INSTRUCTIONAL TECHNOLOGY USE IN MATHEMATICS AND ENVIRONMENTAL SCIENCE GREEK PRIMARY SCHOOLS CLASSES

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Abstract

Research on types of instructional technology used in school classes for teaching is limited. This study focuses on the types of instructional technology that primary school teachers – in third and fourth year classes – tend to use in sessions of Mathematics and Environmental Science subjects. In each subject 160 sessions were observed. The frequency with which the instructional technology types were used in teaching was recorded. The main conclusion is that print textbooks, worksheets and the whiteboard are more commonly used. The use of ICT- oriented types (e.g., computers, video-projectors) while teaching Mathematics and Environmental Science is found to be limited.

Introduction

This project focuses on the field of instructional technology, an essential part of education science, which has been researched and reviewed over the last years. Experts, while identifying the basic points and principles of instructional technology, have arrived at various definitions. The most recent one, as stated by Gagne (2013), treats it as a set of teaching practices and delivery techniques that can facilitate learning processes and increase its' effectiveness, with or without the use of Information and Communication Technologies (ICT). It aims to clarify principles that can assist the desired effectiveness and that can be applied during planning, implementing and reviewing teaching interventions. Overall, it refers to the systematic study and use of methods that are justified as appropriate for educators (Gentry, 1995).

Instructional technology is linked nowadays to the use of technological means or types in education. This is because of the advancement of ICT over the last decades in combination with the wide research around its positive impact and benefits to teaching. More specifically, there has been research about the possibilities and potential of types, means and applications of ICT that the teachers should consider taking advantage of to achieve desired effective outcomes in their teaching work. This research has been expanding in all levels of education and in different subjects. Teachers are provided with a plethora of ideas of what technological types to use in different parts of their work (Uluyol & Şahin, 2016).

Using technological means in teaching is justified to give teachers opportunities to design a more interactive, more interesting and attractive session, which will help learners appreciate the necessity of ICT types and means in learning and their life generally (Kimmel & Deek, 1995).

The integration of instructional technology in the educators' actual work requires thorough preparation. It depends on various factors, which are relevant mostly to the social and educational context. Researchers conclude though that perhaps the most basic of these factors is the role and perception of the educators. It is educators who must decide and plan to use it. This decision is based on their ideas about the benefits that it may bring to the teaching intervention. This may refer to the level that intervention is facilitated using technology. It may also refer to the outcomes of learners and learning generally.

Apart from the teachers though, the context may influence the frequency of technological means, through interrelated factors, such as the availability of technological means or the subject or more specifically the unit taught and the nature of teaching projects (Gorder, 2008). It is for these factors that researchers and experts consider that the integration of technology in classroom should not be treated as a single unified topic but as a multidimensional matter. Each dimension requires individualized approach and study concerning the benefits, general issues and frequency of use in classroom by the teacher (Keengwe, Onchwari, & Wachira , 2008).

The dimension of the frequency of use of instructional technology and ICT calls for study. It is worth investigating how frequently educators tend to use applications of ICT in teaching. This kind of monitoring ICT use in classroom is crucial for evaluation, research and policy making as it provides significant insights about the reality, context and culture of teaching and schooling towards technology and instruction (Wagner et al., 2005).

It is in this direction that this project focuses. The project tends to identify how frequent the use of instructional technology in Greek Primary schools is. In doing so, it takes research findings into consideration. These findings claim that that subjects or units may influence the use of technology in classroom (Gorder, 2008). So, the project centers on two subjects of the Greek Primary School Curriculum. These are Mathematics and Environmental Science. This goal can be reached by observing teachers of primary schools in Greece, during teaching and identifying how much they take advantage of the means and types of instructional technology as they are guided by research to do so (Kimmel & Deek, 1995; Uluyol & Şahin, 2016).

The implementation and accomplishment of this study requires attention to the concepts of technology, educational and instructional technology, technological means and types used for instruction. Besides that it is necessary to investigate the methodological approaches (Cohen, Manion, & Morrison, 2011).

Literature Review

Although there has been significant research to prove that instructional technology assists teaching intervention, limited is the research to identify the types of instructional technology educators use. Literature has suggested that textbooks still dominate in teaching (Horsley, Knight, & Huntly, 2010; Knight, 2013) while use of other types of instructional technology is not common. This applies especially to ICT-oriented types (Kennewell &

Beauchamp, 2003). This research refers mostly to secondary or tertiary education levels. There is room and interest in carrying out similar research at elementary education.

