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Robotics and Stem Methods for Innovative Design Of Escape Rooms And Workshops For Students

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Abstract*: This paper using a workshop of educational robotics, programming and microprocessor applications in S.T.E.M orientation for students 8-12 years seeks to lead them to a beautiful journey of discovery and exploration of the world that surrounds them, developing cognitive, kinetics and social skills as well as improving their digital literacy. Furthermore, the design and analytical description of an educational escape room "the journey of Theseus to Crete" aimed at consolidating the knowledge gained from the seminar S.T.E.M4KIDS with a playful and interactive way.*

Keywords -*elementary school, S.T.E.M education, educational Robotics Laboratory, room escape, Lego, Arduino*

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I. Introduction

Digital transformation of the economy redefines the business activity. New ways to work affect the types of skills required, including innovation and entrepreneurship. This new global reality imposed the need on adapting the existing training systems, in order to enable them to cope with both modern training requirements and the rapid progress of training models on the market working with the adoption of the principles S.T.E.M.

Nowadays Robotics is a cutting-edge technology as an interdisciplinary area closely dependent and interactive with computing, communications, electronics, artificial intelligence etc. Curiosity and talent of creative problem-solving are critical attributes that lead to innovation through engineering processes. Unfortunately, teachers in Greek primary schools find it difficult to recognize these qualifications, so as to provide effective support and boosting.

The aim of this paper is to present the educational Robotics Laboratory STEM4KIDS, which includes 14 activities with increasing difficulty for children 8-12 years of age, without prior knowledge of engineering or technology, using Scratch, Lego Wedo2 and Arduino. The seminar focuses on learning educational Robotics and electronics with the help of educational standard S. T. E. M and is divided into 4 sections. Finally, an escape room for educational purposes is designed and presented thoroughly, utilizing the knowledge gained from the workshop, laying thereby the foundation for new young "Scientists in action", who need to explore the natural world around them instinctively and in a playful manner, but the school framework does not allow them to.
The theme of the educational escape room that is presented in this study is "Theseus adventures till Crete" and comes to complete and help kids to learn and play at the same time.

Professional skills of 21st century and STEM principles

Professional skills of 21st century are the path of employment and prosperity. Through the right skills, people are equipped for good quality jobs and fulfill their abilities with self- confidence as active citizens.

In a rapidly changing global economy, skills greatly determine competitiveness and the capacity to promote innovation. These are the factors of investment attraction and catalyst in the working places and development. They are the key to social cohesion. But the situation in Europe requires action. 70 million Europeans are deprived from adequate reading and writing skills and still have insufficient knowledge of arithmetic and digital skills, something that puts them at risk of unemployment and social exclusion. More than half of the 12 million long-term unemployed are considered as low- skilled [1].

Greece is in an even worse situation because its educational policy is far from the one of the corresponding countries of the world that promote educational innovation. Within the world reality S.T.E.M. education is an imperative need. S.T.E.M. is the modern and innovative teaching approach, utilizing 4 branches: science, technology, engineering and mathematics. Nowadays, in the U.S.A. S.T.E.M. centers have been created in almost all universities. Moreover, there are S.T.E.M. courses in schools of secondary education and in special schools with the S.T.E.M. directions. It is not a coincidence, that the PISA results which are published every 3

years, the countries which are ahead from the others are the ones which have integrated STEM courses in their educational policy.

The United States is leading the way in this educational innovation. On the website of the White House, the former President Barack Obama points out that it is necessary to train a number of professors, specialized in the field of S.T.E.M:

«One of the things that I've been focused on, as President, is how we create an all-hands-on-deck approach to science, technology, engineering, and math… We need to make this a priority to train an army of new teachers in these subject areas, and to make sure that all of us as a country are lifting up these subjects for the respect that they deserve". President Barack Obama. [2]

On 13th of April, the White House Press Release about the White House Science Fair and other educational initiations by the Obama administration, reported that the USA has managed to reach the half of its target of 100.000 S.T.E.M teachers.

The National Science Foundation of America wanted to give particular importance to each of the four components (Science, Technology, Engineering, Mathematics) with two main objectives – one at the micro level and one at the macro level. At a national level (macro level) they wanted to reinforce the necessary technological and mechanical changes so that the country remains competitive on a global level. At the micro level every student should be aware of and understand the basic principles and methods of the S.T.E.M courses and the interaction between them in order to be a literate citizen thus ensuring a decent job in his adulthood.

