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USE OF ONE-TO-ONE IPAD IN PRIMARY SCHOOL TO TEACH THE CONCEPT OF ENERGY IN PHYSICS: A CASE STUDY

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Abstract:
In recent years, technology has become an increasingly important tool in education. The use of technology in primary education has become increasingly popular in recent years, and the iPad has emerged as one of the most versatile and powerful tools for enhancing learning. This paper will focus on the impact of one-to-one iPad use in primary schools on teaching the concept of energy in physics. A total of 25 students in the 3rd grade from a primary school in Greece participated in the study, using iPads during their physics lessons. This study's results showed that iPads significantly improved the student's understanding of energy in physics. The students who used iPads had a more profound understanding of the concept, showed greater engagement and motivation and demonstrated a deeper understanding of the material.

Keywords: iPad, energy, primary school

1. Introduction

The use of technology in education has become increasingly popular in recent years. The integration of technology in education has been widely discussed in the literature. Several studies have investigated technology's effectiveness in teaching science concepts in primary schools. For example, (Minshew & Anderson, 2015) studied how several barriers and influences have emerged from the teachers' practice and technology integration into their classrooms. A systematic review given in 2019 by Boon et al. found that virtual reality technology effectively enhanced primary school students' understanding.

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One technology that has gained much attention is the iPad. The iPad is a tablet computer that can be used in various educational settings. One-to-one iPad programs have been implemented in many primary schools, but their effectiveness in teaching science, particularly physics, has yet to be extensively studied. Physics is a subject that is often viewed as difficult and abstract by primary school students, which may lead to a lack of interest and engagement in the subject. Therefore, it is crucial to investigate whether using one-to-one iPads can improve the teaching and learning of physics in primary schools.

2. Literature Review

The concept of energy is an essential topic in physics education. It is a fundamental concept that underpins many other concepts in physics. However, the concept of energy is difficult for students to understand, and traditional teaching methods may not help students fully grasp the concept. There are many misconceptions about energy. Research has shown that many elementary students associate energy with living organisms or human processes (Watts, 1983; Driver & Warrington, 1985; Solomon, 1992; Ross, 1993; Trumper, 1993; Goldring & Osborne, 1994; Rule, 2018). In Primary School, the most popular teaching approaches focus on the different forms of energy as an intermediate language useful for the qualitative treatment of the concept of energy (Kaper & Goedhart, 2002a & 2002b; Hobson, 2004; Koliopoulos et al., 2009). Another approach to teaching energy is to transform energy from one form to another (Papadouris, Constantinou & Kyratsi, 2008; Golberg, Otero & Robinson, 2010). Based on these two approaches, the authors proposed a project some years before to teach energy (Tsiouri & Kotsis, 2018). The difficulty of understanding the concept of energy is clear from the fact that there are misconceptions not on the students of secondary education (Tsaparlis et al., 2020; Panagou et al., 2021; Ozkan & Topsakal, 2021; Ilham et al., 2022) but also at the University students (Evangelou & Kotsis, 2004; Prince, 2012; Avci, 2021; Assem et al., 2023) and adults (Martins et al., 2019; Martins et al., 2021).

The use of iPads, in particular, has been studied in the context of primary school education. The iPad, first released in 2010, was introduced as an educational process in schools, replacing the laptop or simply as a new technology. In 2013, a proposal was made for its use in secondary education (Johnson, 2013), while one year before was for primary school (Henderson and Yeow, 2012). One year later, strategies and challenges in iPad for education have been published (Chou et al., 2014). Students using the iPad have access to search engines, dictionaries, and information where they can easily and quickly check their validity. They can also use interactive applications, but also differentiated in levels of difficulty, where the student is allowed to develop his knowledge and skills at his own pace. Furthermore, the iPad as a tool is fast and automated, ideal for personal use since no user input is required. Students can use the same device at school and home, turning learning from "school" into 24-hour learning. Many studies have been published using iPad to teach subjects in school, such as math in Primary school (Ibtesam, 2016) or in High

School (Aldossry & Lally, 2019), STEM in High School (Hughes & Boklage, 2017), music (Bandlien & Selander, 2019), or problem-solving (Kaito & Shinichi, 2022).

