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### Implementing Science Theater

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# Implementing Science Theater

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*"The wandering star within the play-of-time space has become exactly what it is: a planet. Cannot humans, too, first inhabit what their place is—within the play-of-time space? With nostalgia and the yearning for faraway places? Provided that adventure and the return home can still be distinguished from one another."* Kostas Axelos

## Abstract

Since 2006, we were implementing a numerous of educational projects on teaching Science - i.e experiments with low-cost materials, developing and using online scenarios, integrating embodied outdoor activities in our physics lesson and engaging the whole school in Interdisciplinary Astronomy Activities. The most fruitful one, in terms of motivating students, was science theater. Science theater - by doing research on scientific topics, writing down the script, organising a play and communicating our efforts - highlights the need of more and systematic (inclusive) thematic learning throughout school topics. Here we will present our last effort, giving a glimpse of our way of work, putting together document theater, science theater and science fiction.

## Keywords

document & science theatre; science fiction; inclusive education.



## Introduction

As early as the end of the 20<sup>th</sup> century, the need for significant changes in education became apparent. Three initiatives, from UNESCO (Delors et al., 1996), the OECD (Ananiadou and Claro 2009 ; OECD 2013b) and the European Commission (Gordon et al., 2009), opened the dialogue on changes in the education of developed countries. Since 2003, it is recognized by the Greek National Curriculum that "*the diverse social, political, economic and cultural conditions of our time have -as their main feature- the fluidity, which is intensified by the rapid scientific and technological development*" (National Curriculum, 2003). Moreover, the most recent Act of our Ministry of Education "*introduces a pilot action entitled "Skills' Workshops", which consists of the pilot addition, in the school program, of new thematic topics in order to enhance the cultivation of students' soft skills, life skills and technology & science skills*" (Act 4692/2020).

Recognising that 'STEM' skills and (rather 'essential' than) 'soft' skills (Cimatti, 2016 ; Mitchell et al., 2010) are becoming an increasingly important part of our students' education in today's globalised economy, we designed and implemented a numerous of educational activities and projects in Science (Nerantzis and Riviou 2015 ; Riviou 2015) based on scientific method (Feynman, 1963-5) and inquiry based science education learning IBSE, aka IBSE (Bogner et al., 2013) and in the context of EU funded projects (see <http://www.eun.org/projects/all>).

Let us refer below a few of our past educational activities that - in order to achieve the educational goals of each student, with any kind of difficulties (Nerantzis, 2016), educational interventions and modifications must be designed and implemented - took into account (a) the difficulty of students to connect basic concepts of science with mathematics representation and transfer of acquired knowledge in a different context (Padeliadou and Chideridou, 2013), (b) that students representations, which are universal, are difficult to be modified (Driver et al., 1994 ; Heywood and Parker, 2010) and (c) there are often difficulties in memory processes (short-term, working and long-term memory) (Panteliadou and Botsas, 2007). For example, students with autism spectrum disorders are strong visual learners and may have more difficulty processing information through the verbal path alone (Goldstein and Naglieri ,2013).

## Past educational activities

A didactic proposal introducing the concepts of *energy flow, wave, oscillation and disorder*. In the context of Pathway project (Nerantzis et al., 2013). The "7E" IBSE model has been used: elicit – engagement – exploration – explanation – elaboration – evaluation – extend. The proposal is



supported by three (3) worksheets – one for every didactic hour. This, extensive, educational scenario includes the “*water cycle*  $\approx$  *DC electrical circuit*” and “*matter*  $\approx$  *energy*” analogies, energy chains, storyline, scientific questions and experimental inquiries on flow(s), wave(s), oscillation(s) with experimental setups and 1D, 2D and 3D pendulums, ICT etc.. The activities proposal can be found also on UDLnet inventory (here <https://bit.ly/UDLnet-2>, a free registration is required to access the resources of the inventory).



Fig.1 The poster of experiments with low-cost materials (left). The setting for an oscillating object: ping pong ball - empty inside or with certain amount of water (center). The 'Waves' poster (right). Credits Nerantzis et al., 2018.