In September of 2017, the American President Donald Trump signed a presidential memorandum to extent across to high quality S.T.E.M education (Science, Technology, Engineering and Mathematics) and the Computer Science of Primary and Secondary Education with the aim of giving Americans the opportunity to acquire the necessary education and supplies that will lead them to good and stable jobs. The question which arises is that how it is possible to design and implement the appropriate educational material in order to meet the goals of S.T.E.M education which are below:

- To develop technology programs for adolescents who are able to grasp the planned world by humans, its tools as well as the systems and the infrastructures that are essential to preserve it
- To be able to manage different tools according to their needs
- To be able to take decisions on the use and development of technology in an environmental and social framework as they should understand the degree of their interdependence.

In our country, by an IEP [3] (Institute of Educational Policy) act we notice the suggestions for the design of analytical programs based on S.T.E.M. "The S.T.E.M integrations are proposed by stakeholder consultations and expert reports, because it serves better through holistic problem-solving and because it bridges the gap between science and its implications. Therefore a framework of the teaching of these sciences through an integration model can be considered more effective for the preparation of the workforce in the field of technology and science of the 21st century."

However, there is no change in analytical programs to this direction in primary school until now. The Greek STEM Education Union was founded in December of 2017. The main purpose of the Union is the dissemination of the epistemology, the methodology and the reformation of STEM teaching and the formulation of valid proposals for the implementation of STEM teaching models at the level of seminars and workshops for the teaching of cognitive subjects which one related or are included in the STEM epistemology at all levels of education with the principle of the scientific validity of the proposals and their credibility.

According the research of Columbia University: Students should be trained to understand that their own well-being depends on the quality of the planet and any training should include education on issues such as adaptation to climate change, preservation of the remaining biodiversity, protection and access to water sources so that they can face such issues.

Challenges that have environmental, social – economic and political impacts. A nation with deep knowledge not only reads but also calculates, inquires and innovates. [4]

While the time requires cultivation of high skills that allows people to adapt on unforeseen changes and solve problems, there is no matched curriculum that supports it in Greece. It would be advisable then, to orient our educational plans by exploiting the knowledge and the experience of countries such as America's that have invested in the STEM Vision as we see above (The S.T.E.M 2026 Vision) and to reclaim the international experience and the records of good practice that exist in almost every developed county in the world [5].

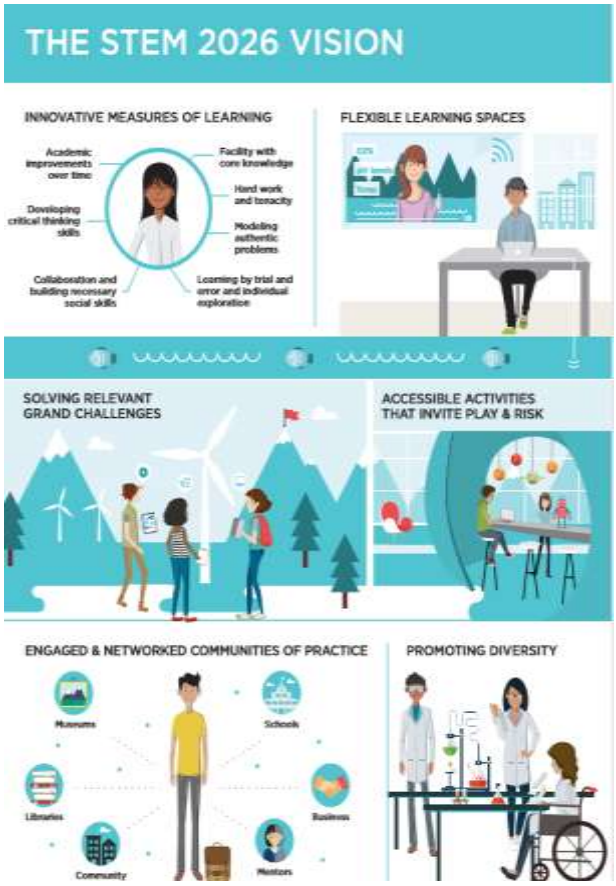

Figure 1: The S.T.E.M 2026 Vision

Also European Schoolnet is at the forefront of the debate on how to attract more people to science and technology to address the future skills gap that Europe is facing. STEM is one of European Schoolnet's major thematic domains. It has been involved in more than 30 STEM education initiatives, financed through European Schoolnet's Ministry of Education members, industry partners, or by the European Union's funding programs. The portfolio of European Schoolnet STEM projects ranges from teacher training (Amgen Teach) to technology-enhanced learning (Next-Lab), and science awareness for schools (Space Awareness). It is also leading the work of two strategic initiatives in science and mathematics education in Europe: STEM Alliance and Scientix.[6].