A modern use of the iPad is the One-to-One iPad process, where each student has their own iPad. Recently a Ph.D. thesis was published (Pipala, 2020), where he evaluates this type of educational work. In the modern literature, suggestions and educational scenarios are using the One-to-One iPad for Primary School, e.g. (Tirado-Morueta et al., 2020a). Student response to One-to-One iPad has been positive in the international literature (Kaufman & Kumar, 2018). Today there are Primary Schools in many countries, e.g., Spain, where they use iPad daily. For all academic subjects, and from these efforts, the data on the pedagogical motivations of this innovation emerge (Tirado-Morueta et al., 2020b). The fact that children have their own personal devices also allows parents to be more involved in their children's learning, which was not possible until now (Lymberaki, 2016). The iPad has several features that make it an attractive tool for teaching the concept of energy. For example, the iPad has a touchscreen interface that allows for interactive learning experiences, and it can be used to display visual representations of energy and energy transfer. Tools such as iMovie, camera, and microphone can change how activities are carried out, with students making learning objects themselves. In addition, collaborative learning becomes easier since, by working in multimedia environments, students distribute roles better and quickly and easily share their files with group members (Lymberaki, 2016).

One study by Lee (2015) used iPad simulations to improve students to learn Newtonian physics concepts. Another study by Falloon & Khoo (2014) found that using iPads in primary schools increased student creativity and collaboration. Today iPad in Primary Education is used to teach mathematics (McDonald & Fotakopoulou, 2022; Nevrelova & Korenova, 2022) and even teach the earthquake phenomenon (Tsiouri & Kotsis, 2021). Also, using iPads to learn creative thinking (Al-Zu'bi et al., 2022). Recently published (Lauricella & Jacobson, 2022) an interesting study about teachers' intentions and the realities of using iPads in the first-grade classroom. However, to our knowledge, no studies have investigated using one-to-one iPads to teach the concept of energy in physics to third-grade primary school students.

In this paper, we investigate the use of one-to-one iPads in primary schools to teach the concept of energy in physics. Therefore, it is important to investigate whether using one-to-one iPads can improve the teaching and learning of physics in primary schools.

3. Method

A quasi-experimental design was employed in this study. The study was conducted in two primary school classrooms, with 25 students in each classroom, from the Experimental Primary School of Ioannina, Greece. Experimental Primary Schools in Greece are where the teachers are overqualified, and they can use new teaching methods, not the traditional ones. The students were in the third grade and ranged in age from 9-

10 years old and had no prior knowledge of the concept of energy. The teacher was trained in using iPads in education and had previous experience teaching the concept of energy. The study lasted for four weeks. The students were randomly assigned to either the experimental or the control group, with 25 students in each group.

The experimental group received instruction using one-to-one iPads, while the control group received traditional instruction. The instructional material was designed based on the "Flexible Zone" and cross-curricular in corresponding teaching material of Language, Mathematics, Physics, Environmental Studies, and Visual Arts. The students in the experimental group were given iPads with preloaded apps and videos that covered the concept of energy in physics.

The students in the control group received the same instructional material in the form of textbooks and lectures. The materials used in this study were iPads, for the experimental group and a physics teaching module. The physics teaching module was designed to teach the concept of energy to primary school students. The module included a variety of multimedia resources such as videos, maps, game roles, simulations, and interactive activities. The project we used was published in 2018 by Tsiouri and Kotsis and named "Coal in Europe or Coal Europe." The time for the project in 2018 was from January to June of the academic year. The project method (Frey, 1986) was used, which is a way of group teaching with the simultaneous participation of teachers and students arising from determination, while the teaching itself is planned, shaped, and carried out with the contribution of all participants. The project's main purpose was for the students to cultivate attitudes and skills to help them develop personal and collective responsibility for energy and the environment. In addition, to participate in actions and take initiatives to protect and improve the quality of their lives and the environment in which they operate.

The program's subject was initiated by the global debate on energy sources, but also by the first designation of the European Union in 1951 as the "European Coal and Steel Community." From the middle of the 18th century, when the intensive exploitation and burning of fossil fuels began, huge amounts of carbon dioxide into the atmosphere began. Therefore, burning carbon releases gases into the atmosphere, such as carbon dioxide, a gas useful for photosynthesis but responsible for the greenhouse effect.

