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The Use of Augmented Reality in Education: Development and Use of Application for the Course "Physics - Explore and Discover" in the 5th Class of the Primary School

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Abstract

This research paper initially attempts to give a brief bibliographic overview of the concept of augmented reality, its applications and corresponding outcomes in the field of education, since enhancing the real-world environment with digital information is considered to offer additional opportunities for teaching and learning. Subsequently, it is designed, developed and implemented in the 5th class of Primary School, an original Augmented Reality (AR) educational textbook application in the "Physics" section of the "Physics - Explore and discover" course to explore the effect of Physics AR textbooks on learning outcomes and on students' interest and attitudes about the subject. The results of this application show a positive impact on learning outcomes and reinforce students' interest and positive attitude towards the Physics lesson, a desire derived towards the extension this type of application to other knowledge objects.

Keywords: Augmented Reality (AR), AR Application at physics book

1. Introduction

In today's reality of rapid technological developments and achievements, education cannot remain unaffected by these changes. It seeks to integrate them into the educational process for the benefit of pupils so as to make the most of them and learn more efficiently. In addition, digital technology gives the opportunity, by leveraging Smartphone's and devices that are fast-spreading and easily used by all students, to make the 'here and now' practice, mobile-learning (Martin & Ertzberger, 2013), bringing about significant changes in the learning process. There are mentioned common points in learning theories, such as those of Piaget, Vygotsky, the cognitive approach to information processing, etc. the need to apply teaching methods based on hands-on practice and hands-on experience. However, practical training often comes with insurmountable obstacles, such as lack of time, space, excessive distance, cost, etc. which ultimately do not allow such experiences to be acquired by trainees. One solution to the above problems is the use of technology in the educational process, using simulation programs, giving the trainee a sense of physical presence in their respective environments because of their three-dimensional graphics. In this paper we will study one of these forms of augmented reality, which in combination with the use of smartphones and tablets, can be much more easily applied to school reality and allow multiple experiences to be acquired by the students who may not have been able to live in real life, always for the benefit of the educational and learning process. In more detail, a thorough investigation of the bibliography will be undergone so as to check whether it is applicable to school reality. A search for information on scientific educational proposals, as well as the first results in their research implementation will be done, and then the results of our research will be presented, from design, development and use of an AR application in a textbook for the course " Physics - Explore and discover".

2. Augmented Reality (AR)

Augmented reality, one of the emerging educational technologies with significant pedagogical benefits (Johnson et al., 2010), was introduced as a term in 1992 by Thomas Caudell, however, the first reference to AR systems is noted in 1968, when Sutherland developed the first application,

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Which involved the creation of a 3D virtual object imaging system in a real-world environment. It is a real time interactive experience that refers to direct or indirect viewing of a natural, real-world environment or situation, but whose elements are augmented by perceptual information / data produced by a computer with multiple sensory methods, such as visual, auditory, tactile, body aesthetic and olfactory. In this way, digital objects give the impression that they coexist with those of the real world (Azuma et al., 2011), however, the real world is not only degraded but, on the contrary, augmented and enhanced. An AR application is not limited to adding virtual objects or information to a virtual environment for visual enhancement, but may also include hiding virtual objects, overlapping them, from a virtual object. Removing real objects is defined by some researchers as diminished reality however it is actually a subset of AR. Therefore, the overlapping sensory information may be constructive and additive to the natural environment or be destructive, with full coverage of the natural environment. In addition, AR alters a person's ongoing perception of a real-world environment, as opposed to virtual reality, which completely replaces the user's actual environment with a simulated environment, which may in some cases lead to confusion with real world. The overriding value of AR is that it brings elements of the digital world in the perception of the individual, about the real-world, not just as a mere representation of data, but through the integration of the senses, which are considered natural parts of an environment, since it is placed in three dimensions and gives the ability to interact in real time. The widespread use of smart phones and tablets has contributed to the rapid development and spread of AR to the general public, as these devices perform quite easy tasks such as tracking the position and the size of objects through real-time video streaming as well as rendering video-based virtual objects that are needed in AR applications. Developing AR applications requires complex computations, combinations of instructions in different programming languages and multiple systems. However, there are several supportive applications, such as toolboxes, libraries, platforms, etc., that provide valuable help for this very purpose.