1.1 EDUCATIONAL ROBOTICS AND S.T.E.M

The STEM oriented educational policy should use the subject of "Robotic Education" by developing and preparing children for new technologies. The dynamic of educational robotics leads young students to construct a mechanical model (for example a car model) and direct it with the help of a simple and useful programming environment. Its positive effects are recognized in both the cognitive domain, emotional domain (self –esteem, self – confidence) and social domain (socialization, demystification). Moreover, through this educator can focus on the development of more crucial skills of 21st century such as teamwork, problem – solving, (analysis, design, implementation, testing, experimentation and assessment), innovation, management, programming, communication skills, valuable intellectual skills (analytical and complex thinking, creativity, critical thinking e.t.c.)

Educational Robotics creates an appropriate learning environment where learners acquire an integrated package of skills useful for their future by using tangible materials [7]. The request for this project is to combine educational robotics programming and microprocessor applications with S.T.E.M orientation curriculum for students 8-12 years with the best possible way.

WHAT MAKES A S.T.E.M ROBOTIC EDUCATIONAL LESSON SUCCESSFUL?

This paper attempts to answer the difficult question: "How to plan and carry out effective S.T.E.M activities to engage and inspire young people?"

Its purpose is to explore: diversity, communicating with young people using feedback to improve their activity and performance. Ultimately, these courses aim to equip kids with the skills and confidence to delve

deeply into S.T.E.M subjects and careers According to Marc Prensky, (Prensky, 2003) kids, as everyone else love learning whenever it is not obligatory. The education issues with the question of "why school weakens the mood of children for learning has preoccupied important personalities of history especial if we consider the view of Aristoteles that all the people of their nature have the desire of learning" [8].

Jean-Jacques Rousseau, was totally agreed and said that "childhood has a particular way of seeing, thinking and feeling which is unique. Nothing is the least possible that want to replace it with our own ways".

So the design, organization and implementation of the educational laboratory was done taking into account the theoretical educational model of constructionism, (Piaget, 1972) and in particular the model of constructivism (Papert, 1993). The constructivistic perception of the phenomenon of learning supports the fact that the learning environment should provide authentic activities embedded in open – ended resolution processes from the real world in order to encourage expression and personal involvement in the learning process and support social interaction. Also, constructivism advocates that trainees build more effectively when they are actively involved in the design and construction (manual and digital) of real objects that have a meaning for the same ones either they are sandcastles or LEGO constructions and computer programs (Papert , 1991).

In this paper it is proposed that the training of "young engineers in action" is to be a continuous and sequential process. All the knowledge gained by the workshop should become the property of children through the game in the escape room and solving the puzzles that will lead them out as capable problem solvers.

The educational objectives pursued through the courses of this" STEM4KIDS" seminar are multiple and differentiate according to the degree of familiarization of the students with the robotic constructions, their age, but also according to their previous knowledge in programming.

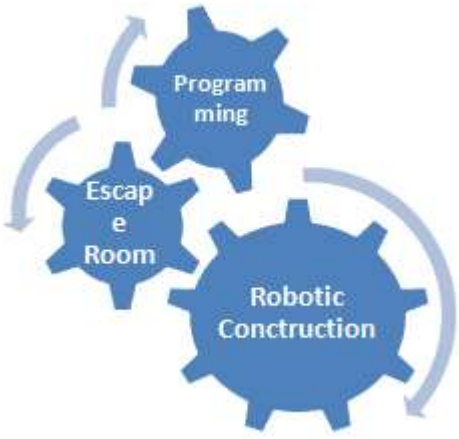

Figure 2: Structure of project "S.T.E.M4KIDS" and THESEUS ESCAPE ROOM

No matter how many their differences may be, their common cause is the words of Anatole France: "We can't be educated if we don't have fun. The art of teaching is nothing but awakening the curiosity of young souls and to satisfy it in the years to come, as curiosity is not lively and healthy but only in happy spirits. The knowledge, which is driven violently, can blur and drown their souls."

Basically the common features of all seminars are the active participation, team working and practicing through problem solving. Fortunately, the subject of both robotics and STEM seminars trigger the child curiosity and imagination by solving the problems of natural world which surrounds them. This condition acts as a driving force for young students.