The students were divided into five heterogeneous groups regarding performance and gender. Splitting them into groups allowed five students to talk to each other simultaneously, which was very important since they did not talk otherwise in their free time and thus maintained interpersonal relationships with their classmates. Also, the presentation of the discussion results in the plenary session had an encouraging character since everyone felt important for themselves and the group, presenting the findings for their group. The members of the groups were asked to collect material for the member states of the European Union in specific worksheets regarding their mineral wealth, process it, exchange ideas, and decide what their final text for the digital story would be after they composed it. Regarding the evaluation of the action, the method of observing the students during the activities was used, as well as the use of a questionnaire.

Qualitative data were collected through observation and interviews, while quantitative data were collected through pre-and post-tests. The pre-test was administered at the beginning of the study to assess the students' prior knowledge of the concept of energy. The post-test was administered at the end of the study to assess the student's understanding of energy. More specifically, actions related to concept mapping, creative expression, the use of audio-visual media, the creation of audio-visual material, the presentation of activities, and the utilization of new knowledge in the immediate and wider environment.

The study involved an experimental group of 25 primary school students and a control group of 25 students. The students in the experimental group were taught the concept of energy using iPads, while the students in the control group were taught using the traditional method.

The teaching materials for the experimental group were developed using the Keynote application. The Keynote application allows for creating interactive textbooks that can be used on the iPad. Also, the students use the Pages application. The teaching materials included interactive simulations, videos, and quizzes. The management from the teachers was done with the School Manager application.

The teaching materials for the control group were developed using traditional methods, such as lectures, textbooks, and worksheets.

Both groups of students were given a pre-test and a post-test to measure their understanding of energy. The students were also observed during the teaching sessions to measure their engagement and the interactions between the teacher and the students. Concerning the activities for their implementation, questions were asked, research was designed and carried out by the groups of students, data were interpreted, explanations were constructed, students were involved in argumentation based on evidence, and information was exchanged.

The following activities were implemented for the project:

- **1st Activity**: The students were informed about Europe, its countries, the European Union, and its member states through relevant books, maps, and the internet.
  Objective: To get to know Europe and the European Union. The students understood the extent of Europe and separated the E.U. and its member states.
  The students with the iPad found the information immediately, they found maps, and they realized that E.U. started as a Union for Coal or a Union for Energy. Contrary to the control group, students had to go to their homes to find the information and to make their maps.
- **2nd Activity**: They were divided into groups and played role-plays, organizing and implementing virtual trips to Europe.
  Objective: To learn to work in groups and to get to know the countries of Europe. The students started to work in groups, and each group chose the Member States to examine.

The iPad students easily found the virtual trip routes using Google Maps, iBooks, and activities at Wordwall, contrary to the control group students, where someone first has to propose the virtual trip on a map at the projector.

- **3rd Activity**: They brainstormed concept maps, first for Europe and then for coal.
  Objective: To connect the member states of the E.U. with their mineral wealth. The students understood each EU member state's mineral wealth (the subsoil) and collected relevant data.
  Once again, the experimental group students with iPads could find this information at once and easily, contrary to the control group students who had to draw their maps by hand and find out all this information at home.
- **4th Activity**: They were informed about the carbon cycle.
  Objective: To understand the perfect combustion of coal. Students mastered the concepts of the perfect combustion of coal and connected coal with energy.
  The control group students found the information from books and the Dictionary of Common Modern Greek from the Greek Language Portal. The experimental group of students found using iPad, videos, and e-books from upper-grade class.
- **5th Activity**: They drew the carbon cycle on a poster and understood the related concepts.
  Objective: To connect coal as an energy source and interpret its combustion results. Students distinguished the perfect from the incomplete combustion of coal and understood related concepts. They also understood what happens to the emission of carbon dioxide into the atmosphere during perfect combustion.
  The experimental group of students using the Popplet application, make Mind Maps about the carbon cycle. The control group student had to draw by the hand the whole thing.
- **6th Activity**: To create a representation with information about coal and the carbon dioxide produced by burning it & related this phenomenon to the operation of lignite thermoelectric plants.
  Objective: To understand the emission of carbon dioxide from their daily activities. Students to understand the emission of carbon dioxide from lignite thermal power plants.
  The control group students create a collage, while the experimental group students do their own virtual experiment using the site of Phet Colorado.
- **7th Activity**: They studied the operation of power plants, and each group made a representation of their own.
  Objective: To investigate and understand the operation of power plants. The students understood the operation of lignite thermal power plants.
  The control group students got the information from the teacher's presentation and drew the operation of the power plant. The experimental group of students studied through airdrop from the website NOESIS and used the iMovie application to create a video about the operation of power plants.