Research and theory have suggested certain ways with which environmental and mathematical science teaching can benefit form the use of ICT. Using technologies has been stated to assist educators in implementing their teaching strategies, by allowing them or the learners to gather, use, investigate, manipulate, analyze and share information or data. Hardware, such as computers, laptops, projectors, and interactive whiteboards, in combination with software, such as applications, sites, simulators, and digital social networks has expanded the opportunities for communication and interaction. This might be between learners themselves, teachers and learners and generally the members of the education community and the wider social context (Eady & Lockyer, 2013; Gorder, 2008).

Instructional Technologies Types in Class

ICT therefore has been treated as an opportunity improve learning. The influence of ICT expands in various dimensions. A significant dimension is the benefits for teaching subjects. In many countries, curricula, which are influenced by literature, research have stated each subject can be enhanced by involving types and applications of ICT. Teachers are therefore expected by National Curricula to do so, under the general impression and aspiration that such approach might make learning more attractive and effective. Even in elementary schools, literature and curricula have pointed out types and task directions where types of technology, either software, or hardware can be of assistance. However, no benefit can occur automatically. If technology types are to be taken advantage of, teachers should act accordingly (Comi, Argentin, Gui, Origo, & Pagani, 2017; Uluyol & Şahin, 2016). Indeed, research has shown that teachers' decision about what type to use, in what way and for how long, influence significantly the outcome of the session. These outcomes may refer to knowledge that learners gain in what concern the subject taught as well as ICT. They may also link to skills or attitudes about ICT and their role in learning and everyday life generally. In short, the teacher is a crucial factor (Gagne, 2013; Kimmel & Deek, 1995).

Even the same teacher, however may use instructional technology types differently, depending on the subject. Certainly, there are general principles concerning how to use these types, which can be implemented in many, if not all, subjects. Literature though identifies subject-influenced implementation practices. This specification is based on the nature of each subject, its characteristics and individual, general goals around knowledge, skills and attitudes. These factors influence the types of instructional technology that might seem more appropriate and the practices that teachers should implement with them (Comi et al., 2017; Gorder, 2008).

Environmental science and mathematics teaching can therefore be assisted by ICT. In environmental science, types that can be used include computers, interactive whiteboards, websites, projectors, simulators, virtual experiments, data logging kits and sensors. These can provide the teacher with up-to-date-

resources, opportunities for learners to experiment with contexts that are difficult to experience otherwise. For example, the teacher can help learners observe, test and understand phenomena of photosynthesis, pollution, global warning or the greenhouse effect. Learners can take part in discourse or activities around these topics that could be difficult to implement with conventional means (Law, 2009).

In mathematics classes, ICT can also help in many ways. Computers, interactive whiteboards, the Internet, spreadsheets, sites and software can assist in gathering information, in carrying out complicated and highly skilled calculations and statistics. By using these means, teachers can implement tasks that engage learners in activities that require or promote complicated arithmetical or geometrical skills and thinking. Such activities would be rather time-consuming and challenging if they were implemented without the use of technological means (Law, 2009).

In short, the benefits of using instructional technology types in environmental science and mathematics have to do with identifying accurate data, promoting interactive learning, by motivating learners to seek, test and experiment. These factors assist the promotion of knowledge skills and attitudes (Comi et al., 2017; Law, 2009).

Purpose and Research Questions

This project focuses on the types of instructional technology that primary school teachers tend to use in sessions of mathematics and environmental Science subjects. More specifically it aims to explore the frequency of instructional technology types' implementation in Greek Public Primary Schools.

The main points of this implementation are three. The first is that there is a variety of types specifically used in the classroom. The second is that there is a difference in the frequency of the use of these types (Gorder, 2008; Kimmel & Deek, 1995; Uluyol & Şahin, 2016; Wagner et al., 2005). Finally, the third has to do with whether there is significant difference in instructional technology use in environmental science and mathematics (Comi et al., 2017; Gorder, 2008;). The research questions are formed as follows

1. What types of instructional technology are used by teachers in the classroom?
2. Is there difference in the use frequency of these types?
3. Is there difference in the types of used between the subjects of environmental science and mathematics?