1.2 ROBOTICS WORKSHOP USING S.T.E.M PRINCIPLES

S.T.E.M4KIDS is a S.T.E.M Robotic Education workshop designed to create an inspirational atmosphere for students to be change-makers, by placing right tools in their hands, tinkering with robotic kits and S.T.E.M Learning Models, foster collaboration, enhance learning and engender their creative curiosity.
Several resources have been used so as the educational curriculum to be designed such as :

- Sample PBL-S.T.E.M lessons and problems developed and shared by the participants. (Appendix B SOLAR CELLS) Asghar, A., Ellington, R. , Rice, E. , Johnson, F. , & Prime, G. M. (2012). Supporting S.T.E.M Education in Secondary Science Contexts. Interdisciplinary Journal of Problem-Based Learning, 6 (2). Available at: https://doi.org/10.7771/1541-5015.1349

- "Arduino as a S.T.E.M educational tool for students with hearing impairment" Practical Tasks 5th Panhellenic Conference "Integration and Use of ICT in educational process», Tsiastoydis Dimitrios, Polatoglou Hariton M. • Workshop for coaching Educational Robotics Competition Wedo2 (WROHELLAS 2016-17)- Fotis Fotinakis
- https://www.eie.org/eie-curriculum (Museum of Science, Boston)
- Engineering in K-12 Education: Understanding the Status and Improving the Prospects (Linda Katehi, Greg Pearson, and Michael Feder, Editors; Committee on K-12 Engineering Education; National Academy of Engineering and National Research Council)
- Integrative Learning in K-12 S.T.E.M Education: How to Prepare the First Step? Gary K. W. Wong Faculty of Education the University of Hong Kong
- http://courseweb.stthomas.edu/apthomas/SquishyCircuits/PDFs/Squishy%20Circuits%20Classroom%20Guide.pdf (University of St. Thomas)
- Robotics in Education Research and Practices for Robotics in S.T.E.M (Education, How to Teach with LEGO WeDo at Primary School, Karolína Mayerové and Michaela Veselovská) κ.α.[Robotics in Education][53]
- ASEE 2012 – K-12 & Pre-College Engineering Division – Paper 3021 1 «Design, Development, and Implementation of Educational Robotics Activities for K-12 Students (Can Saygin , Timothy Yuen , Heather Shipley , HungDa Wan , and David Akopian) The University of Texas at San Antonio (UTSA) Interactive Technology Experience Center (iTEC) San Antonio, Texas 78249-0670
- NGSS Front Matter (Next Generation Sciene Standards) "Prepare and inspire: K-12 education in science, technology, engineering, and math (S.T.E.M) for America's future."
- https://www.spacecamp.com/ (US Space and Rocket Center)
- https://www.S.T.E.M.org.uk/community/group/37017/robotics-resources/39270
- https://community.computingatschool.org.uk/resources/3042/single

The workshop consists of 4 different sections:
1. Introduction,
2. Scratch programming,
3. Lego Wedo2,
4. Arduino +S4A.

Section 1: Introduction

At the first section "Robotics through STEM principles in every day issues of a young mechanic" is presented an introduction to robotics and S.T.E.M principles. Also webinars and additional resources are available for the kids and the educators.

STEM4KIDS

Introduction: General principles of robotics. Microprocessor and automation

Code	Title	Difficulty	Duration (hours)	Lesson Plan	Videopresentations Webinars	Extra Resources
M1	«Robotics through STEM in every day issues of a young mechanic»	1	2	M1.pdf	https://www.k12videos.mit.edu/videos https://www.youtube.com/watch?v=WdEac7IfQb8 https://www.youtube.com/watch?v=6VqS8c_eC0U	https://www.eu-robotics.net/ http://images.studica.com/resources/Robots_and_Machines_in_our_Surroundings.pdf

Figure 3: Lesson Plan – Introduction

Section 2: Scratch programming

At the second section "Young Mechanics" realize that programming ability is necessary in order to give specific orders and directions to an avatar. Scratch is the program that is selected for 8-12 years old kids. Scratch is designed and maintained by the Lifelong Kindergarten group at the MIT Media Lab. By Scratch, students can program their own interactive stories, games, and animations — and share their creations with others in the online community. Scratch helps young people learn to think creatively, reason systematically, and work collaboratively — essential skills for life in the 21st century. [12] While Scratch is primarily designed for 8 to 16 year olds, it is also used by people of all ages, including younger children with their parents. The workshop starts with four lessons on Scratch programming providing a fun way to learn more and more. At this first level students learn designing scenes and sprites as well as basic commands like controls (if, repeat, for, wait), events (when key pressed), sensing (touching, counting distance). At the next level the difficulty can increase so as to keep the kids engaged and fully involved with the projects.

