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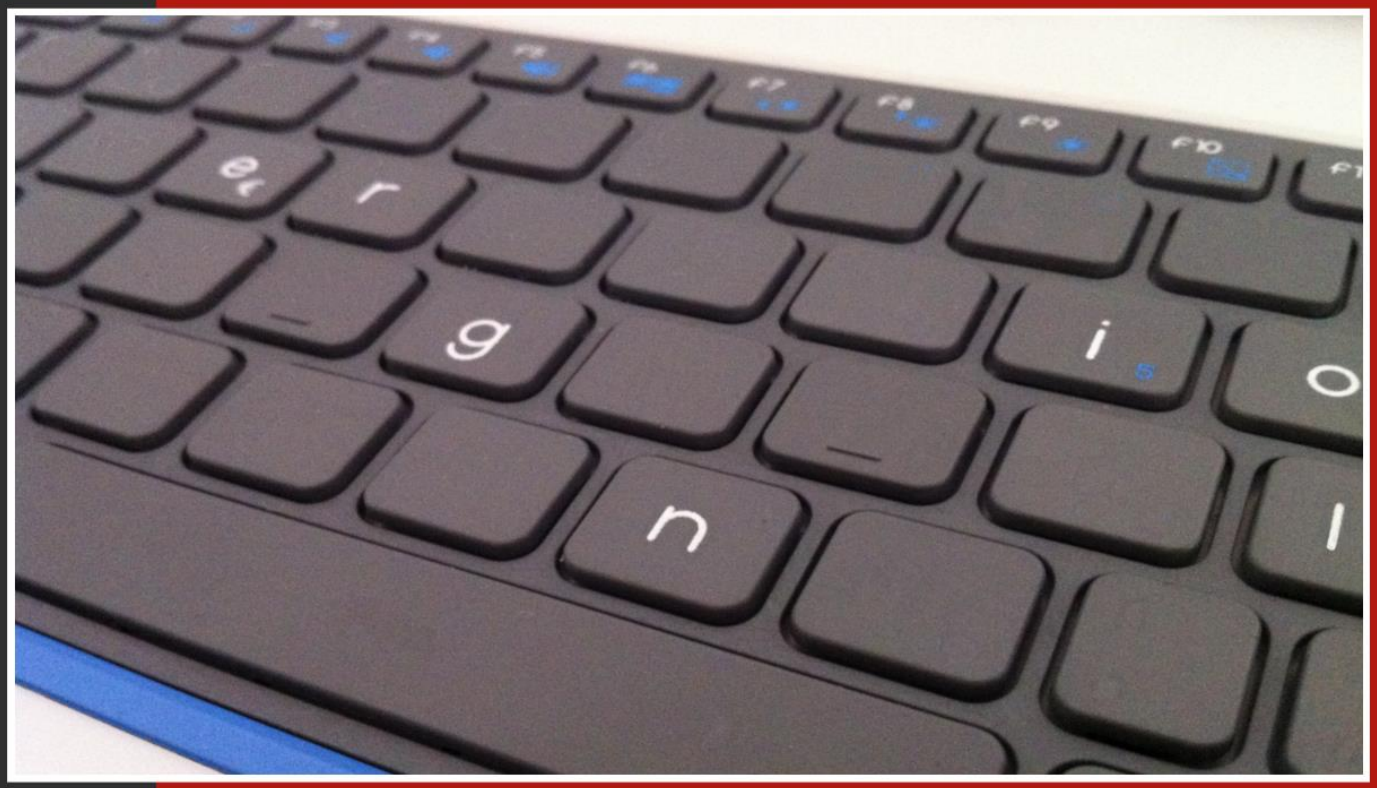

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The Design of Educational Materials for Teaching the Most Common Religions to Students in their Final Year of Primary School:

A Cross-Curricular Approach of Religious Studies and Music, Through the Use of Augmented Reality

Polykarpos Karamouzis & Michalis Keffalas

Abstract

The aim of this research is to establish whether teaching approaches based on the use of Augmented Reality (AR) facilitate deeper and more engaging learning. The religions of Christianity, Islam, Hinduism, Buddhism and their sacred musics were taught through an interdisciplinary methodology.

Qualitative research was conducted with a sample of 34 final-year, Greek primary school students. The syllabus and teaching conditions were identical for all students. However, the experimental group was taught using educational materials designed on the Aurasma AR application. The research findings suggest that the use of AR supported deeper and more engaging learning, confirming the limited relevant findings in international literature.

Keywords

Educational material, cross-curricular approach, religious studies, sacred musics, augmented reality, *Aurasma.*

1 Introduction

The contribution of new technologies has greatly changed the structure and demands of modern life. 'Traditional' teaching is gradually being replaced by a new model of education, which enforces its own parameters on the educational process. Despite the undeniable current pervasiveness of technology in the school environment, endeavours to use technology, such as Augmented Reality (AR), within school education remain exploratory and experimental. However, these technologies have much to offer and can bring about radical change in the field of education.

2 The concept of Augmented Reality

The technology of AR allows the live presentation of the natural environment, augmented through additional information, as well as the presentation of virtual characters or spaces designed and processed through a computer. The systems which allow real and virtual objects to co-exist in space and to interact in real time are defined as AR systems (Azuma 1997). The process of combining virtual data with real world data allows users to access a rich, direct and interactive content (Billinghurst, Kato & Poupyrev 2001).

2.1 The Augmented Reality application *Aurasma*

The *Aurasma* application (https://www.aurasma.com/) uses the smartphone or tablet camera to recognise real-world images (trigger images), which are overlaid with content in the form of images, videos, animations, 3D models and websites. This way *auras* are created, which are activated when the smartphone camera focuses on the specific object or image. This technology, according to the categorisation by Pence (2010), belongs to the category of AR systems, which use QR codes to allow the smartphone or table to connect with the codified information (marker based). Furthermore, *Aurasma* allows these *auras* to be published and shared, through a free online platform (*Aurasma Studio*, https://studio.aurasma.com/login). Both the abovementioned tools, *Aurasma* and *Aurasma Studio*, are supported by the *Hewlett Packard Corporation*.