Methodology

The appropriate methodology should bear in mind the scope and the context of this project, which aims to identify the types of instructional technologies used in specific subjects. The project focuses on how much time educators spend using them during their teaching. The findings can give insights concerning the implementation of ICT in classrooms as teaching means. This can serve as

a supplement to current research (Gorder, 2008; Kimmel & Deek, 1995; Uluyol & Şahin, 2016; Wagner et al., 2005). In doing so, it is necessary to point out the context of the project and the method used to collect the required data (Cohen et al., 2011).

The project focuses on environmental science and mathematics. The context is Greek Elementary Education (MINEDU, 2011). Research has justified that these two, just like other subjects can be assisted by instructional technology. Computers, the Internet, interactive whiteboards, along with other hardware or software specific for these subjects can be and are used in classroom to enhance teaching (Comi et al., 2017; Law, 2009). Though, as research points out that use of instructional technology is still limited, it is necessary to compare it with the use of traditional and conventional means, such as the textbook and worksheets. This calls for the use of a data collection tool that can help measuring quantitatively the use of each kind of means. This includes both ICT-oriented means and conventional ones. This collection method should provide data itself, so that the necessary comparison can then be carried out (Cohen et al., 2011).

Sample

For the scope of this research observation was selected as the most appropriate data collection method. Indeed, observation is known to be giving directly more accurate insights and information about what happens in classroom, and what approach, practices and means are being used by the educators (Cohen et al., 2011). After carefully preparing, studying and planning the observation process, researchers observed 80 elementary school teachers while they were teaching the subjects of environmental science and mathematics. These were teachers of the third and fourth grades of the Greek primary school. Pupils that attend these grades are between the ages of 8-9, or 9-10, respectively. These pupils attend four sessions of mathematics and two sessions of environmental science every week, according to the Greek curriculum. Each session lasts for 45 minutes properly (MINEDU, 2011).

Having in mind the timetable of the research, in combination with the teachers' workload and obligations, it was planned that each teacher would be observed for two hours in each subject. This was done as planned. This provided a total of 160 observations in each subject and 320 in both, which could give a wealth of data to achieve the goal of the research. During observation, the focus would be on the types of instructional technologies used. It was important to note down these types along with the amount of time each type was used, which could then give a percentage of frequency of their use compared to the total time of the session. The instructions and steps of implementation of the Teaching Dimensions Observation Protocol (TDOP) (Hora, 2015) were followed carefully (Hora, Oleson, & Ferrare, 2013).

Data collection

The project is of quantitative nature. The most appropriate instrument that can serve this method and the general scope of the project is the Teaching Dimensions Observation Protocol (Hora, 2015). TDOP is designed to reflect

on the processes, means and approaches used by educators or learners during the teaching interventions.

The protocol primarily pays attention to three basic factors. The first one is instructional practice, which includes the methods and activities implemented by the instructor while teaching, which can be either teacher oriented or student oriented, depending on who has the primary role and responsibility. The second is student-teacher dialogue, which is linked to the communication and interaction between teacher and student, which can again be student led, or teacher led, depending on who is the primary speaker. Finally, the third basic dimension is the instructional technology dimension, which is focused on what means are used while teaching and in what context or goals. When implementing any version or adaptation of the specific protocol, it is expected to include these dimensions (Hora, 2015; Osthoff, Clune, Ferrare, Kretchmar, & White, , 2009).

Apart from the basic dimensions, however, there are other optional ones. The first is the learners' potential cognitive engagement in the teaching. The second is the dimension of pedagogical strategies. Lastly, the third one is the dimension of learners' engagement. Those optional dimensions are involved, whenever there is need for further detail of observing teaching practices (Hora et al., 2013).

This project, as it is designed, focuses on the third basic dimension, which is about instructional technology. Researchers who use this instrument are expected to emphasize the time spent on the use of specific technology types. This can help calculate frequencies of their use. These types can be: textbooks; smartboard or whiteboard; projector; PowerPoint presentations or digital slides; digital clicking response systems; demonstration equipment, which can be digital but not necessarily, as it may involve experiment equipment and tools; hardware such as laptops, cameras tablets, which promote interaction; movie files, such as YouTube videos; and simulations and websites of any kind that can assist in class.