Figure 4: Student Worksheet S3- Section: Scratch

Section 3: Lego Wedo2

At the third section Lego bricks bring abstract concepts to life with a fun, hands-on approach that really engages students. LEGO bricks turn ideas into real models that can be touched, described, and innovated upon. Then they combine applied engineering and integrated technology in order to implement their project. The suggested kit for this part is Lego Wedo2 Core Set. The set is delivered in a storage bin along with sorting trays, labels, a Smarthub, a Medium Motor, Motion Sensor, a Tilt Sensor, and enough building elements for a group of maximum 4 students. The Smarthub is an electronic system based building brick that has built-in Bluetooth low energy to wireless connect to the control software/App. It is powered from a battery source, 2 AA batteries or a rechargeable battery pack. It has two I/O ports to connect to external motors, sensors or any new component belonging to the LPF 2.0 system. It has a built-in RGB light surface that can show up to 10 different colors that be controlled by the software/App. Lego bricks and Wedo2 helps make abstract S.T.E.M concepts tangible by taking teaching out of the textbooks and putting it into the hands of your students. Create a better understanding of S.T.E.M subjects while building 21st-century skills. [13].

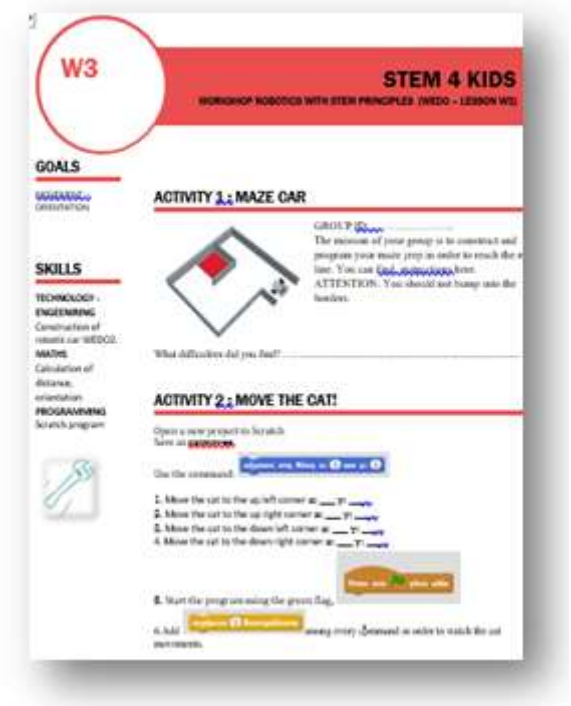

Figure 5: Student Worksheet W3- Section: Wedo2

Section 3: Arduino +S4A

At the last section programming Arduino microprocessor is difficult for 8-12 years old kids but S4A (Scratch for Arduino) can transform this hard task into an engaging and inspiring learning procedure. S4A is a Scratch modification that allows for simple programming of the Arduino open source hardware platform. It provides new blocks for managing sensors and actuators connected to Arduino. Arduino objects offer blocks for the basic microcontroller functionalities, analog and digital writes and reads, and also for higher level one such as manage standard and continuous rotation servomotors. In S4A, an Arduino board is represented by a special kind of sprite. The Arduino sprite will automatically find the usb port where the board is connected. It is possible to connect to multiple boards at the same time by just adding a new Arduino sprite. [14]

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. [15] Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs.

The software, too, is open-source, and it is growing through the contributions of users worldwide. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. That is the reason that is selected for the needs of STEM4KIDS workshop.

Built-in assessment resources, students' worksheets, and digital documentation tools are also implemented. Teacher guides with classroom management tips and tricks make getting started easy.

From the above description it is obvious that the whole workshop structure is designed so that "Young Mechanics" can move step by step deeply into the digital world of educational robotics, programming and microprocessor applications. S.T.E.M4KIDS workshop is making the subjects tangible, collaboration is fostered and self-guided learning is encouraged by creating enthusiasm and giving students the tools they need to overcome challenges.