The application is free and easy to download and use both on the IOS 7.0+ and Android 4.0+ operating systems. Detailed instructions on how to use *Aurasma* for educational purposes are available on the *Autonomy Software Company* (Cambridge) website, the application's creators, as

well on YouTube[1]. *Aurasma* provides teachers the opportunity to enrich their teaching materials through the integration of AR in the curriculum, without requiring specialist programming knowledge. It is directed towards primary school students over 6 years old, as well as high school students, provided that its use is adapted to the needs and interests of the different student age groups. This use of AR supports the students in developing their critical thinking regarding the curriculum content, the *auras* (additional information) and the trigger images, while the *auras* themselves can be applied in virtually all teaching subjects.

2.1.1 Prospective educational applications of Aurasma

The *Aurasma* application can be used to:

- enrich school course books with further information, par example, in the form of a label on a graph or diagram, a demonstration of a definition, synonym or antonym of a word, the solution to a calculus task, the dramatization through animation of the class rules, or the explanation of laboratory equipment,
- the creation of workbooks through images (the *auras*), which will be able to play video, audio and a live projection of images,
- the presentation of historical figures as a 'live' characters who are able to speak,
- the connection of *auras* to revision notes, articles, or practice through games.

2.1.2 Educational and pedagogic objectives of the Aurasma application

It is expected that the students:

- will use communicative learning methods, which ensure their active and creative engagement in the educational process,
- will develop their understanding regarding the value of group work,
- will develop exploratory learning,
- will come into contact with the arts as different forms of creative expression (music, art, fashion, architecture, theatre, cinema, dance),

1 https://www.youtube.com/watch?v=GBKy-hSedg8 and https://www.youtube.com/watch?v=uHIxYpBW7sc.

- will understand the different forms of speech, such as, for example, recitation, chanting and singing.

2.1.3 Technological objectives of the Aurasma application

Through the use of the *Aurasma* application, students will be able to develop innovative forms of expression, communication and collaboration skills, and alternative approaches towards exploring and constructing knowledge (digital and visual literacy). Specifically, children can:

- become familiar with the critical exploration of webpages, in search for the appropriate materials to be used for the creation of *auras* (overlay)
- create and publish their own presentations, leading to the widespread sharing of digital content and the students' participation in new, extracurricular, learning environments and communities (for example, the *Aurasma Studio* online community),
- learn to use, apart from the specific application, further AR applications focusing on a range of subjects and activities, such as *Augmented Pixels* (games), *Word Lens* (translation), *Imag-n-o-tron* (storytelling), *Zooburst* (creation of stories with animals), *Cromville* (art), *Star Chart and Sky View* (space, planets, asterisms), *Arloon* Geometry/Anatomy/Chemistry (Geometry, Anatomy and Chemistry, respectively).

2.1.4 Further benefits – Particular characteristics of the Aurasma application

The *Aurasma* application has much to offer, through simpler or more imaginative and enriched use, depending on the students' knowledge level. It makes learning more exciting and interesting, and can provide further motivation. However, *Aurasma* is yet difficult to use within the Greek educational context, since the use of smartphones within the school environment is very limited, while there is no mention whatsoever of such methods within the Greek public education curriculum.

2.2 Applicability of *Aurasma* and other Augmented Reality applications in the teaching of religion and music – A Literature review

This section discusses the limited findings of relevant research. While AR is not so new, it is still at its initial stages, particularly regarding its application in educational contexts. There are yet many challenges to be overcome and explored in order for the existing AR technologies to be utilised for

educational purposes in the best possible way (Yuen et al. 2011, p. 133). Bacca et al. (2014) endeavoured the first systematic review of relevant literature, exploring the efficiency and different applications, benefits, limitations, challenges and characteristics of AR within educational contexts. Undertaking content analysis, they examined thirty two (32) studies published between 2003 and 2013. In summary, their main findings are the following:

- The number of published studies on the use of AR within education has progressively increased, particularly during the last four years,
- AR has been used to enhance learning mainly in the Sciences, Humanities and Arts,
- AR has been used mainly in the higher levels of compulsory education, in order to motivate students,
- AR applications, which use a QR code to connect smartphones and tables to marker based information are the technologies which have been used most. Location-based AR is also popular,
- the main aim for using AR is the explanation of teaching subjects, as well as to provide additional information. The use of AR educational games and AR for laboratory experiments is also increasing,
- the main limitations of using AR are the difficulties in maintaining the superimposed information, the excessive attention to virtual information, and the perception of AR as 'intrusive' technology,
- AR is especially effective in increasing learning outcomes, motivation for learning, and the development of commitment and positive attitude in students,
- there is a lack of studies regarding the special needs of students,
- most studies have used medium-sized research samples (between thirty and three-hundred participants) and have adopted a mixed methods approach. The most popular data collection tools were questionnaires, interviews and surveys, while most research is cross-sectional.

According to Bitter and Corral,

> AR apps have also been developed for teaching chemistry, biology, physics, languages, English, religious studies, astronomy, geometry, medical practice, musical education, education support, visual art, and library studies (2014, p. 15).

Chow et al. (2013) in their article *Music education using Augmented Reality with a head mounted display* discuss individual piano lessons for beginners, but do not refer to the group sessions which take place at school. Liarokapis (2005), furthermore, in his article suggests the use of AR in individual guitar instruction.

Martíns et al. (2015) highlight the difficulties and applicability of AR in education, particularly within school music education, through a case study. They developed *Music-AR*, an AR application which teaches the main characteristics of sound, such as pitch, volume, hue and tempo. *Music-AR* is a series of brief, easy to understand, test-games, which was designed to be used by 14 children (9 girls and 5 boys), 5 to10 years old, at a private primary school in Sao Paolo, Brazil. Through observation, the researchers found that the children were able to understand the abovementioned main characteristics of sound before engaging in music education, through the use of AR, while based on the questionnaire findings, the children were motivated to use this technology. Martíns et al. (2015), furthermore, highlight the significance of the fact that the children seemed to understand how to use AR as soon as they began engaging with the technology. Interviews conducted with the childrens' teachers also supported that AR can be used effectively in music education. In addition, AR seemed to be effective and appropriate to be used by young children, due to its playful character. AR can be an effective tool used to learn the main characteristics of sound (Martíns et al. 2015, p. 231, 232).