TDOP implementation is done through seven steps. After the first step, which is the clarification of the project goals and the selection of the TDOP as an appropriate tool, the second includes selection of relevant dimensions. The third step includes clarifying the nodes and means for measurement. The fourth has to do with deciding if current versions and variations of the protocol fit the project or if there is a need for a new one. The fifth involves preparation of the research context and arrangements with the people who are to be observed. The sixth involves conduction of the arranged and planned observations. Finally, the seventh involves analysis, interpretation and dissemination of the results (Hora et al., 2013).

Data Analysis

Analysis of the findings was planned with the help of quantitative approach, either descriptive or inferential statistics. With regards to the first research question, the answer is expected to come from the former. By calculating and identifying relevant frequency, as a figure itself, it is possible to name which

types are being used. With regards to the second research question, descriptive statistics is expected to give answer as well. By identifying means, range and mode, as criteria of tendency and distribution is it is possible to see which types of instructional technology are used more often. Lastly, with regards to the third research question, the comparison can be achieved by benchmarking measurements or even referring to inferential statistics and the use of the T-test. More specifically, for the sample of the study, the paired sample test was appropriate, since the pairs of data date referred to the subjects (Cohen et al., 2011; Swift & Piff, 2014).

Findings

The results of the observations and the frequency calculations have been gathered and their average has been identified. This has led to the desired findings about the types of instructional technologies used in classrooms. As far as the first question is concerned, the findings as shown from the calculated frequencies indicate that most mentioned types of instructional technology are being used in the mathematics and environmental science classrooms. These data are presented in Table 1. Almost every type has a use frequency value larger than 0, as it is noted to be used for a period, during the class. In fact, the only type not used and that gets a 0 value is the projector. In mathematics, specifically there was no observed use of videoclips either. Overall, in both subjects there is use of ICT-oriented instructional technology, such as the Internet and computers as well as conventional, traditional types such as the textbook. This finding is compatible to the relevant literature (Gorder, 2008; Kimmel & Deek, 1995; Uluyol & Şahin, 2016; Wagner et al., 2005;).

Table 1

Frequencies of Instructional Technology Types Use, as Percentage (%) of Session Time

Instructional Technology	Mathematics	Environmental Science
Instruments, Materials (IM)	1.76	4.06
Demonstration Equipment (D)	12.13	14.53
Posters (P)	0.88	4.34
Textbooks (T)	44.57	48.67
Worksheets	15.84	7.79
Projector (P)	0.00	0.00
Whiteboard (CB)	21.54	10.16
Movies, Documentaries, Video clips (M)	0.00	3.25
Education Software, Simulations (S)	0.52	3.46
Websites (WEB)	2.77	3.75

As far as the second question is concerned, the range of responses in both subject shows that there is a rather significant difference in the frequencies of use. These are illustrated in Figures 1 and 2 as well as in Table 2. The range as a measure of spread, reaches 44.57% and 48.67%. Indeed, the use of the textbook, which gets the maximum value, is more common that others, as it almost reaches half of the total time. Similarly frequent seems the use of worksheets, whiteboards and demonstration equipment, though not used as much as the textbooks. Instruments, materials, education software and websites are being less used. This justifies the research findings that state that in spite of the possibilities that ICT offer, textbooks still dominate teaching (Horsley et al., 2010; Kennewell & Beauchamp, 2003; Kimmel & Deek, 1995; Knight, 2013; Swift & Piff, 2014; Uluyol & Şahin, 2016).

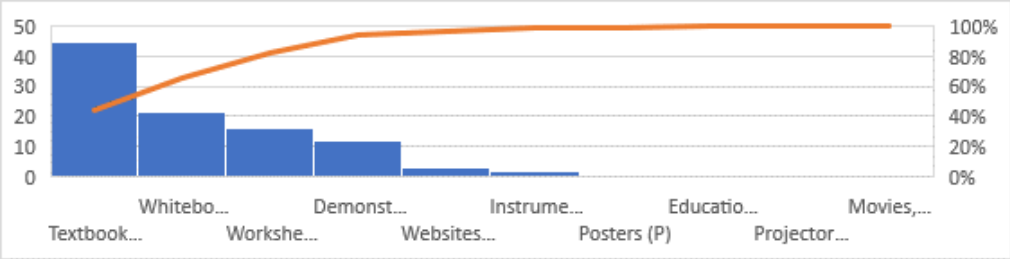

Figure 1. Instructional technology use in mathematics.