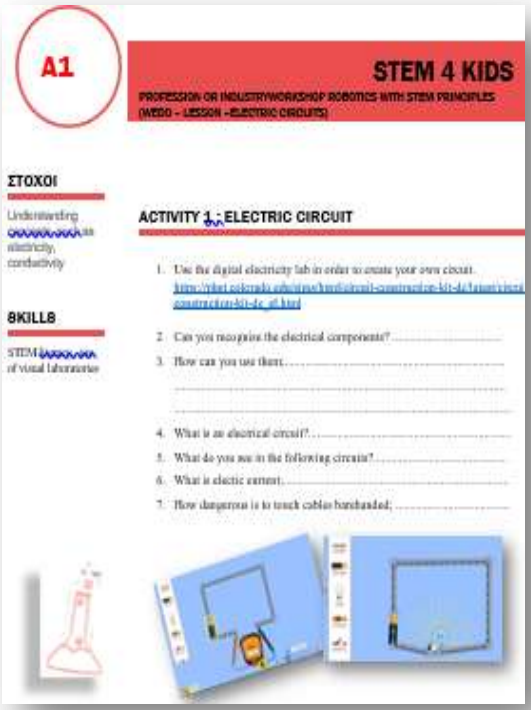

Figure 6: Student Worksheet A1- Section: Arduino

The designing, organization and implementation of an educational workshop is done taking into account the theoretical educational models of constructivism and the approach to teaching S.T.E.M education is integrated, which is the most successful model according to world – wide researchers. [9], [10] (Laboy-Rush, 2011; Wang et al., 2011). [11] , [8].

1.3 DESIGN AND DESCRIPTION OF EDUCATIONAL ESCAPE ROOM

At the end of the seminar students have to face a new challenge, taking part into an interesting and innovative escape game. An escape room game is being played in a uniquely themed game room where the team of young participants works together, solving puzzles, finding clues, opening locks and secret doors in order to complete the mission and escape the room in less than 60 minutes The theme is chosen from mythology so the kids are familiar with it. This is set to an appropriate place with stage effects and theatrical scenery and sounds.

Adam Clare, is Professor of Game Design and Director of Interactive Education at George Brown College, and Web producer of experience escape rooms (LA, SCRAP Room Escape, Escape Games, Inside Out Claustrophobia) argues that the first step in designing a room escape is the choice of a topic, which creates the proper framework and helps "the metaphor of narration and justifies the challenges that players should experience". In his view, the topic should not be limited to physical space, where the game takes place, but it can, and probably should be spread in the field before the game or even in the entire available space that is allowed at a time. [16]

An escape room for educational purposes, is designed utilizing the knowledge gained from the seminar STE4MKIDS, laying thereby the foundation of new young "Scientists in action ", who need to understand the natural world around them intuitively, in a playful manner, but the school framework does not allow them to.

The Escape room is called: "Theseus' adventures till Crete". Escaping of these challenging rooms requires all the elements of good teamwork. Keen observation, problem-solving skills, and proper communication are essential in order to beat the clock following the steps of Theseus. It is the perfect activity for corporate groups to come together for one unique and engaging purpose. Build up the young team's ability to problem solve together and at the same time be entertained in the process. It contains 5 missions that have to be accomplished using the knowledge gained of the STE4KIDS seminar

Five different rooms are designed using automatic constructions, secret codes, vaults, padlocks, hidden clues and a series of challenges and interactive puzzles in order to move through the rooms and escape. The whole concept provides safe, challenging and an incredibly fun experience for groups of children 8-12 years old, or even older.

Initially the players informed about the scenario and then wearing Virtual Reality goggles travel into the past. Because young children like disguises group leader could be given a cloak, sword and sandals left to Theseus by his father Aegeus. Some items could be hidden there in order to help the first mission. Theseus started his trip from Troezen with only one great dream: to meet his father Aegeus, king of Athens. On the journey he encountered many adventures like Perifitis the mugger. At the Isthmus of Corinth, he killed Sinis, called the Pine Bender because he killed his victims by tearing them apart between two pine trees. Later he slew Procrustes, who fitted all comers to his iron bed by hacking or racking them to the right length. On his arrival in Athens, Theseus found his father married to the sorceress Medea, who recognized Theseus before his father did and tried to persuade Aegeus to poison him. Aegeus, however, finally recognized Theseus and declared him heir to the throne. In the end, using Ariadne's help Theseus killed the Cretan Minotaur, half man and half bull, shut up in the legendary Cretan Labyrinth full of complex corridors and returned as a hero to Athens.

