

The Shield of Achilles using 3D Technologies to Support Teaching Scenarios of Homeric Epics

P. Angelopoulos, and E. Solomou

Abstract—The “Shield of Achilles” is an effort to teach in an interdisciplinary way both the teaching subjects of Ancient Greek (Omer’s Iliad) and Informatics (3D modelling and printing), that took place in the 1st Junior High School of Vrilissia, Athens, during the school year 2017-2018 [13]. Students of B grade of Junior High School (ages 13-14), on a voluntarily basis, separated into groups of 4, created in a 3D design environment the “Shield of Achilles” as were taught during the subject of Ancient Greek and according to the description of the shield given by Homer in his poem “Iliad”. The most of the shields were eventually printed out using the 3D printer of the computer lab. The aim of the project was to support teaching between STEM and Classical subjects, co-create and implement integrated models inspired by STEM and classical disciplines and to investigate the behavior of students through a school program based in both formal and non-formal educational approaches. Part of the program was supported through the school’s curriculum, part of the program had to be implemented out of school hours. After the completion of the project students responded to a questionnaire prepared by the teachers in a google form format. The most important results of this questionnaire are discussed in this work.

Index Terms—STEM, Innovation, Teaching Approaches, Ancient Greek, Homer’s Iliad, 3D Modelling, 3D Printing.

I. INTRODUCTION

According to the OECD’s PISA 2015 [1], which tested around 540000 15-year-old students in 72 countries and economies in science, with reading, mathematics and collaborative problem solving, only 12 out of the 72 countries and economies assessed have improved their science performance over this period. For this reason, there is a need for innovative approaches to increasing the motivation of pupils towards both STEM [2] and classical subjects and for offering teacher training on new ways of introducing innovation and new teaching approaches. Students interested in classical subjects do not use scientific thinking, computational thinking, practice and methodologies based on the understanding of STEM subjects. Also, students with interest in STEM subjects are less interested in classical studies which lessens their chances of developing comprehensive knowledge and literacy on issues such as history, philosophy, languages, religions, etc. The project «Shield of Achilles” tackles objectives relevant to secondary education, looking to increase the interest of the pupils in STEM studies and Ancient Greek and contribute to tackling the issue of underachievement in Informatics and Ancient Greek and specifically in Homer’s Iliad. The overall objective of the

“Shield of Achilles” program is to increase students’ proficiency in the key competences necessary to shape the future towards 2030 by integrating STEM disciplines, social sciences, humanities, arts, and entrepreneurial disciplines (Classical disciplines) as broader educational goals are acknowledged and supported by modern educational systems [3]. The program aimed to expose pupils and their teachers to integrated approaches leading to the development of key competences necessary to shape the future towards 2030; integrate STEM thinking actions and methodologies in Classical disciplines to augment interest in STEM education and vice-versa, strengthen teachers [4] and pupils to understand and assume the role of each discipline in the development of 21st century skills and the added value of their integrated contribution and to improve teachers’ competences by supporting them to become innovative and work collaboratively[5].

There is a need for innovative approaches to increasing the motivation of pupils towards both STEM and classical subjects and for offering teacher training on new ways of introducing innovation and new teaching approaches [6]. Students interested in classical subjects do not use scientific thinking, computational thinking, practice and methodologies based on the understanding of STEM subjects. Also, students with interest in STEM subjects are less interested in classical studies which lessens their chances of developing comprehensive knowledge and literacy on issues such as history, philosophy, languages, religions, etc.

Youth, even if they considered to be very good at their subject of studies do not seem to have an overall perception of issues not related directly to their studies. Connecting STEM and Classical subjects (Informatics and Ancient Greek in our case) is vital in ensuring that the general knowledge sector will benefit of much needed new talent in its various fields, and that students think and act not only like scientists-experts in their field, but also as integrated personalities, weighing evidence to draw conclusions, and learning how to navigate the claims bombarding us in our everyday lives.

The “Shield of Achilles” program proposes to:

Support teaching between STEM and Classical subjects’ teachers in the school. The project aims to create a community of practice for STEM and Classical teachers inside the school, on how to teach their subjects supporting each other and provide input and methodologies to their subjects’ activities and teaching from STEM to Classical subjects and vice versa.

Co-create and implement integrated models inspired by STEM and classical disciplines, increasing relevance while supporting the development of 21st skills in students and

school progress.

Provide open and/or free educational tools and applications to revolutionize the teaching method and motivates students to benefit from the latest technology during learning.

