baroody, 1989; Kilpatrick, Swafford, & Findell, 2001). The above fears are not only theoretical, but are based on repeated bad experiences in Mathematics classrooms, where materials and tools were not used in the best way (Szendrei, 1996). The above surveys provide information on teachers' intention to use additional

educational material, on the type and frequency of its use, on what motivates teachers to seek it, as well as on the factors that inhibit its use. Evidence on the influence of instructional material use on teacher characteristics is limited Although it is one of the important parameters of the relationship between teachers and instructional materials, little data exists on where and how teachers seek additional instructional materials. From the above, it can be seen that the research that examines the use of educational materials has focused more on the use of the provided educational materials for Mathematics and

Natural Sciences, while it is particularly limited for the new (additional) educational materials. Also, there is limited research that examines teachers' views on the use of Math and Science teaching materials. Additionally, research comparing teachers' views on the use of instructional materials in Mathematics and Science is particularly limited. The necessity of carrying out a research that systematically studies and compares teachers' perceptions of the use of Math and Science educational material emerges.

## PURPOSE AND RESEARCH QUESTIONS

The present research is part of the wider field of studies that investigate teachers' opinions on the use of educational materials. Its main purpose

research is to investigate and compare the views of primary school teachers on the use of Math and Science teaching materials.

In particular, this work aims to answer the following research questions:

Research question 1: What are the opinions of primary school teachers regarding how they use the Maths and Science educational materials provided to them and to what extent do they differ based on the subject (Maths, Science) they teach? Research question 2: What are the views of primary school teachers regarding whether they use additional teaching materials for Mathematics and Science and (if so) how often and how and to what extent do they differ based on the subject (Mathematics, Science) they teach? do they teach? Research question 3: What are the views of primary school teachers about what motivates them to look for new (additional) teaching material in Mathematics and Science and to what extent do they differ based on the subject (Math, Science) they teach? Research question 4: What are the opinions of primary school teachers regarding what they look for new (additional) educational material in Mathematics and Natural Sciences and to what extent do these differ based on the subject (Mathematics, Natural Sciences) they teach?

Research question 5: What are the views of primary school teachers regarding the reasons they do not use new (additional) educational material in Mathematics and Natural Sciences and to what extent do these differ based on the subject (Mathematics, Natural Sciences) they teach? Research question 6: What are the opinions of primary school teachers regarding whether the actions they take when using Math and Science educational material affect their knowledge, beliefs, teaching practices and the learning outcomes of their students and to what extent do they differ based on the subject (Mathematics, Natural Sciences) they teach?

## METHODOLOGY

### Research process and sample

This research was conducted during the 2017-2018 school year and was carried out in two phases.

In the first phase (pilot research), the data collection tool (questionnaire) was constructed. Initially, the questionnaire was given to ten primary school teachers. A short collective discussion was held with the teachers to elicit comments and observations. Also,

it was given to two researchers (of the Teaching of Mathematics and of the Teaching of Natural Sciences) in order to check its internal validity and to correct any deficiencies or ambiguities. Then, the questionnaire of the main research was formulated, based on the observations and shortcomings pointed out in its application in the pilot research, in order for it to meet the objectives of the research and be understandable by the teachers. In the second phase

(main research), the questionnaire was completed electronically by primary school teachers and their responses were then analysed. 212 public elementary school teachers

participated in the main survey. Of these, 74 were men and 138 were women. Their average age was 44.2 years and their average classroom teaching experience was 19.2 years. During the school year of conducting the research, 32 teachers taught in 1st grade of primary school, 23 in 2nd grade, 25 in 3rd grade, 29 in 4th grade, 61 in 5th grade, 34 in 6th grade and the remaining 8 in reception classes.

**Data collection**

The questionnaire in electronic form was defined as the research tool for data collection. The questions of the questionnaire were "closed" with the possibility of either a single "Yes/No" type answer or multiple choices or based on an equal-spaced rating scale.

The final questionnaire composed included two parts with a total of 25 questions. The first

part included seven questions that requested information about the teachers' record (question 1), age (question 2), studies (question 3), their teaching experience (question 4), the class in which they taught school year 2017-2018 (question 5), as well as the type of school (public, private) (question 6) and the type of school they worked in (question 7).

The second part of the questionnaire included 17 questions that explored the teachers' opinions on the use of the Maths and Science educational material provided to them as well as the new (additional) educational material that they themselves are looking for. These questions were formulated for the needs of the research based on the research questions (see Table 2) and the relevant research literature regarding the use of educational materials by teachers (indicative: Davis et al., 2016). These questions were preceded by the definitions for the following terms: educational material, educational material provided and new (additional) educational material. Questions 8-15 referred to the teachers' decisions regarding the teaching materials of Mathematics and questions 16-23 referred to the decisions of the teachers regarding the teaching materials of the Natural Sciences during the school year 2017-2018.