1st MISSION: Perifitis the mugger

The group of kids entering the first room that looks like the inside of the cave are informed by the speakers of the area for any details of the first mission. It is useful for both the background music and dim lighting in the cave to create an atmosphere of mystery. The pieces of the map that will lead them to seek out Perifitis' metal bat, in whose interior they will find a numeric combination to the lock that opens the door to the next room. The pieces of the puzzle are hidden around the room space.

2nd MISSION: Sinis, the Pine Bender

In the 2nd room the team is looking for 2 keys that can be traced with the help of a custom magnet into a robotic vehicle. Branches are blocking the entrance to the next room. The vehicle is half-finished and the kids must complete its construction, as they learned at the S.T.E.M4KIDS seminar. The instructions as well as LEGO pieces that are missing are hidden in the field (covered by branches, into glasses of water or cook wares with flour etc.

3rd MISSION: Procrustes

In the 3rd room kids are driven into a tunnel and enter into a space with Procrustes' bed. Their purpose is to mount the bed in accordance with the instructions that will find out in a frame on the wall. With the help of a measure they assemble the PVC pipe pieces they found on the floor so the visitor Theseus to fit exactly. When they finish an actor is entering the space impersonating Procrustes and requests one of the kids to lie in bed so as to measure if it fits exactly. If the mission is successful, then he opens the door for the next room.

4rd MISSION: Sorceress Medea in Athens

In the 4th room children are placed in the workshop of the sorceress Medea (wife of Aegeas) that manufactures hemlock to poison Theseus. According to the scenario she is so exhausted that she falls asleep Kids mission is to prepare the antidote without waking her up. In the space there should be an hourglass in order to know how much time is left until Medea wakes up. Other useful elements are a ring with a hidden message on it , a compass, an old book with magic spells that misses a ripped page, a bottle with colored water (conium). These clues can lead the team to a half-finished project in Scratch. When it is completed then one vehicle will be driven towards a balloon full of water and will burst it resulting in water contain dropping inside the Grail and activating the dry ice. Then the antidote is ready and the sorceress Medea has lost her chance to poison Theseus. The key is hidden under the dry ice and reveals when the ice is evaporated.

5th MISSION: Theseus and Minotaur During the 5th mission children must lead a robotic maze vehicle through the labyrinthine corridors in Minotaur location. But firstly they have to unlock the computer in order to complete scratch commands. They only have 4 trunks with a name written on them. They should decide which one to use according to their history knowledge. This is the last mission that kids have to accomplish. The detailed instructions given to the team are below:

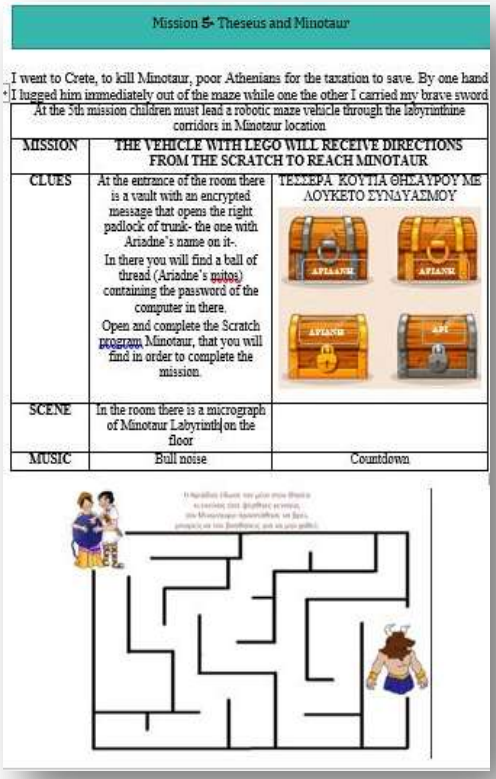

Figure 7: 5th Mission of Theseus in the escape room.

The design of the educational escape room, in accordance with the international practice, followed the Breakout Edu model and the Experience Pyramid model. [17],[18].

II. Conclusion

The educational Robotics is an innovative way to increase the attractiveness of science education and scientific careers in the eyes of young people. The robotic embraces many different sectors through innovation such as physics, mathematics, computer science, industrial design, as well as arts or social sciences. As an interdisciplinary field, promotes the development of systems thinking and problem solving. In addition, it cultivates various areas of application such as teamwork, creativity and entrepreneurial skills required for designing, programming and using of robots and robotic services. Robotics confronts students in the four areas of science, technology, engineering and mathematics (S.T.E.M) through the design, creation and programming in tangible objects for creating personal items facing real social needs.