3. Bibliographic Overview of AR’s Use in Education

Utilizing the results of other literature reviews of this type of research to achieve a more centralized presentation and cross-section of individual results, we have a more complete picture of AR's use in education, its areas of application, its impact on learning and potential its limitations. So, overall, we have: Research by (Martin et al., 2011), in a sample of 10 researches conducted on AR, as a reinforcing method of the educational process, which has shown an increasing tendency to engage with this topic in the relevant articles, but also a very early implementation situation of AR in education.

In (Radu, 2012) and (Radu, 2014) bibliographic reviews of studies, 32 & 26, respectively, which aimed to compare learning outcomes in environments with or without AR, showed a positive impact of AR on understanding and especially spatial structures, memorization and linguistic associations. However, there were also reports of difficulties in applying to the classroom, a negative impact on the concentration of some children, and difficulties in handling. Research by (Santos et al., 2014),in a sample of 87 IEEE Explore-based surveys on learning experiences from using AR, showed a large difference in the impact of AR on student performance, from slightly negative to very positive. In addition, in terms of qualitative analysis of the design criteria of these applications, three design advantages of AR have been identified, namely: visualization of concepts, tactile visualization and the introduction of digital information into physical environments. A review of 32 empirical studies by (Bacca et al., 2014)on the uses, limitations, and advantages of AR in education has shown that the greater use of AR is in science teaching, the limitations of the AR's use were few and the benefits referred so on student’s mobilization as well on the effectiveness of the learning process and performance improvement. The same results with the previous research, but also indicating the development of a positive attitude towards the lesson used by AR, were also found by (Chen et al., 2016) who investigated 55 bibliographic studies of the SSCI database, conducted from 2011 to 2016. Several researchers have also reported increasing interest in and focus on student / peer use of AR applications (Cai et al., 2013),(Radu, 2014),(Akcayir et al., 2016). As for the purpose of using AR, in the majority of research, it has been used to explain a topic, through digital information enhancement, and to areas of the educational process where the use of AR appears to have a positive impact, in frequency series, they are: 1. learning benefits, 2. motivating students for learning, 3. engaging students, 4. focusing students on the lesson, 5. creating a positive attitude for learning the lesson, 6.the excitement, 7.the eagerness, 8. the ease of concentration increasing knowledge, 9.enhancing spatial perception, 10.developing observation. Almost half of the research (48.1%) concerned the field of Physical Sciences, such as the conceptualization of concepts or objects that students could not see in the real world, e.g. atoms, molecules, chemicals, nucleus decay, simulation of laboratory experiments, but also teaching mathematical and geometric concepts, geography and environmental education (Tzortzoglou & Sofos, 2017).

Finally, deploying AR applications in education using mobile devices seems to have positive effects (Liu et al., 2016),(Radu et al., 2016), (Tzortzoglou & Sofos, 2017), et.al. However, the use of these AR applications in the Greek school reality is quite limited and their use in the form of a textbook is slowly becoming a reality, with recent examples, the book for the Geography of the 6th class of the Primary School and the book about Informatics of the High School, by Georgiou & Tzortzoglou.