On supporting and teaching visual impaired pupils (VIPs) we used firstly Braille Textbooks. Notes were given either on printed pages in Braille or in the form of electronic texts as the use of a smartphone, using access & screen recognition applications, such as NVDA, is extremely helpful. Tactile material was made on heat-sensitive swell paper, which was given to our students. A typical example is the Periodic Table which our students had never 'seen' (See Figure 2) In addition, using 3Doodler Start (3D Pen for Kids) we were able to create instant tactile designs and shapes. 3Doodler Start was particularly useful in the Biology class as it can directly attribute shapes and functions such as the heart, kidneys, cells, etc., giving immediate feedback to our students (See Figure 3). Note that 3Doodler Start 'tip nose' is not very hot (unlike the 3Doodler whose 'tip nose' is burning!) So the shape can be touched and traced - something necessary for students to immediately produce a tactile design (Nerantzis et al., 2018).



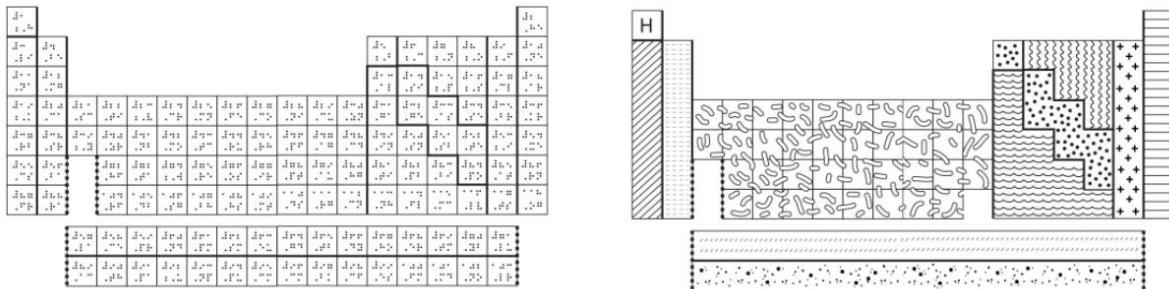
**1.**


Fig.2 Using Tactile Graphic Image Library's file for the Periodic Table (<http://imagelibrary.aph.org/aphb/>) we fill up the 112-118 elements (left) and, we created a Periodic Table highlighting the Group of elements (alkaline, halogens e.t.c.) (right). All the tactile material is available here <http://bit.do/TPT-2>. Credits Nerantzis et al., 2018.



Fig.3 Using 3Doodler Start (left and center). A tactile human heart with 3Doodler Start (right). Credits 4myfileswordpress.com

Our students participated in live online connections with Dr. C. Penzo in Paris, with D. Bożek-Andryszczak and Dr. K. Leptokaropoulos in Krakow, CMS experiment at CERN and the IceCube experiment at South Pole (see here <http://bit.do/issc-2017>). Tactile material was created so that visually impaired students could participate the presentation. The action was communicated via blog and posters and, under the title 'Inspiring Students & Science Careers' (see <http://bit.do/issc-2017>), was distinguished as one of the ten (10) best actions in the European competition "All-STEAM, AllStars" (see here <https://bit.ly/stemalliance-2017>).