Brown (2014) developed *Prelude*, an AR iOS application for music teachers, which is used as a music notation recognition tool to support teaching. *Prelude* is comprised by two elements: i) an iOS application with quizzes, which allows students to practice recognising the various music notation symbols, and ii) a website which is managed by teachers, in order to adapt the music quiz games to the individual needs of their students and assess their performance. Therefore, it is a two-way, collaborative communication and approach, in which teachers develop materials for their students, who, in turn use the application, obtaining deeper understanding of the taught subject. Brown (2014) closes by suggesting various future expansions and functional amendments to the application, such as having the ability to recognise music phrases and scales, execute phrases and individual notes simultaneously, and playback further educational information, when the student scans a notation symbol which does not correspond to the value of a note. The researcher believes that *Prelude* is an example of an AR application, which increases the engagement of students in the learning process and an alternative –technology-focused – method of teaching in 21st century schools.

Figueiredo et al. (2014) discuss in their work the most popular AR applications used in everyday school activities, within nurseries, primary schools, and high school, which satisfy three criteria: i) they are user-friendly, ii) do not require specialised programming skills, and iii) they are free. These tools aim towards the improvement of reading, understanding and learning of music,

and are to be used by students of the Algarve University, Portugal, future teachers. According to the writers, the most popular AR applications are: i) *Wikitude*, ii) *Layar*, iii) *Metaio*, iv) *Aurasma*, and v) *Augment*. As they discuss, a project was undertaken in the *Padrão da Légua* school complex in Portugal, which aimed to combine AR technology with the use of mobile devices for learning. The main aim of the project was to create an artefact, through the contribution of different disciplines and the collaboration between teachers and students. This artefact would then be potentially integrated in the learning and teaching processes in this educational context. Teachers and students from a wide range of disciplines, such as music education, art, audio-visual art, as well as from the centre of education resources, and the *Leça do Balio* special education school in Portugal, contributed to this project. The design focused on a shared topic, the sea, and was selected between sixty other designs, to be presented at the *Fourth National Competition of Marine Equipment*, in the Building of Knowledge, in Lisbon, on the 17th of May 2013. The project outcomes were published in the form of a book, augmented with audio-visual elements through the use of the AR *Aurasma* software.

Gomes et al. (2015) discuss an interactive exhibition based on AR technology. The exhibition focused on the aesthetic periods of music history, and was directed towards students of the 2nd and 3rd cycle of basic public education in Portugal. The writers highlight that

> Technology is essential in teaching, communications, mathematics and science, and it is no less important in the arts. Technology is an important tool that can improve the educational system, but the challenge of integrating technology into the delivery of content remains. Digital technologies, in all areas, can enhance student achievement by addressing introductory and advanced skills, assessment of student progress and student motivation (2015, p. 31).

The history of music is traditionally taught in schools, conservatoires and Universities around the world through the method of direct instruction. In contrast, Gomes et al. (2015) use the AR *Music Gallery*, which adopts a constructivist approach towards the learning and teaching process of music history, and supports the use of an advanced AR technology for the delivery of audio-visual material to students. The AR *Musical Gallery* is characterised by:

- the role of existing knowledge,
- the role of the specific context and learning experience,
- the element of interactive and cooperative learning,
- the focus on change in order for learning process to be more effective,
- the new roles which are undertaken by teachers and students,

- the significance of the students' correspondence with the agreed educational process,
- the idea of strengthening one's ability to "learn how to learn" (Gomes et al. 2015, p. 32, 33).

Music and other forms of art are known to develop discipline, higher-level cognitive skills and creativity, and engage students in a wide variety of learning styles.

> Technology in […] arts education can be thought of as applied science […]. It is an extension of a person's capabilities as well as a way of expanding his/her ability to learn (Assey 1999, p. 2).

The use of technology can accelerate learning in the arts, while this is also true for music history, where the understanding of a given aesthetic period requires of the students to listen to music excerpts of works of this period, study the biography and works of composers and analyse music instruments, paintings or photographs, which reveal the wider historical context and environment. It is necessary for different technological mediums to be used, in order to understand the development of music in time, its value and influence on different cultures.

The exhibition, which took place at the *Basic School Maria Manuela de Sá* in Portugal, on October 2014, was presented through ten A3-sized posters, which displayed images and information in the form of text. In order to enhance the informative material available to students, further interactive digital materials were available through the use of AR technology, such as video, audio and 3D depiction of musical instruments. The posters were displayed on boards at the entrance of the library, in such a way which allowed individual and group exploration.

Other examples of the use of the AR *Aurasma* application in school music lessons were documented in the educational materials of Rebecca Dennis (https://www.youtube.com/watch?v=zQsKwgclbQg), focusing on primary schools in Kentucky, the *Bullitt County Public Schools* and *Cedar Grove Elementary School.* In 2012 Dennis displayed her students playing musical instruments on the relevant board in the school corridor, while in 2013 she submitted a 45-minute video with her students' most significant work. These videos show students in their 5th year of primary school, playing xylophones and glockenspiels, singing, talking and dancing. During this project, the Dennis quickly noted that the use of the *Aurasma* application worked encouragingly towards the students: "I've noticed that the kids are trying more in the classroom […], they want their video to go in the hallway" (Roscorla 2016, p. 1-3).

While Bitter and Corral (2014, p. 15) discuss the use of AR applications within a wide range of disciplines, including religious studies, they do not discuss specific cases. Extensive research within relevant literature produced no further outcomes. In summary, this section discusses five

examples of the use of AR applications, based on a literature review, focusing on music education in schools, as an independent subject or through an interdisciplinary approach, combined with art, audio-visual art, music history and others.