4. Educational Value and Benefits from Using AR Applications

Using AR applications in the educational process, images, sounds, texts, 3D graphics and videos are placed in the students' real-time, real-time environment, and combining the real-world environment with additional digital information is an effective way of representation, that maintains a balanced interaction between real and virtual environments. According to (Lee, 2012) and (Wasko, 2013) the use of AR is based on a combination of principles, on the one hand, of constructivism, which refers to the construction of mental models and on the other hand, contextual learning, which emphasizes the importance of the context in which they are realized all students' interactions with people, objects, various materials that result in learning. As a result, new knowledge is integrated into the appropriate context and the students interact with it, so this knowledge becomes meaningful within the context, is strongly linked to it, and consequently integrated mental structures are created with the end result of learning (Dunleavy & Dede, 2014). Many researchers have dealt with these applications and their educational potential because of their ability to be applied everywhere and at all times. According to research(Martin et al., 2011),(Tarng & Ou, 2012),(Chang et al., 2014), AR applications are utilized in a variety of subjects, such as Physics, Chemistry, Biology, Anatomy, Mathematics, Language, Geography etc., are considered a valuable educational tool and offer significant benefits to the educational process. Students have the opportunity to experience situations and observe events that would not be difficult or in any way experienced in their real life. The motivation for learning is increased, fosters interactions with others, as Virtual objects, provide a clear picture of the concepts of time and space enabling them to be fully understood, contribute to the development of students' ability to relate what they learn to everyday life so that they can apply it to it. AR pilot applications have revealed evidence of a positive contribution to the learning process by maximizing student interest (Di Serio et al., 2013),(Wu et. al., 2013), increasing their participation(Bidin & Ziden, 2013), framing knowledge (Lee, 2012),(Wasko, 2013)influence on the development of their creativity, imagination and critical thinking (Lee, 2012), (Mang & Wardley, 2013), (Wasko, 2013), et al. Concerning the benefits of using AR in the educational process, as mentioned in the relevant research, the following are: Personalized learning: One of the biggest problems of traditional education is the lack of time and resources to provide personalized teaching to every student in the classroom. AR provides teachers with the tools they need to have information for each student, so they know who needs more help, who is doing very well, and who has really understood the lesson.

Interacting with inaccessible objects: The presence of interaction in AR applications is considered as one of their main features. Several studies (Lee, 2012), (Wasko, 2013), (Wu et. al., 2013), (Martin et al., 2014), (Chen et al., 2016), et al., refer to its importance, since AR applications give the opportunity to students to interact, directly and in real time, with various virtual objects that they would have no contact with in the real world, for various practical reasons such as long spatial or temporal distance, enormous dimensions of objects, their danger or even their non-physical existence. Equality in education: Sometimes money is an obstacle in learning and thus both schools and students can be affected. AR bridges inequalities in education as it makes content accessible to everyone in the classroom, with no differences between them. Wide variety of fields: AR technology can be applied to many fields and levels of knowledge. However, it maximizes it's benefits in terms of skills training. AR provides the perfect combination of reality and virtual reality, so real physical devices can be used, saving costs and reducing risks. Increased interest and motivation: (Di Serio et al., 2013) report that students are more interested in the subject they are studying when approached through AR applications. Using AR can transform the classroom and its content, making it all the more visual and appealing to students (Kucirkova et al., 2014). Their motivation to pursue a particular subject is increasing and this results in increased commitment, greater effort, and consequently better learning outcomes (Lee, 2012),(Wu et. al., 2013). Enhancing the learning process and improving learning outcomes: AR applications enable learners to experience a different learning cycle, which will help them to retain more knowledge for a longer time as they help visualize tricky phenomena or concepts, or the presentation of objects that are not easily found in the real environment and allow users to interact with this data. This simplifies concepts and new information, which contributes to easier and more effective knowledge acquisition and, in general, to improved learning outcomes, as several studies have shown (Lee, 2012),(Di Serio et al., 2013),(Wu et. al., 2013),(Papadakis et al., 2016), (Chen et al., 2017).