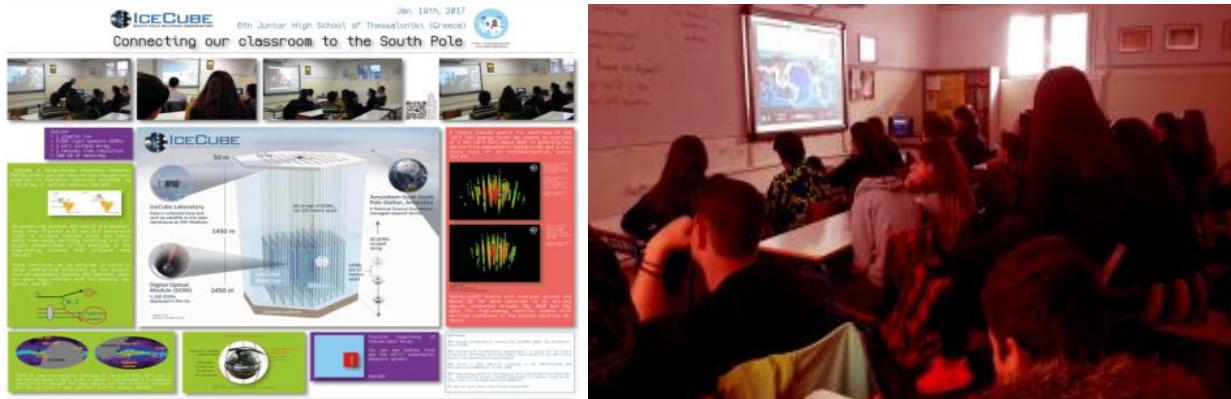


Fig. 4 The poster for our connection with Ice Cube at South Pole (left). During the connection with D. Bożek-Andryszczak and Dr. K. Leptokaropoulos at Krakow (right). Credits 4myfileswordpress.com

All teachers and students of the school were involved (using a 'circular' program): (a) in a STARLAB mobile planetarium activity on secrets of the night sky, (b) in the projection (with comments) of the following videos: Journey to the end of the universe, Rosetta update, The Solar System, Ambition the film and (c) in activities such as Meet our home, Meet our neighbors - from astroedu repository. We were pleased to see these activities as a part of "Join the Cosmic Light Edu Kit / International Year of Light 2015 program" (see <http://wp.me/p6Hte2-1l>). An Abstract an a poster were presented at the session in GIFT (Vienna, Austria - see <https://bit.ly/GIFT-2016>).



Fig.5 From the 'Meet our neighbors' activity (left). From the STARLAB mobile planetarium activity (center). From the video session (right). Credits: eidgymthess.wordpress.com

## Science Theatre at Schools

The scientific initiative and implementation of 'Learning Science Through Theatre' (LSTT, <http://lstt.eu>), by ScienceView, in the context of being motivated, being supporting and developing our activities on integrating Science Theatre (Smyrnaiou et al., 2017) in-school or (mostly) in after- school extra-curricular projects. Right above you can see the 'evolution' of our activities, from embodied outdoor activities, to science theatre, to document - science (and science fiction) theatre. We will also try to present our last effort, giving a glimpse of our way of work, putting together document theater, science theater and science fiction. We will present,



in short, the 'steps' of our last science theatre activity in terms of scientific method and IBSE, that also integrates document theater (Snyder-Young, 2013) and science fiction (Raham, 2004 ; Brotherton, 2017)

### 'Laser & Bubbles' - 2015

Under the guidance of the science's teacher, the students, at Public Special Gymnasium of Thessaloniki, are acting like photons undergoing changes in their (light) path via two different materials. The analogy demonstrates lights capability to ...jump on atoms, in order to pass through a crystal material, just like we jump on rocks to pass across a river. The analogy also demonstrates how a non-crystal material traps light – just like we will fell into the river's rock end – see <http://wp.me/p3oRiZ-hu>. We also created a poster presentation for CREAT-IT 2015 "Creativity and education futures", see Figure 6 (Nerantzis & Mandiliotis, 2015).