The examples discussed, alongside this study, are summarised in the following table:

Researchers / teachers	Publication year	AR applications	Teaching subject	School/University	Country
Brown	2014	Prelude	Music notation	*Bowling State University*, Ohio	U.S.A
Figueiredo et al.	2014	Aurasma & other applications	Interdisciplina-ry approach of music, art, audio-visual art, main theme: the sea	*Padrão da Légua & Leça do Baliop* public primary schools	Portugal
Gomes et al.	2015	Aurasma & other applications	Music history	*Basic School Maria Manuela de Sá* public primary school	Portugal
Martíns et al.	2015	Music-AR	Main characteristics of sound	*San Paolo*, private primary school	Brazil
Dennis	2016	Aurasma	Musical instruments	*Bullitt County & Cedar Grove,* Kentucky, public primary schools	U.S.A
Karamouzis, Keffalas	2016	Aurasma	Interdisciplina-ry approach to religion studies and music	*91st public primary school of Athens,* Pagrati	Greece

Table: Literature review summary on the use of AR Software in teaching music in schools, independently or through interdisciplinary approaches combined with other subjects

3 Research methodology

3.1 Objectives, benefits and innovation of this research

The purpose of this study was to explore the depth and appeal of learning when using Augmented Reality Technologies (ART), and especially AR, in designing the educational materials. The use of AR applications in education is still at its early stages, while there is limited relevant bibliography. The element of innovation in the educational approach adopted during this study is based on the use of the *Aurasma* application. The value of this research is based on the endeavour to suggest ways through which modern technological applications can make teaching more interesting and valuable for the students, but also to discover the level of success of using AR within an interdisciplinary approach towards religious studies and music.

3.2 Research sample

This research was conducted using a participant sample at the 91st Public Primary School of Athens, in the area of Pagrati, Athens, Greece, as the researcher Michalis Keffalas is currently positioned as a music teacher at this school. The sample was comprised of 34 students, in their 6th, and final, year of primary school. ST 1 (7 boys and 11 girls) were the control group, and ST 2 (6 boys and 10 girls) were the experimental group for this study. The specific age group was chosen as it is this class's curriculum that includes teaching religions other than Orthodox Christianity, the country's 'official' religion. Furthermore, this age group is able to provide high-quality information, since the students have already been in education for 5 years and are able to express their personal opinions and perceptions in a fully articulate way.

3.3 Experimental design

The chosen matched subjects design is a form of experimental process, according to which the experimental groups are initially quantitatively matched, according to one or more variables, which are relevant to the focus of the study. In this study, therefore, the matched variables were the common design of the syllabus and the educational material which were presented to the students by the researcher himself, the identical period of time and conditions in which the sessions took place (1 teaching hour per week, for the duration of 1 ½ month, on the same day of the week). The only non-matched variable was the use of AR technology. The control group (ST 1) was taught the defined syllabus through the traditional approach, whereas the experimental group (ST 2) was

taught through an alternative approach, based on the use of ART, such as the use of computers, internet, virtual tours and, mainly, educational materials designed for the AR application *Aurasma*.

3.4 The educational intervention design

A cycle of 5 teaching sessions was designed focusing on the five most widespread religions of the world and their holy musics. Atheism (16.4% of the world population, according to the Pew Research Center Forum on Religion & Public Life, 2010) was excluded, rather arbitrarily; however it was clearly discussed during the sessions, especially during the presentation of the relevant map. In the case that Atheism was to be included, there would be two significant difficulties: i) comprehensively explaining the concepts of Atheism and Agnosticism to primary school children, and ii) finding, if it indeed exists, the 'holy' music of this specific population.

The learning journey began from the 'familiar' Orthodox Christianity, followed by a class on Catholicism and Protestantism (31.5% of the world population based on the Pew Research Center Forum on Religion & Public Life, 2010). These were followed by a presentation of Hinduism (15%, ibid), Buddhism (7.1%, ibid) and Islam (23.2%, ibid). The sessions were designed to present and discuss each religion (50% of the class duration) and its holy music (50% of the class duration). The researcher, given the specific conditions, endeavoured to discover the 'gold balance', which would allow the selection of specific, representative and valuable topics to focus on, that would also interest the students. It was not possible to teach all the topics discussed in the relevant bibliography, nor teach these in depth.

Every teaching session was concluded by the completion of a survey. Half of the questions focused on topics such as the central character or founder of each religion, the population size of its believers and the countries they come from, the name of the God and the appearance of the temples. The rest of the survey questions focused on whether the holy music of each religion is polyphonic or monophonic, phonetic or phonetic and instrumental, the names of their music notes, notation systems, intervals, modes, musical instruments and music ensembles that they use. This second group of questions was followed by music listening exercises and tasks where students were asked to identify music excerpts. For the students of the experimental group, each session began by approaching the topic and engaging the students' interest through a short virtual tour of a temple, or a video with each religion's respective choral or instrumental ensemble, displayed on the class's interactive blackboard. Furthermore, the students of the experimental group were also able, at the end of the session, to use their smartphone or tablet camera, focusing on each survey question, in order to see the letter corresponding to the correct answer in their screen, as well as the text of the answer itself, usually accompanied by an image (map, image of a temple or sheet music). In some

question, using their devices activated a short video of a holy music being performed live. Representative examples of the AR educational materials used in this research are presented below.

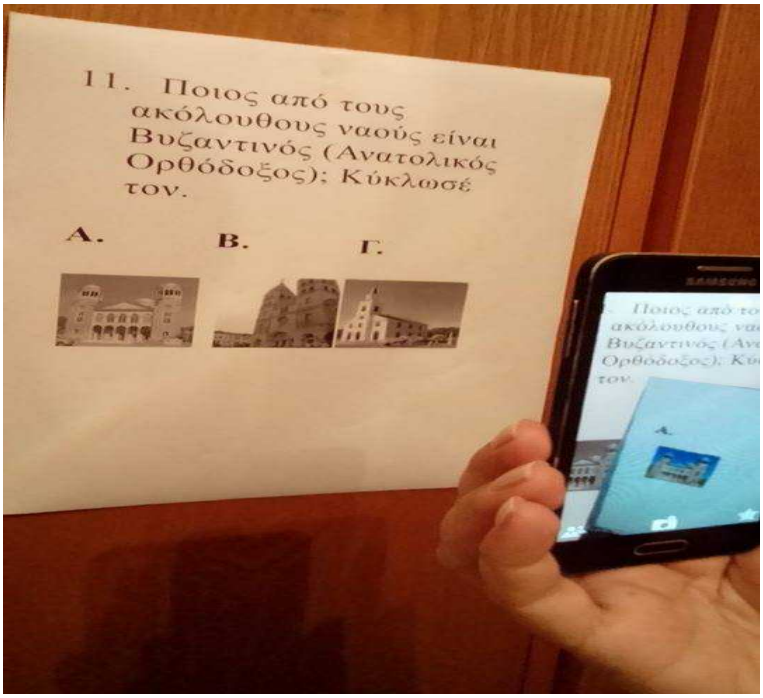


Image 1: An answer to question 11 of the final survey, which focused on the architecture of temples within different religions