The study and design of the S.T.E.M4KIDS workshop was based on the achievement of learning objectives through S.T.E.M robotics education corresponding to the age group 8-12 years, without prior knowledge of mechanical or electronic, as mentioned in the above chapters. The curriculum of the course S.T.E.M4KIDS gives mainly emphasis on the engineering design process in the section of Robotics (1. Work plan 2. Brainstorm 3. Design 4. Construction 5. Test 6. Redesigning and 7. Sharing). Thus enhancing learning skills algorithmic thinking as defined by ISTE and CSTA [19] including additional skill though as confidence in dealing with complexity, perseverance when working with difficult problems, capacity to deal with open problems, to communicate and to cooperate with others in order to achieve a common goal.

In addition to the ability of solving puzzles and missions of escape room highlights in an experiential and playful way the exploiting of the knowledge acquired during the conduct of the seminar. Through this challenging trip learning expands students' skills, supports the educational objectives and stimulates curiosity on learning and deepening in the field of Robotics and S.T.E.M

In conclusion this study reveals that an educational robotic course following S.T.E.M principles can support the goals of S.T.E.M education, broadens 21st century students ' skills, cultivates motivation for learning and prepares the problem solvers of tomorrow.

All of this can really engage kids through the stimulating, inspiring escape room game that converts the whole educational procedure to an exciting trip to adventure.

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References

[1]. European Commission, Brussels, 10.6.2016 COM(2016) 381 final .Communication from the Commission to the European Parliament, The Council, The European Economic and social committee of the regions. A new skills agenda for Europe. "Working together to strengthen human capital, employability and competitiveness. {SWD(2016) 195 final}."
[2]. https://obamawhitehouse.archives.gov/the-press-office/2013/04/22/remarks-president-2013-white-house-science-fair
[3]. http://aesop.iep.edu.gr/sites/default/files/fysiki_02. pdf
[4]. Οικονόμου Βασίλης https://economu.wordpress.com/εκπαιδευτικό-υλικό/S.T.E.M/
[5]. American Institutes for Research (AIR), U.S. Department of Education- The S.T.E.M 2026 VISION
[6]. European Schoolnet http://www.eun.org/el/focus-areas/stem
[7]. Bradley S Barker, Gwen Nugeut , Neal Gradgenett &Viecheaslav I. Adamchut, Robots in K-12 Education. A new technology for learning IGI, Global ,2012 (p3)
[8]. Γαβριηλίδου Μαρία Ελένη ΑΠΘ, Τμήμα Πληροφορικής, Πτυχιακή Εργασία Α.Ε.Μ 259 Αρχές Σχεδίασης Εκπαιδευτικών Παιχνιδιών (Design Principles for Educational Games)
[9]. Laboy-Rush, D. (2011). Integrated S.T.E.M education through problem-based learning. [White paper]. Retrieved from http://www.slideshare.net/dlaboyrush/integrating-S.T.E.M-educationthrough-project-based-learning
[10]. Wang, H., Moore, T., Roehrig, G., & Park, M. (2011). S.T.E.M integration: Teacher perceptions and practice. Journal of Pre-College Engineering Education Research, 1(2), 1-13.
[11]. The Library of Congress http://www.loc.gov/rr/program/bib/ourdocs/Morrill.html
[12]. SCRATCH GUIDE http://www.scratchplay.gr/scratchguide_el.pdf
[13]. LEGO EDUCATION https://education.lego.com/en-us/elementary/intro/S.T.E.M
[14]. Scratch for Arduino http://s4a.cat/
[15]. https://www.arduino.cc/en/Guide/Introduction
[16]. Clare, A. 2015. Escape The Game: How to make puzzles and escape rooms. Wero Creative Press.
[17]. Outi Heikkinen ,Julia Shumeyko Designing an escape room with the Experience Pyramid model (Degree programme Experience and Wellness Management
[18]. Tarssanen, S. 2009b. Handbook for Experience Stagers. 5th Edition. LEO, Lapland Center of Expertise for the Experience Industry. Rovaniemi.
[19]. International Society for Technology in Education (ISTE) and Computer Sciene Teachers Association (CSTA). Operational Definition of Computational Thinking for K-12 Education. 2012 [cited 2014 February 15

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