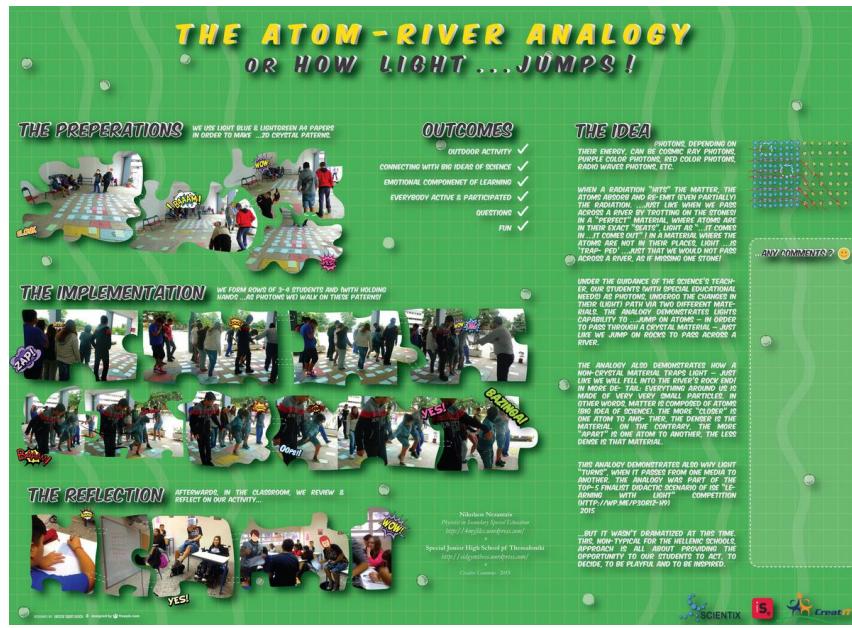


Fig.6 The poster for the atom ~ river analogy, presented at CREAT-IT 2015 "Creativity and education futures" at Ellinogermaniki Agogi. Credits 4myfileswordpress.com

### 'Jake in the Sea' - 2016

In the context of the School Activities Program on Environmental Education, at Public Special Gymnasium of Thessaloniki, and with the leading of Dr. Eleftheria Baka, we organised a theatrical performance based on the book "Jake and the Sea" by Yo Someyi (and we special thanks to Modern Horizons Publications). Throughout this action, we emphasized the value of biodiversity and our, in-danger, environment. In addition, Theatrical Education was used as a means of enhancing students' self-perception and self-esteem. The play was presented to the school



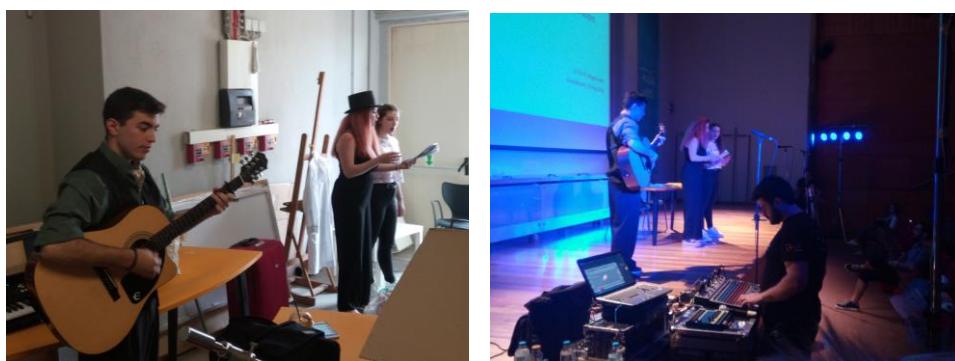
community and participates in the action "Learning Science Through Theater" for the school year 2015-2016.



Fig.6 From our play "Jake and the Sea". Credits 4myfilewordpress.com

#### 'Scientists in Yesterday, Today, Tomorrow' - 2018

At 1<sup>st</sup> Lyceum of Nea Michaniona (Thessaloniki), in the context of a School Activities Program on Environmental Education, along with the co-operation and support of the colleagues M. Masouti & A. Giannaki, we foster the making of a theatrical performance based on the lives of A. Einstein, M. Curie, Ch. Darwin, M. Lamarck, S. Gluecksohn-Waelsch. The students wrote the play and they presented it at LSTT's event in Thessaloniki (see <https://bit.ly/lstt-18-b> and <https://bit.ly/lstt-18-a>). Let us note that this project was a large-scale production with a lot of extra hours