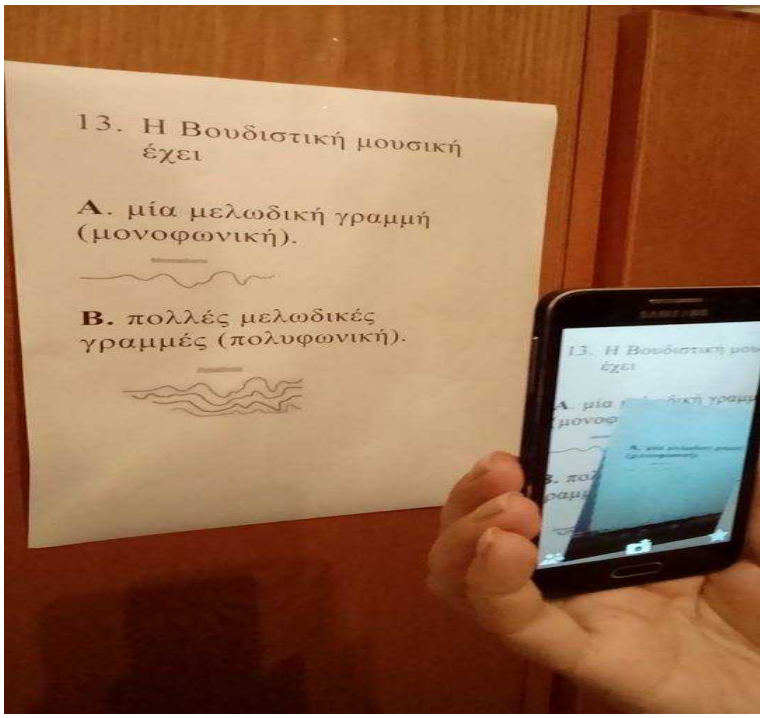


Image 2: An answer to question 13 of the final survey, which focused on the main characteristics of the different holy musics, such as whether the music is monophonic or polyphonic

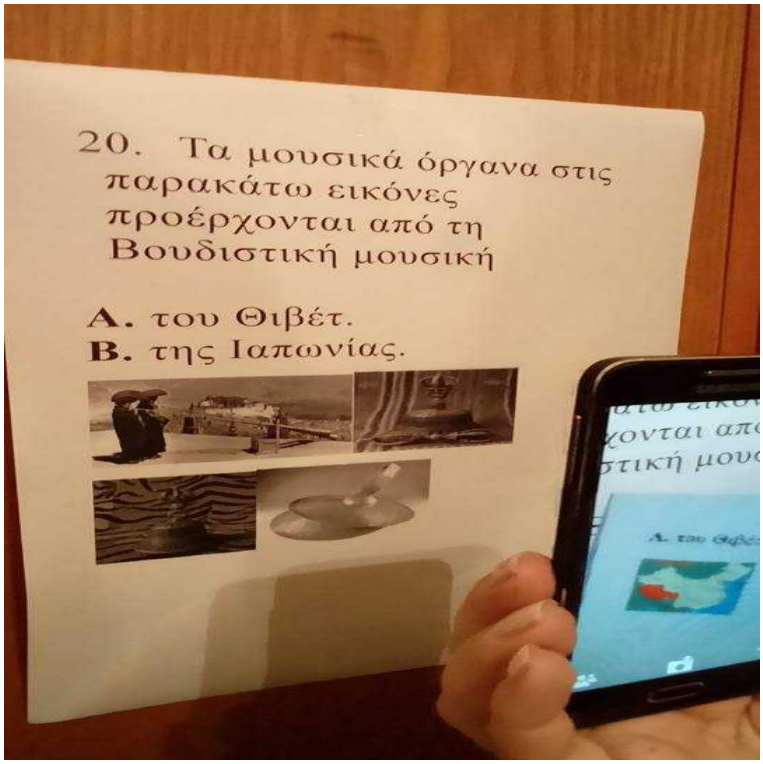


Image 3: An answer to question 20 of the final survey, which focused on the musical instruments used in the different holy musics

3.5 Data collection

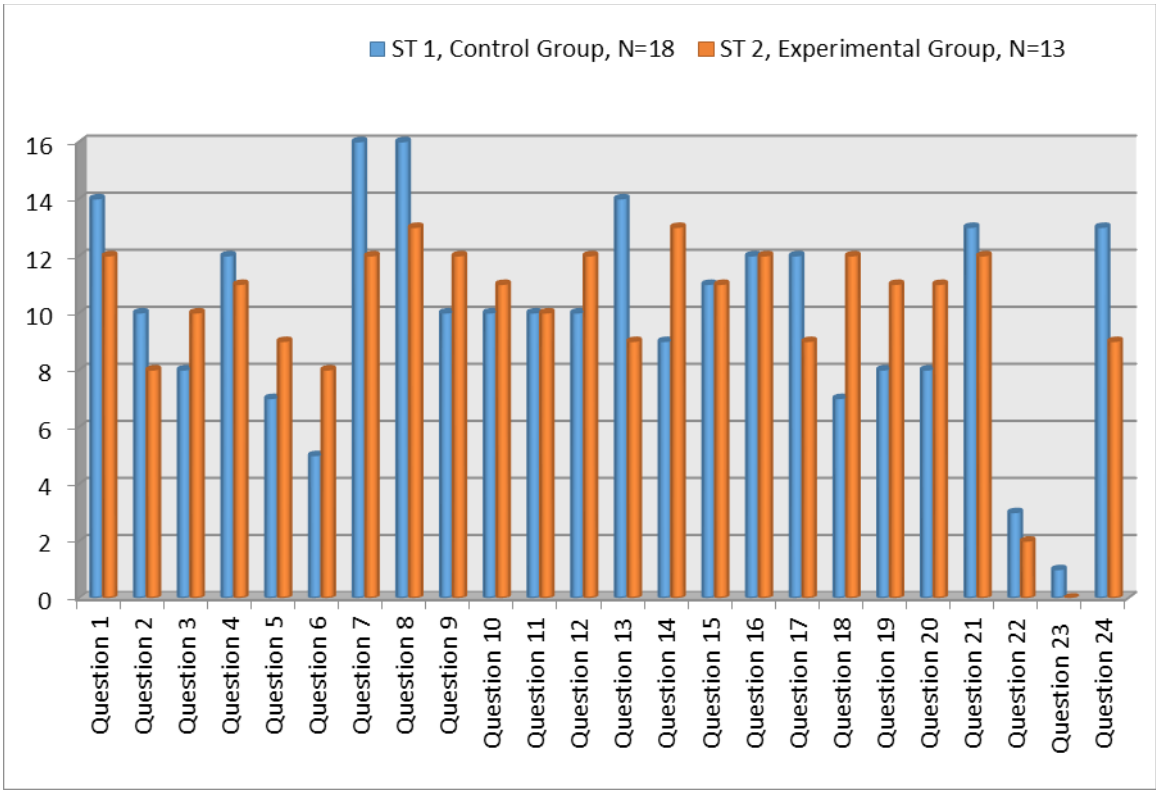
This qualitative study included a final survey of closed questions (multiple choice or binary questions), which investigated the depth of learning across the whole syllabus, which the students were taught: 12 questions about the specific religions and 12 questions about their holy musics. Qualitative data were collected through 3 further survey questions (one ranking question and two open-ended questions), which in combination with brief semi-structured interviews with each student, aimed to investigate the students' perception regarding the level of innovation and appeal of this cycle of teaching sessions. The interview allowed further follow-up questions to be asked, while the students of the experimental group also commented on the ART which were used. Overall 31 surveys were completed, as three students were ill during the survey collection.