Skills Development: Through AR applications, students are able to explore and learn more about whatever they find interesting while practicing self-directed learning techniques (Wu et. al., 2013) developing a variety of skills such as, collaboration (Kearney et al., 2012), (Rossing et al., 2012), critical thinking, problem solving, and reflection (Wasko, 2013). They also promote their creativity and curiosity (Lee, 2012). Facilitating distance learning: AR technology enables distance learning and collaboration between students and teachers who are not in the same room, as they can share a common learning environment and interact with additional virtual objects, materials or information displayed in this environment.

5. Educational Need to Develop an AR Scientific Applications

In particular, in the field of Science, according to (Özdemir & Clark, 2007) it is observed that students have formed very strong but incorrect attitudes and perceptions of the world around them, through their experiences and interactions with individuals and situations. The role of the school is to teach students to replace these misconceptions with the correct ones, through the development of a scientific way of thinking. Therefore, in this area, where traditional teaching often involves difficulties in understanding the concepts, misunderstandings and inability to construct mental representations, because of the ambiguity of the concepts and their distancing from the perceived reality, the use of AR applications seems to be more than necessary, but necessary. Interactive simulations and visualizations prove to be extremely important in this area, and the fact that they are connected to the real world contributes to a better understanding of knowledge. In addition, according to (Potkonjak et al., 2016) and (Akcayir et al., 2016), in the case of lack of laboratory resources and equipment, demonstrates the utility of AR applications, since they are used to perform virtual experiments and in addition for learning flexibility. In addition, by utilizing AR applications in the subjects of the Natural Sciences (Physics, Chemistry, Biology, Geology) and if they succeed in mobilizing students and increasing their interest, it is possible to limit the recorded indifference or repulsion for these theoretical lessons.

6. Purpose of the Research / Research Questions

Taking into account the above facts, it was decided to carry out the present research, given the difficulties faced by students in the field of science in understanding the concepts. The following research questions arose: 1st RQ: Does using a Physics AR textbook have better learning outcomes compared to conventional / classical teaching? 2nd RQ: Does the use of AR textbooks have an impact on the interest of students and their overall positive attitude towards the subject, compared to traditional textbooks? Therefore, the purpose of the present study was to investigate the impact of AR applications, in the form of an AR textbook upon Physics course in order to check the learning outcomes springing from their use. The two main goals are to evaluate the learning outcomes that will originate from their use and in enhancing and shaping the interest and attitude of students in this subject. (**Table 1**).

Research Questions	Research Tool	Individual Questions
1st Research Question	Evaluation Test E.G & C.G.	Compare MO Performance E.G & C.G.
2nd Research Question	Questionnaire E.G.	Questions 1-13

Table 1. Research Questions-Research Tools

7. Methodological Approach

The method used for conducting the research was field research, which is considered suitable for exploring or applying innovative practices at the school or classroom level, so that they can then be disseminated to the wider educational community in case of positive results and observation. Specifically, it included educational intervention in two groups of students in a public Primary school of the city of Rhodes, which has two 5th classes, one of which was the experimental group and the other the control group. The intervention was implemented in the period from 20 to 28 September 2018, with a total of 44 students (22 per department or group). Initially, a short pre-test was implemented to check students' prior knowledge and to establish the same conditions regarding the level of students in both groups. In the experimental group, the intervention was made using tablets and using the AR application in the textbook we developed for this purpose, whereas in the control group the intervention was done with conventional teaching, but technology was also used, with format for displaying images, videos, etc., using computers and projectors.

In both groups applied the research-based teaching model, which is student-centered and utilized the collaborative learning method, with our role being purely organizational and mentoring. The course of the learning process was shared and organized in the following phases (Schmidkunz & Lindemann, 1992):

Phase 1: Incentive: During this phase it is aimed to orient students' interest in the subject that will be studied.

Phase 2: Experimental: In the experimental phase, students perform experiments, systematically observe and record their observation.

Phase 3: Drawing a conclusion: At this stage it is sought to generalize the observations by formulating a conclusion. It is the teachers' intention to adopt the correct scientific view of the students and to abandon any pre-existing misconceptions.