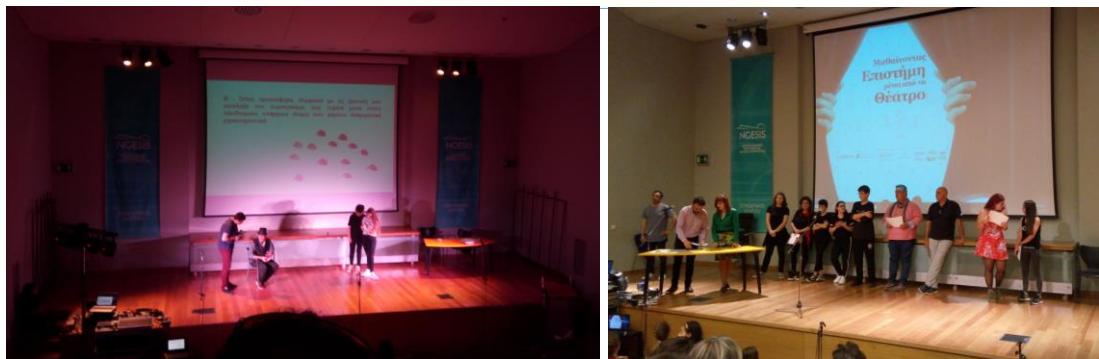


Fig.7 From our play “Scientists in Yesterday, Today, Tomorrow” in LSTT event, at NOESIS, Thermi, Thessaloniki. Credits 4myfileswordpress.com

### ‘Betelgeuse, a journey to the unknown’ - 2020

This year, at 1<sup>st</sup> Gymnasium of Thermi (Thessaloniki), and after the lockdown because of the COVID-19 pandemic, we manage to deliver a video of our theatrical play, using also green screen technique. We are also presenting, in short, the ‘steps’ of our activity in terms of scientific method and IBSE