4 Presentation and analysis of findings

4.1 Findings and discussion

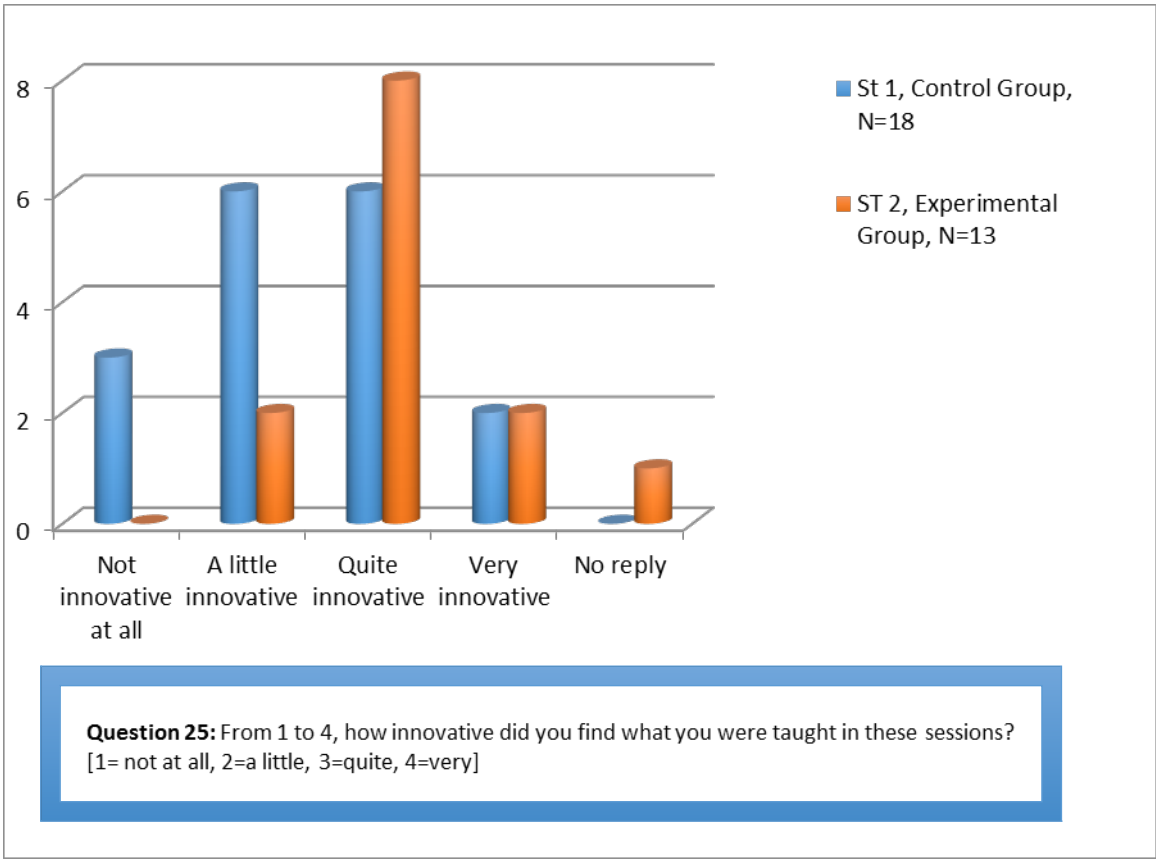
In each of the following graphs (1, 2, 3 and 4) the control group is indicated in blue colour (ST 1, N=18) and the experimental group in orange (ST 2, N=13). In order for the results to be comparable, all calculations took place through a process of reduction, as 18>13. Statistical analysis was conducted on the data collected through the initial 24 closed questions.

The number of correct answers per question (1-24) for both groups is presented in the following graph (1). It is evident that the experimental group expresses a significant advantage compared to the control group, regarding the number of correct answers given. Namely, 19 questions were answered correctly by the experimental group, 2 questions were answered correctly by the control group (question 13 and 23), and 3 questions were answered correctly equally by both groups (questions 17, 22 and 24. It is very interesting to note that questions 22, 23 and 24, which differentiate the results, are listening questions, to which most of the 31 students responded incorrectly, confusing the excerpt of Buddhist holy music with that of Hinduist holy music.



Graph 1: The number of correct answers per question 1-24, for both groups

The answers by both groups to question 25 are presented in the following graph (2). 23% of the control group replied that they do not find "anything innovative" about the sessions, while no student in the experimental team expressed this. 31% of the control group either replied that they found the sessions to be "a little bit innovative" and "quite innovative", while 15% of the experimental group answered "a little bit innovative" and 61% "quite innovative". Finally, twice as many students from the experimental group answered that they were taught something "very innovative" (15% and 7.7% respectively).