Phase 4: Consolidation - Generalization: This phase seeks consolidation - generalization through tasks - examples and applications. These are tasks that are often referred to in everyday life and are aimed at creating opportunities for applying the conclusions reached by the students in the previous phase.

Therefore, the only point of difference between the teachings is that the students in the experimental group had additional information when using the student's book, since in addition to the written text contained therein, they had the opportunity to watch the corresponding videos or see additional pictures of each individual passage in the book. Throughout the above learning process both groups received the same information and used the same educational material. As far as the assessment is concerned, this was done in both groups in the same way, with the electronic Assessment Test, so that the only reason for their possible differentiation is their use of the AR textbook.

8. Research Design - Creating an AR Application

8.1 Research Design

The research design included the choice of the subject and the module to which the intervention would apply: The choice of the subject was based on its difficulty, for a large number of pupils, and on the fact that visualization of the subjects was necessary for different concepts, in order to clarify and understand them, on the part of students. The course "Physics - Research and Discover" is taught in the last two Primary classes (5th & 6th) for three hours per week (https://www.minedu.gov.gr, 2018). The study of the course aims at the course "Physics - Research and Discover" in the curriculum (http://www.pi-schools.gr, 2018) which reveals the necessity of utilizing technology in every phase of the educational and learning process for achievement of each individual goal. In addition, due to the nature of the object, which encompasses a large number of difficult concepts and obscure topics, the utilization of simulation applications and AR in general achieves the visualization of the concepts and their interrelations and thus their fuller understanding. Specifically, the section on Material Bodies was selected, which is contained on pages 12-17 of the textbook "Physics - Investigate and Discover" and refers to the Structure of matter and the properties of material bodies. The selection of this module was based on the continuity of the subject, since it is the first module that students come into contact within the field of Science.

8.2 Creating an AR Application

In the context of the present work, it was decided to design and develop an AR application in a school textbook, and in particular to enrich, with digital material, the first section of "Physics - Research and Discover" book. Given the fact that the pages of the book are dominated by texts and static images, the main idea was to increase the cognitive material contained in the schoolbook, with new digital data of various formats, such as pictures, videos, etc. This will provide additional information to the pupils and serve as an illustrative guide to the already existing lessons of the book. Next was the design and development of AR micro-applications aiming at enhancing the textbook, utilizing the Unity engine (https://unity3d.com) and the Vuforia library (https: // developer.vuforia.com), which allow them to be implemented quickly and easily, since Unity's overarching philosophy is that in order to develop games or other applications, a fully integrated graphical interface should be used and the use of programming minimized. In addition, the material is enriched with the superposition of links that lead to relevant activities for student learning. Moreover, brief assessments are incorporated to control the achievement of learning objectives. Micro-applications were created for this purpose, which are activated by using textbook images / extracts as markers.

The following digital data were used to enrich the book's knowledge material: From the Educational Television website, the video "Explaining to the microcosm ...the renewable repositories "was used (http:/www.edutv.gr/index.php/fisikes%20-epistimes%20/ %20me-to-mikrokosmo-eksigo-tis-dynameis) and more specifically two extracts were used, the first duration 00:03:37, from 00:01:07 - 00:04:45, in order to enrich the cognitive material of the book (p. 14),

Referring to the Structure of matter and the tiny particles of matter and the second, duration 00:01:30, from 00:04:46 - 00:06:15, to enrich the material referring to solid, liquid and gaseous material bodies (p. 15). From Google / images (https://www.google.com/imghp), we have used an image for the symbolism of chemicals, which very graphically illustrates the simulations of atoms and molecules and explains the difference between chemicals and chemicals (p. 15). From YouTube, the following have been fully utilized a video showing the movement of electrons around the nucleus of a person (https://www.youtube.com/watch?v=CFFa4Uv-OBA), (p. 14), a video that analyzes its concepts mass, volume and density and their relationship (https://www.youtube.com/watch?v=Dc_YY2NvXE0) and a video, referring to volume and density and their relationship (https://www.youtube.com/watch v =kFsFEZJF3Sw), (p. 16 and 17 respectively).