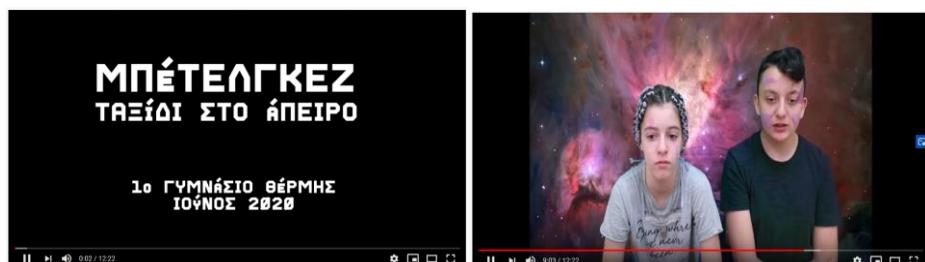


Fig.8 From this year’s - Snapshots from the video. Credits 4myfileswordpress.com



<b>SCIENTIFIC METHOD</b>	<b>'BRIDGES'</b>	<b>IBSE</b>
	<ul style="list-style-type: none"> <li>• We present anecdotes about scientists' lives. For example Did really fell an apple in Newton's head? Why Coulomb's equation is 'so similar' with Newton's? Did, really, Galileo let objects to free fall from the Pisa tower? (Martínez, 2011)</li> <li>• We also gave to our students the links (LSTT, <a href="http://lstt.eu">http://lstt.eu</a>) of former science theatre plays, in order to see previous and current students' plays.</li> </ul>	<b>Curiosity</b>
<b>Question</b>	<ul style="list-style-type: none"> <li>• Three Questions raised, during our initial discussion:</li> </ul> <p>Q#1 How common or how extreme are the lives of scientists?</p> <p>Q#2 What about biases? Our school textbooks are 'full' of men scientists</p> <p>Q#3 On how we will implemented such a project.</p>	<b>Question</b>
<b>Hypothesis</b> <b>Prediction</b>	<ul style="list-style-type: none"> <li>• Students present their (initial) ideas, proposals and explanations.</li> </ul>	<b>Explanation</b> <b>Prediction</b>
	<ul style="list-style-type: none"> <li>• Our students had to read scientific books (e.g. Segre, 1997 ; Segre, 2001 ; Helge, 2004) and scientific papers, searching also the internet for other (reliable) resources with documents about the scientists' lives.</li> <li>• We 'focused' on Astronomers and the current phenomenon of Betelgeuse's dimming, the public's 'agony' to observe a supernovae, and the scientists answers (see here <a href="https://bit.ly/On-Betelgeuse">https://bit.ly/On-Betelgeuse</a>).</li> <li>• Special interest on future travels and science fiction (Brotherton, 2017).</li> <li>• We decided to use 'last year's' scenario 'Betelgeuse, a journey to the unknown'.</li> </ul>	<b>Investigation</b>
<b>Testing</b>	<ul style="list-style-type: none"> <li>• Preparation for using green screen technique - very intriguing and 'novel' use of smart phones!</li> <li>• After the re-opening of the school (because of the COVID-19 pandemic) we implement our play and took a video.</li> <li>• Video editing</li> </ul>	<b>Evidence</b>
<b>Analysis</b>	<ul style="list-style-type: none"> <li>• Our video can be found at LSST site and in an our blog post (<a href="http://wp.me/p3oRiZ-il">http://wp.me/p3oRiZ-il</a>).</li> <li>• This Article gave us the opportunity to communicate further more our work.</li> </ul>	<b>Communicate</b>



## Discussion

Education should prepare our students to face 'real' problems in their (after school) 'real life', 'equipping' them with new ways of thinking, with critical analysis, problem solving and decision making skills (Griffin and Care, 2015). The 'stiffness' of the school timetable leaves no room in order to properly integrate innovative teaching practices that would maximize active student engagement and creative interaction.

Moreover Heywood & Parker (2010) state that «there appears to be no study which found that a particular student's conception could be completely extinguished and then replaced by the science view. Indeed, most studies show that the same old ideas stay alive contexts. Usually the best that could be achieved was a 'peripheral conceptual change' in that parts of the initial idea merge with parts of the new idea to form some sort of hybrid idea». So, we need any help we can get, in order for our students to take part and succeed in learning. For example, classrooms (hallways, courtyards, etc.) arrangement can be designed so to promote 'new' learning practices (FCL, 2017; FCL, 2019) facilitating the need for an educational "shift" towards thematic learning and inclusion.

Our first aim should be to offer students educational activities that facilitate their learning and provide them with the necessary life experiences. Our second aim should be the design of inclusive innovative educational activities, a process that has been greatly facilitated by participating in networks, online communities, training competitions, workshops and summer schools. All of the above are objectives in an effort for inclusive education that we can develop through open access scholarships and open educational resources (UN 2014).

## Conclusion

The most fruitful activity, in terms of motivating students and actively engage them in innovative and inclusive science educational activities, was science theatre. Another important aspect was that the emotion component has also been integrated in learning (Hinton et al., 2008). Science theater - by doing research on scientific topics, writing down the script, organising a play and communicating our efforts - highlights the need of more and systematic (inclusive) thematic learning throughout school topics.

"For a long time" Boser states (at Paul, 2017) "people assumed that the ability to learn was the same thing as intelligence: If you're smart, you can learn". Offering all students suitable learning activities that promote their learning, *anyone can learn*. The educational results are -among other



things- the knowledge of the basic scientific ideas, the best relations between teachers-students and teachers-parents / guardians as well as strengthening the self-esteem of students (Riviou, 2015).

By designing medium & long term innovative educational activities, all of the above are objectives in an effort to inclusive education. By involving as many teachers as possible and supporting them in their teaching and providing a network of communication and feedback, we believe that we are contributing to the 'transformation' of the Curriculum. We believe that education in scientific thought and practice sets a broader framework for individual integration through the development of critical thinking and the incentive to act locally and globally, while aiming at human rights awareness, world peace, the preservation of human dignity and human dignity, a culture of peace (UNESCO, 2013).

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