Its aim is also to investigate the behavior of students through a school program based in both formal and non-formal educational approaches. Part of the program is supported through the school's curriculum; part of the program has to be implemented out of school hours. Particularly, its objectives are to monitor

- the acquisition of knowledge and skills related to both involved subjects
- students' potential participation and performance in both subjects
- the need and enthusiasm of students to attend an interdisciplinary program based on creativity and co-operation

II. IMPLEMENTATION

A. Scenario

Cognitive objects: Ancient Greek Texts from translation [7], Homer Iliad, Informatics.

Addressing class: Second Class of Junior High School (age 14-15)

Chapter: Ancient Greek Texts from translation, Homer Iliad.

Rapsody 18 478-616 (from the school handbook).

Duration:2 teaching two hours in class

2 teaching hours in the Computer Laboratory

4 preparatory teaching hours in the Computer Laboratory

Free access to the Computer Lab a day every week for two months after the school time.

Number of students: 40 volunteers among the 103 students of 4 classes of B grade

Space/Room that the classes take place: Computer Laboratory and Classroom.

Printer Used: Ultimaker 2+ that had been granted for two years to the 1st Junior High School of Vrillissia by GFOSS (www.gfoss.eu)

3D applications used the Tinkercad web 3D modelling tool (<https://www.tinkercad.com>) [8] and the 3D printing software cura (<https://ultimaker.com/software/ultimaker-cura>)

Achilles' shield is a hymn to technology, a poetic presentation of the most famous work of art in the Homeric era.

This teaching scenario effectively uses 3D modeling and printing techniques in order to support the level of learning and comprehension of one of the most important Homeric epic poems of global literature, Homer's Iliad.

Following HOMER, the epic poet, and Hephaestus, the Greek god of fire and technology, students can freely express themselves and produce their own creation, and proceed to the construction of "the Achilles' shield" through the use of digital 3D technology.

The general idea of this scenario, that is considered part of the cognitive context of multilingualism and multiculturalism, is to give a chance to the students to:

- Enjoy through an epic poem the meaning of the Achilles' shield which is considered to be an hymn of life.
- Design the shield by experimenting with 3D tools, concepts and shapes of Euclidean geometry and stereometry,
- Print a 3D model by experimenting with the properties, attributes and parameters of a 3D printing tool (cura) [9]
- Acquire skills in 3D modelling and printing, following Homers description and Hephaestus steps in constructing the shield.
- Students become creators of their own personal shield!

B. Cross-linking: Ancient Greek Language and Information Technology.

As to the cognitive object of Ancient Greek, realization of the lesson involves elements from the text centered approach and the recruitment method and of the comprehension of the learning objectives by using the critical analysis of discourse to analyze the text [10].

Learning activities: It is expected from students to:

- Understand the Homeric civilization – physical and spiritual.
- Debate analogies and differentiations from the contemporary epoch between the civilizations.
- The multicultural - cooperative approach is connected with the roles that students are going to take during the two hours' class and concern:
- The participation of all the students, especially of these that are considered "frails/weak" or these that have been born in another country.
- Discover the different ways that other nations and races construct and decorate their shields.

As to the cognitive object of Informatics, students had to capture and model the shield in 3D display. Students after web search decided to use the free 3D printing application of Tinkercad (www.tinkercad.com). Alternately for better modelling and printing results the open 3D design and modelling software Blender (www.blender.com) is suggested. But as it is considered to be a professional application, it cannot be easily used by 13-14 years old students. Consequently, they transfer the model and experiment in the 3D printing software "cura", looking forward to create the ultimate printing model of the Shield of Achilles close to the real srurlpured model made by Hephaestus.

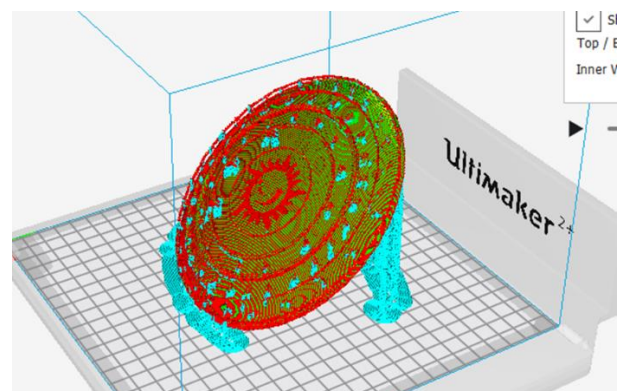


Fig. 1. Model of the Shield of Achilles made by students in Layer view

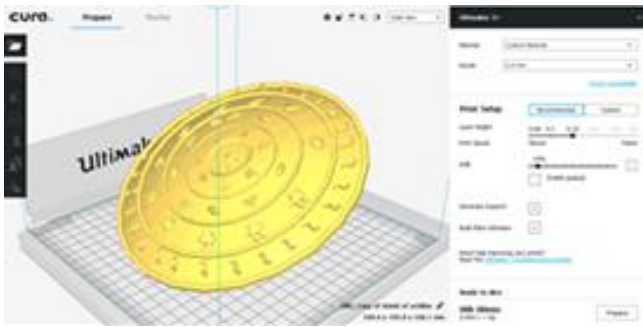


Fig. 2. Model of the Shield of Achilles made by students in Solid view

Students are expected to be able to:

- Search for free 3D sketch/design software.
- Understand basic functions and tools of 3D sketch/design.
- Experiment and understand the behavior of stereometric and euclidean shapes when used in 3D modelling.
- Research advanced functions and tools of 3D modelling/design. Moreover, they can try to practice them in the design of the shield.
- Learn about the materials and the applications of 3D printing.
- Get familiarized to the program, the properties and the parameters of the printing software.

C. Means of teaching-materials-conditions:

School handbook, used application tutorials, office suite, Internet browser, headphones/speakers, Interactive White Board system, 3D design software, 3D printing software, printing material PLA and/or ABS, 3D printer.

The teaching of the unity from the school handbook and the information of the students for the way of realization of the class objectives is pre-required.

First of all, the students will read the 180 verses of the Homeric poem that describe the Shield of Achilles. Secondly, with specific questions (how is the shield described, how many are the circles, what is the meaning of each one) in mind about the shield, they will search for keywords in that text. After, they will identify and separate the five circles of the shield. Then, they will return to the text to locate specific information and passages related to each circle of the shield. After dividing the verses that are referred to each circle, they will write down all the information that can be found in the text, under the guidance of their teacher. Then they will proceed to the next step by designing and printing the shield.

- Navigate to the internet in order to a) locate information relevant with the shield and b) locate information and tutorials about special modelling techniques needed for designing the shield
- Transfer the data to the 3D printer's software and setting the proper parameters for the final printing
- organize the construction of the shield as follows:
 - Central circle decorated with stars
 - Second circle decorated with twig of olive or dove and swords or javelins.
 - Third circle decorated with ear, grape, sprout and soil.
 - Fourth circle decorated with a lyre, a flute and a sheep.

- Fifth circle decorated with an ocean full of waves.
- Students are allowed to decorate the shield according to their inspiration.

Students in the context of the information technology class have already been familiarized (four teaching hours) with the usage of 3D design and 3D typing applications. Although, after they study the description of the shield two more hours are devoted for the construction of the shield for research-organization-modification of the information that have been collected already from the Ancient Greek lesson. They are going to start designing the shield based on the knowledge acquired by the Ancient Greek Language subject.

Finalizing the shields model, export it to an .stl file, configuring the parameters of the 3D printing software, export it to an .gcode file and start the printing.

The printing process continues after the end of the teaching hour for the time needed.

III. PROJECT EVALUATION

After the completion of the project students responded to a questionnaire prepared by the teachers in a google form format. Analytical presentation and evaluation of the questionnaire are outside the scope of this work, however it is worth noting some of the students' answers.

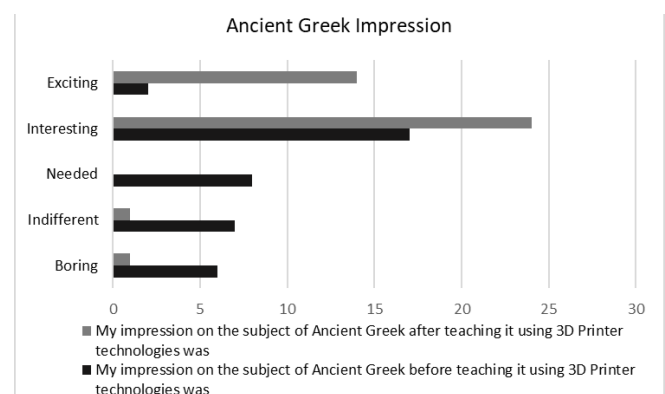


Fig. 3. Change of the students' impressions in the subject of Ancient Greek before and after the implementation of the program