Using Google Quiz Forms, we created an Evaluation Test (https://goo.gl/forms /ZC6v G4wYBKVGMkuc2), which covers all the content of the section in the form of a variety of questions, such as multiple-choice, drop-down, multi-grid. options, etc., utilizing relevant images and videos. The results from this test were used to compare the learning outcomes of the two groups, experimental and control. In addition, a questionnaire was developed, which was formulated on a five-point Likert scale, ranging from 1: strongly disagree to 5: strongly agree, with the aim of investigating students' impressions and attitudes towards the use of the AR textbook. The questions that the students answered were: 1st: The enriched book was enjoyable. 2nd: The enriched book was useful. 3rd: The additional information was interesting. 4th: The additional information explained the lesson more. 5th: With the additional information I understood the lesson better. 6th: The application was quite easy to use. 7th: Using the app made the Physics lesson more interesting. 8th: Using the app and other lessons can be more interesting. 9th: The app looked like a game. 10th: The lesson became enjoyable as a game. 11th: The lesson was boring. 12th: I want to use such an application again in the next Physics courses. 13th: I want to use such an application again in other lessons.

9. Results

9.1. Results of the Pre-Test

The pre-tests results showed that initially there was no difference between the two groups, since they showed a negligible difference of 0.09 in the mean of pre-tests scores (Mean Difference = 5.14-5.05 = 0.09) (**Table 2**).

	N	Mean	Std. Deviation	Std. Error Mean
Grade Pre-Test (Experimental Group)	22	5,14	1,457	,311
Grade Pre-Test (Control Group)	22	5,05	1,397	,298

Table 2. Compare Grades of Pre-Test

9.2. Research Question 1

Does using a Physics AR textbook have better learning outcomes compared to conventional / classical teaching? The answer to this question can be deduced from a comparison of the Means of Comparison scores, which students in both groups achieved in the Assessment Test. To this end, the Independent - Samples T Test procedure was applied, since we want to investigate whether the two independent groups (experimental and control) have the same mean scores in the Evaluation Test (zero case). In the alternative case, the mean scores will be different, and unless we make a prediction about which of the two groups will have a higher or lower average, the assumption we make is two-way. The results obtained from this application, as shown in the table below (**Table 3**)**,** show a mean difference of 2.95 in the mean scores (Mean Difference = 26.27-23.32 = 2.95).

Therefore, in the present case, where we have t (42) = 2.95, p = 0.05), that is, 42 degrees of freedom (df = N1 + N2-2 = 22 + 22-2 = 42), a two-way assumption and statistical significance level p = 0.05, the critical value is 2.02. This means that we have a statistically significant result, since the mean difference value is greater than the critical value (2.95> 2.02), so we accept the alternative and conclude that the group taught with AR had better learning outcomes and scored, on average, about three points (2.95) more than what was taught with conventional / classical teaching.

	Teaching Method	N	Mean	Std. Deviation	Std. Error Mean
Evaluation Test Score	Using AR	22	26,27	3,027	,635
	Without Using AR	22	23,32	3,835	,818