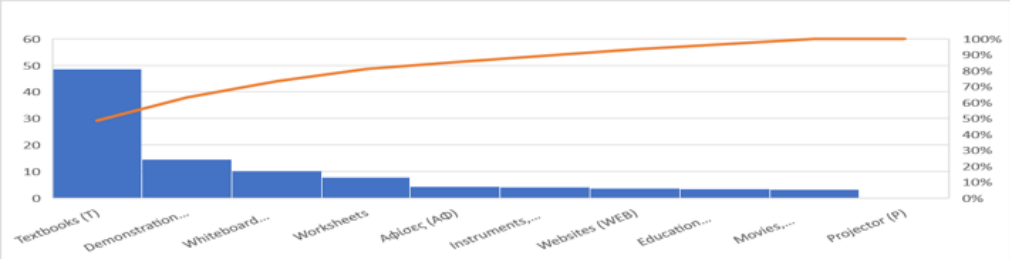

Figure 2. Instructional technology use in environmental science.

Table 2

Descriptive Statistics Values, as Calculated from the Frequencies

Instructional Technology	Mathematics	Environmental Science
Mean (μ)	10.00	10.00
Median (M)	2.27	4.20
Minimum Value	0.00	0.00
Maximum Value	44.57	48.67
Range (R)	44.57	48.67
Variance	205.06	201.64
Standard Deviation (σ)	14.38	14.20

Finally, as far as the third question is concerned, by implementing the T-test, the outcome is very low, as shown on Table 3. This signifies that overall, there is no significant difference in the use of instructional technologies in both these subjects. Certainly, individual types might differ. For example, white boards seem to be used more in mathematics, where the frequency seems to be double. However, simulations and software seem to be used more in environmental science. This finding might show that the instructional technology use depends on the subject taught too (Comi et al., 2017; Gorder, 2008; Law, 2009). However, in general no major difference..

Table 3

Descriptive Statistics Values, as Calculated from the Frequencies.

Variable		Mathematics	Environmental Science	t-value	prob
Instructional Technology	M SD	10 (14.38)	10 (14.20)	0	0.5

Discussion and Conclusions

This research aimed to identify the types of instructional technology used in classrooms, in the subjects of environmental science and mathematics in elementary schools in Greece. Instructional technology types are suggested through research to have significant benefits when implemented in the classroom. Such types could be conventional, e.g., textbooks or ICT-oriented, e.g., computers, websites, projection material, hardware, and software, such as simulations. The suggestions may be common in every subject (Gagne, 2013; Uluvol & Sahin, 2016). Additionally, there are specialized suggestions and practices that address specific subjects, such as environmental science and mathematics (Comi et al., 2017; Gorder, 2008; Law, 2009).

Despite this promotion of instructional technology, research points out that its' implementation in classrooms is in some cases limited (Gorder, 2008; Wagner et al., 2005). This research therefore aims to point out the frequency of implementation of instructional technology types used in the specific subjects, in Greek elementary schools. Within this scope, the project aims to identify at first what types of instructional technology are used; at second, which types are used more frequently and; at third if there is significant difference between the two subjects.

Data for this research were collected through observation. The Teaching Dimensions Observation Protocol was selected as an appropriate tool for this research. Thanks to TDOP, it was possible to observe, note, calculate and compare the amount of type that the teacher uses each type of instructional technology. This protocol also allows comparison with other means such as textbook and worksheets (Hora et al., 2013).

Data analysis was done by a quantitative approach. By calculating the time, it was possible to identify the percentage of the session duration, that each type

was used. The findings show that plenty of means of instructional technology have been used in the classroom. Textbooks and whiteboards though seem to be used more frequently. With regards to the comparison between the subjects there seemed to be no significant differentiation. These findings are overall compatible to the conclusions of research around this topic (Gorder, 2008; Kimmel & Deek, 1995; Uluyol & Şahin, 2016).

Limitations of this project though, should be taken into consideration. The sample of the research was specific. Data came from a single area of Greece. This was done, due to time and place restrictions. The focus was in two specific subjects of the curriculum for only two grades of elementary education. Emphasis was paid in identifying frequencies of instructional technology types use. It might be worth expanding research to other subjects and other grades of Greek elementary school. Moreover, this could be combined with other relevant dimensions such as teaching practices and types of question. That would give a more complete picture of the teaching process and lead to more broad conclusions (Cohen et al., 2011; Hora, 2015).

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