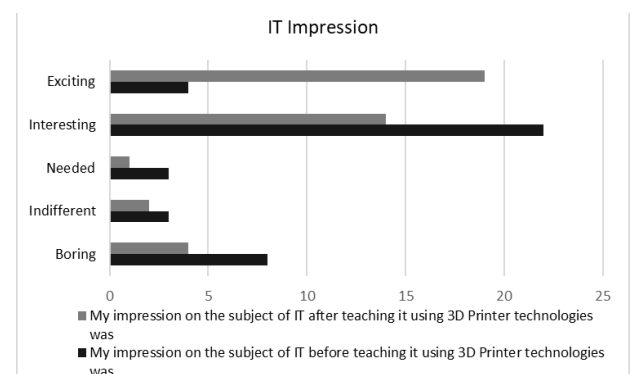


Fig. 4. Change of the students' impressions in the subject of IT before and after the implementation of the program

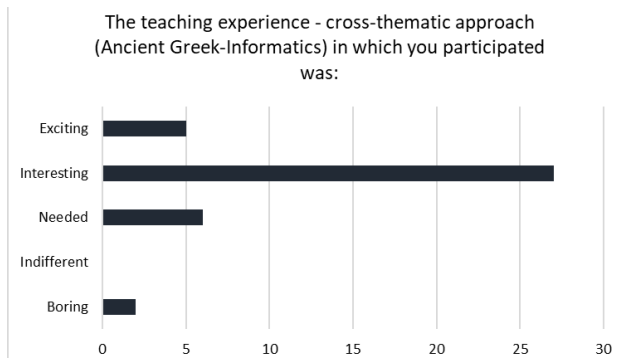


Fig. 5. Students evaluate their experience

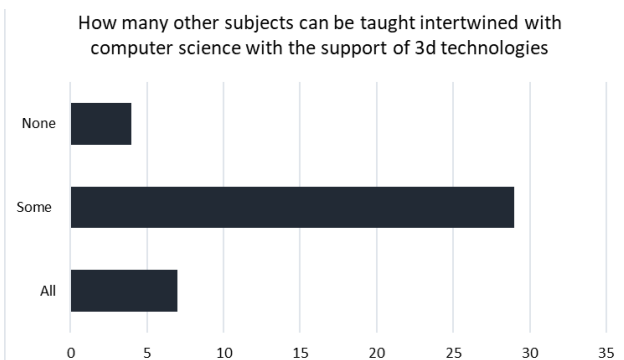


Fig. 6. Students' opinion about cross teaching subjects using 3D technologies

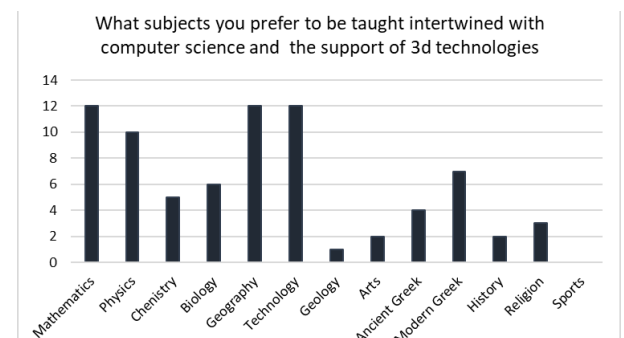


Fig. 7. Students preferences about cross teaching subjects using 3D technologies

Students and teachers had fun during this two months' project. Students seem to have a more positive view about the subject of Ancient Greek than they had before the program. They would prefer more subjects to be taught in an interdisciplinary way together with IT and the support of 3D printing and designing technologies [11]. Even if the involved subject was Ancient Greek, it seems that they believe and prefer that STEM subjects are more suitable to be taught in a cross teaching approach using 3D technologies. The most of them found the experience interesting and both the subjects become more attractive and pleasant to them.

IV. CONCLUSIONS

The use of 3D technologies is an approach where students explore, invent, discover, and engage in real problems and situations [12]. Students in this way are encouraged to innovate by discovering natural and scientific laws through the use of 3D technology, engineering and arts, thus creating interconnections between scientific areas and shaping views associated with other disciplines and scientific areas [11].

Three-dimensional printing technologies are quite mature and economical so they can be used at the level of a school. Students have come into contact with manufacturing methodologies through a promising field, such as three-dimensional printing. They understood that 3D printing is used and will be used in many areas of human activity in the future.

Since the implementation of the program, it has been shown that students' interest in both IT subject and the cognitive subject of Ancient Greek, was highly increased. In particular, enhancing interest was much greater for weak students in both Homer's Iliad and IT.

The use of three-dimensional technologies can make cognitive subjects more attractive to students, enhance the quality of teaching subjects, increase students' interest in them and acquire skills [13] such as: problem solving, digital skills, teamwork, communication with my classmates, learn how to learn on my own, etc., skills that are necessary to improve the personality and education of the students.

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