- **8th Activity**: Completed relevant worksheets, which helped students with digital storytelling.
  Objective: To collaborate and make the story of digital storytelling, initially in groups and then all groups together. Students successfully collaborated and completed the text for digital storytelling.
  In the control group, all students wrote a text about it and made it digital. Each student from the experimental group recorded information using the Voice Recorder application and then used the iMovie application to create a video for their storytelling.
- **9th Activity**: They produced a final material to inform the wider community.
  Objective: To inform the wider community about energy, the mineral wealth of the states, and the operation of lignite thermal power plants regarding the daily use of energy. Students produced a final related video and shared it with the wider community via the school website and class blog.
  The control group students inform the wider community through a video on the school's website. The experimental group students make their personal e-me blog (an application from the Greek State for the students) and share it with the wider community.
- **10th Activity**: They proposed reducing the use of coal by switching to renewable energy sources and building a carbon dioxide detector.
  Objective: To study renewable energy sources and connect them to energy use in their daily lives. Students developed critical thinking in the rational and irrational use of energy in their daily lives.
  In this activity, both groups worked, in the same way, proposing the daily use of renewable energy sources.

4. Results

The study results showed that iPads significantly improved the student's understanding of energy in physics. The students who used iPads had higher average scores on their assessments, with an average score of 87%, compared to the traditional group's average score of 71%. The iPad group also demonstrated a deeper understanding of the material, as evidenced by their ability to explain the concept of energy using their own words and examples. In addition, the iPad group showed greater engagement and motivation during their physics lessons. They were more enthusiastic about learning and more likely to participate in class discussions and activities. They also reported that iPads made learning more fun and interactive.

Because the present research has to do with the study of how the students experience the new experience and their opinions, the qualitative approach methodology was used to record the student's opinions (Hancock et al., 2007). This research is qualitative. We recorded the student response since qualitative data was collected. The qualitative research method used was the Focus group (Wilkinson, 1998) which evaluates the new experience in groups. In our case, the students in the experimental group were 25. Through group dynamics and direct interrelation, qualitative data were extracted after specific, common questions related to the achievement of the expected learning outcomes were asked. From the questions with the Focus Group method, it emerged that all the students would like the distance teaching of the poems to be done this way. A large number of students expressed the desire to adopt this teaching with the iPad in other academic subjects, like Language, History, etc. Additionally, when asked about working with their classmates and breaking into groups, students indicated that it was a way to chat with their classmates, exchange opinions and come to conclusions. The presentation of the group's conclusions in the plenary session is shown to impress the students. However, the desire of other students to speak and show plenary knowledge and formulate their points of view was observed. Also, when asked if the time was enough, most students asked for more time with the iPad. In the last question regarding the comparison of using iPad and the traditional method of teaching, all students preferred using the technology of iPad and being to their physical space to school, reminding that it does not focus on the specific way for distance teaching but can be socializing with a physical presence.

5. Conclusion

Using one-to-one iPads in primary schools can effectively teach the concept of energy in physics. The study showed that iPads improved learning outcomes, student engagement, and teacher-student interactions. The results of this study suggest that iPads can be a valuable addition to teaching physics in primary schools. The findings have important implications for primary school educators, as they highlight the potential of technology to enhance the learning experience and improve academic outcomes. Future research could investigate the impact of iPads on other physics concepts and explore the use of other technologies in primary education.

Conflict of Interest Statement
The authors report that there are no competing interests to declare.

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Mrs. Eleftheria Tsiouri, MSc, studied at the Department of Primary Education at the University of Ioannina, Greece. She got her first MSc from The Department of Sport Management of the University of Peloponnese in 2014. She also got a second MSc in 2018 on Didactics of Science from the Department of Primary Education at the University of Ioannina. She has been a teacher at the 1st Experimental Primary School of Ioannina for more than ten years. Experimental Primary Schools in Greece have overqualified teachers, and they can use new methods and models of teaching. Her research interests are Didactics of Physics and Science Education for Primary School.

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