Table 3. Compare Grades after the Use of AR at the E.G

These results are in agreement with the results of related research, which have been mentioned in the theoretical part. The reasons that contributed to this outcome may be: 1.The additional information that students have the opportunity to recruit because of the immediacy of the tablet, which is in their hands and thus in their immediate visual and auditory field, as opposed to the computer and projector , which due to the general presentation to the whole class, is the fact that it receives several influences from the classroom environment, follows a certain rhythm for everyone, during the presentation various interventions of third parties, such as noise disturbances, With the use of the augmented reality, the Physics textbook is enriched with additional images, 3D objects, videos, and more. and is transformed into a dynamic learning medium that offers students' interactions with extras that are in many cases inaccessible. Several studies report on the opportunities offered by the use of AR students to interact, directly and in real time, with various virtual objects with which they would have no contact in the real world. 2. Ability to give students the opportunity to study additional elements of the application at their own pace and come back to them whenever they wish or when they feel they have not fully understood the point. In addition, it enables the presentation of two-dimensional images in the book, in 3D format, with the possibility of magnification for better viewing and understanding of the subject. Helps enrich an image or text of a book by viewing a related video that illustrates or enhances text information, visualizing concepts and further analyzing obscure points, so as to simplify concepts and new information, helping easier and more effective acquisition of knowledge and in general the improvement of learning outcomes, as several other studies have shown. It enables use at any time and place, thus allowing students to see this material again in their school or home to better understand the difficult points.
3. Strengthening student interest. Student interest is increasing, as the use of AR can transform the classroom and its content, making everything more visually appealing to students. 4. Mobilizing them due to their active involvement in the process, since it allows students to self-act and supports a constructivist view of education, since AR applications act as mediators between students their subject and theirs facilitate better understanding.

9.3. Research Question 2

Does the use of AR textbooks influence students' interest and their overall positive attitude towards the subject in comparison to traditional textbooks? The study of the responses of the students in the experimental group, which were taught using the AR book, reveals a significant overlap in the following points (Table 4):

1. All students rated the enriched book as very interesting (Mean = 5).
2. Almost all students find that using the app made the Physics lesson more interesting (Mean =4.95).
3. The same view holds for the use of corresponding applications in other courses (Mean = 4.95).
4. The same question was also expressed in the opposite question, if the lesson was boring, where everyone disagreed completely (Mean = 1).
5. Both the application and their lesson seemed like a game (Mean = 5).
6. Want to use the app in both Physics (Mean = 5) and other courses (Mean = 5).
7. They believe that the additional information given to them through the enriched book helped them understand the lesson (Mean = 4.95).
8. They find the application easy to use (Mean = 4.82).
9. The most varied answer appears in the usefulness of the enriched book (Mean = 4.45), however it is not particularly important.

Teaching Method/Using AR	N	Mean	Std. Deviation	Std. Error Mean
The enriched book was enjoyable.	22 0[a]	5,00	.000	.000
The enriched book was helpful.	22 0[a]	4,45	.671	.143
The additional information was interesting.	22 0[a]	4,86	.468	.100
With the additional information explained the lesson further.	22 0[a]	4,91	.294	.063
With the additional information I understood the lesson better.	22 0[a]	4,95	.213	0.45
The application was easy to use.	22 0[a]	4,82	.395	0.84
Using the app made the Physics lesson more interesting.	22 0[a]	4,95	.213	0.45
Using the app, other courses became more interesting.	22 0[a]	4,95	.213	0.45
The application looked like a game.	22 0[a]	5,00	.000	.000
The lesson became enjoyable as a game.	22 0[a]	5,00	.000	.000
The lesson was boring.	22 0[a]	1,00	.000	.000
I want to use such an application in the next Physics classes.	22 0[a]	5,00	.000	.000
I want to use such an application again in other lessons.	22 0[a]	5,00	.000	.000

Table 4. Questionnaire of the Experimental Group

10. Conclusions

Upon research completion, the initial goal has reached its hallmark, since it gave answers to the research questions. The results enlighten two different potentials of Augmented Reality. The first one is that students who were taught using the AR book had better learning outcomes upon learning and performance than those who were taught the same module in the conventional/ classical way. The second refers to enhance students' influence in using AR application at the classroom for the lesson of Physics. In addition, it can be argued that AR applications are truly inexhaustible and when used properly in the field of education have the potential to radically change the educational and learning process as well as to contribute to the more effective learning of the stakeholders. Future research needs to be undergone in order to surpass the present research questions for this particular subject.

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