Graph 2: Answers to question 25, by both groups

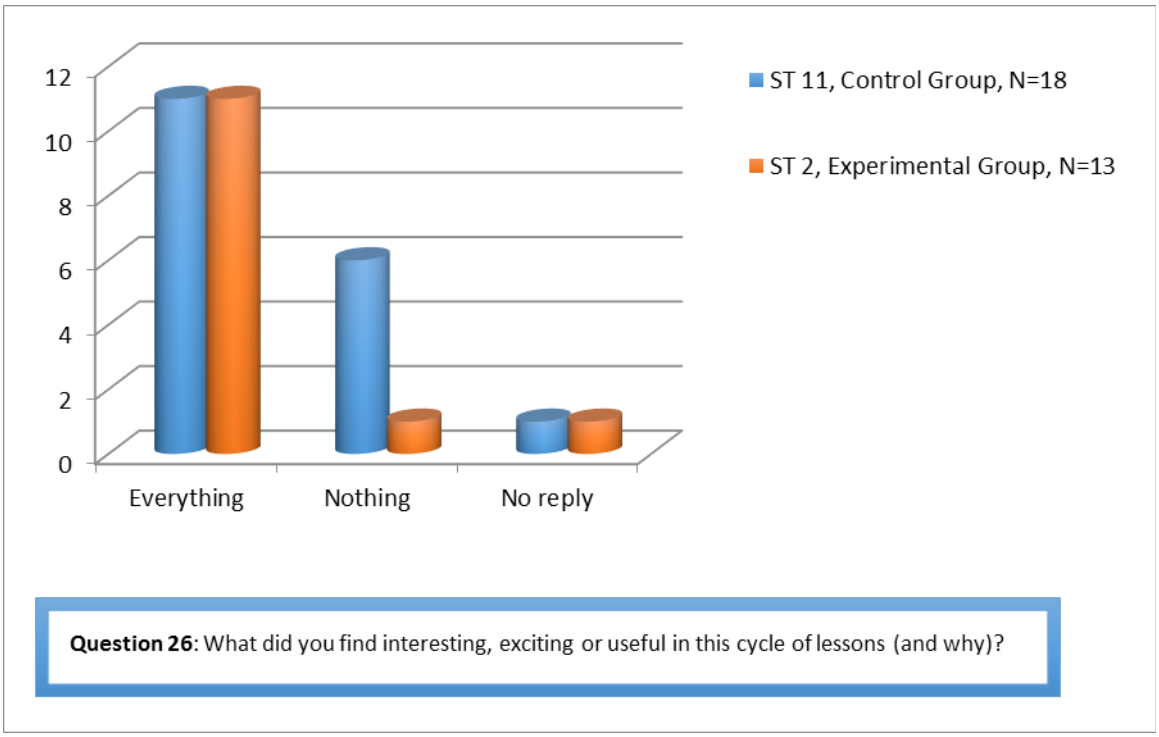
The answers to question 26 by both groups are presented in the following graph (3), which are discussed below alongside the interview data. However, the data collected through the survey may be seen as more reliable, since the survey was anonymous, encouraging honest replies from the students (Cohen, Manion, L & Morisson 2011, p. 219). The answer "all the content taught was interesting" was given by 61.5% of the control group students and 85% by the experimental group, while the option "I was not interested in anything" was given 31% and 7.7% respectively. Thematic analysis of the interview data, as well as the researcher's field notes, adds a qualitative aspect and further supports these findings,

The students of both groups who found the sessions interesting, exciting or useful (10 and 11 students, respectively) explained why:

- "because I learned things I did not know, such as about the religions and cultures of other countries"
- "because I learned things that I can use in conversations"
- "because they will help us/be needed during our lives"
- "because I will not have the opportunity to learn such things in the future"
- "because I learned to distinguish the musics of other religions, which are different to the music of my religion"
- "the most exciting and interesting of all were the questionnaires/surveys/the temple architecture/the musics of other religions, because I had not heard them before/Christianity and Buddhism".

Specifically, the students of the experimental group commented as following, on the ART, which was used, and particularly on the design software used:

- "I liked it very much/I feel very lucky/it was very impressive"
- "it was good software/innovative/very smart/the smartest software I know"
- "it was less tiring/it helped me answer the questions easier/the correct answer popped up in colour/we worked in a way through which I did not forget what we had gone through"
- "when they were combined with the interactive blackboard, I could see more clearly/I could see things bigger/I could hear the music excerpts more loudly"
- "I really liked the interactive games"
- "I have never used such applications in another class/with another teacher"



Graph 3: Answers to question 26, by both groups

The answers to question 27 by both groups are presented in the following graph (4), and are discussed below alongside the interview data. 61.5% of both groups said that "they found nothing uninteresting", while 23% of the control group and 7.7% of the experimental group said they "found everything uninteresting". 7.7% of both groups did not provide an answer, while 7.7% of the control group and 0% of the experimental group said that they found "some elements uninteresting". The same trend was suggested through the interview data, according to which the number of students who found nothing uninteresting was 7 and 11 respectively, and those who found it "all uninteresting" were 3 and 1 respectively.

To the additional question "why did you not find anything uninteresting" the students replied:

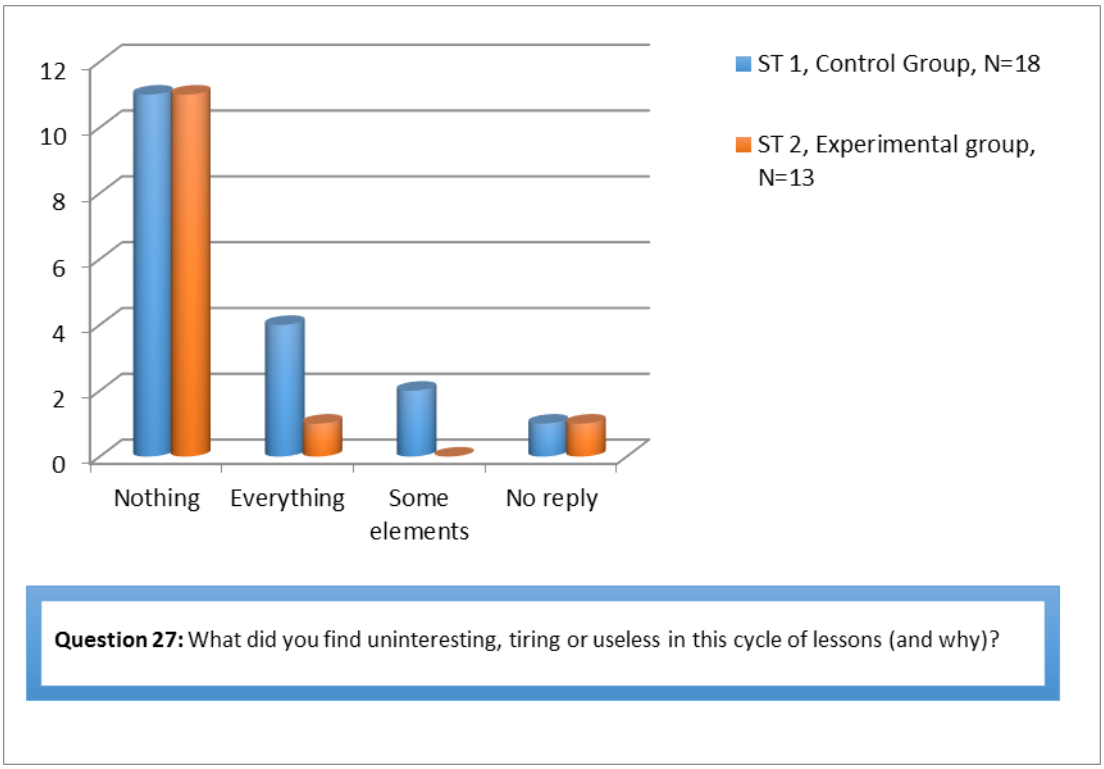
- "because I need to learn these/I will use them in the future"
- "because I was drawn in/they were innovative/I expected it to be worse, but it proved to be good"
- "because I was interested, apart from the information regarding Christian Orthodox dogma which I already knew"

To the additional question "why did you find everything uninteresting", the answers were:

- "because all the lessons were equally boring/I did not want to learn these things/I did not like them
- "because we were taught the same last year"
- "because there was too much writing"

To the additional question "why did you find some elements uninteresting" the answers were:

- "I did not find anything uninteresting, tiring or pointless, but I did not like it that much"
- "some things were boring and others not"
- "from what we were taught, I did not like the music listening exercises"
- "I found the holy music of Buddhism funny"



Graph 4: Answers to question 27, by both groups

4.2 Reliability and credibility of the research

The reliability and credibility of research is based upon the trust and truth of the collected data. Given that qualitative research focuses on small samples, it is characterised by restricted generalisability and comparability, and is influenced by the personal opinions and perceptions of the researcher, his communication skills, and specific techniques which were used aiming to increase the reliability of the produced results. The first technique was the researcher's extended engagement with the research environment, obtaining the participants' trust. The second technique was the triangulation of methods and data sources, the mixed-method survey, the semi-structured interview and the researcher's notetaking and observation, in combination with the findings of relevant research in international literature. The third technique was the preservation of elements, such as the questionnaires and the researcher's diary of notes, in order to allow the possibility of the study's external reassessment. The final technique was the contribution of the participants, in order to control and assess the researcher's understanding and observation of their answers. The ethical research guidelines were fully adhered to throughout this research, focusing on guidance regarding student participation (informed voluntary consent, parental consent, briefing of teachers and head teacher, permission by the supervisory Professor of this research), as defined by the Greek Ministry of Education, Research and Religion (official approval of research, reference number: F15/488/67814/D1/21.04.2016).

4.3 Outcomes and suggestions for further research

The objective of this research was to ascertain whether teaching based on ART, and specifically the AR software *Aurasma,* can engage the students' interest and strengthen the process of learning. The overwhelming difference in the number of correct answers given by the students of the experimental group, in comparison to the control group, for the initial 24 survey questions, demonstrates the positive effect of ART on the learning of children. The analysis of data from the last survey questions and the interviews suggests that the use of educational materials appropriately designed for the *Aurasma* AR software provides a unique learning experience for the children, in accordance to the few relevant references in international literature.

In the overwhelming majority of cases discussed in relevant literature, as in this research, AR is used by educators to provide students predesigned educational experiences. This may lead to a situation in which AR supports the development of low-level cognitive skills, such as the understanding and application of knowledge, without, however, encouraging higher-level, complex cognitive skills, such as analysis, critical assessment and creativity. An alternative suggestion,

aiming towards the development of these skills, is for the students themselves to become designers through the use of AR, in order to develop higher-level thinking (Bower et al. 2014, p. 7).

In the literature review by Dunleavy & Dede (2014) it is highlighted that, due to the exploratory nature of these technologies,

> AR is in many ways the solution looking for a problem, […] an instructional approach looking for the context where it will be the most effective tool among the collection to strategies available to educators (2014, p. 26).

The majority of studies which are discussed in the work of Dunleavy & Dede (2014) use AR in order to multiply and guide the dynamic and complex nature of solving collective problems within a real natural environment. While the challenge of facilitating collective empirical questions within and outside the school classroom may be the most significant educational challenge, which AR has solved, further research is needed into how this approach can contribute towards the solution of further, long-lasting educational problems, discussing at the same time the inevitable limitations within this expanding ecology of education.

Conducting similar quantitative research at this point would not be possible, since it would require a large number of teachers to be training on the topics of religion, music and technologies. However, this qualitative research conducted may be the precursor of a future quantitative study, at a time which would allow the systematic examination of new complex educational phenomena and their implications. According to Tsiolis

> Qualitative research, as a core scientific activity, can be the predecessor of quantitative research, with the objective of highlighting innovative and unexpected aspects, mainly regarding the exploration of social areas or life forms, which are unknown to sociological theory and research. In this way it can contribute to the expression of hypotheses (in the stage of discovery), to be followed by the main 'scientific' phase of research, the process of assessing these hypotheses through the use of quantitative methods (the stage of confirmation) (2011, p. 60, 61).

Furthermore, it is seen as necessary for AR technologies to be included in future curricula, adopted and used by schools.

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