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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 20th 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 ≈ DC electrical circuit*" and "*matter ≈ 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).

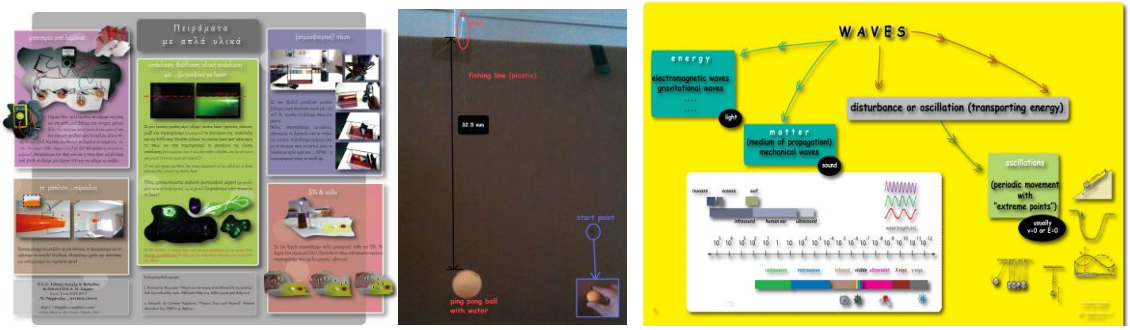

Fig.1 The poster of experiments with low-cost materials (left). The setting for an oscillating object: ping pong ball - empty inside or with certain amount of water(center). The 'Waves' poster (right). Credits Nerantzis et al., 2018.

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).

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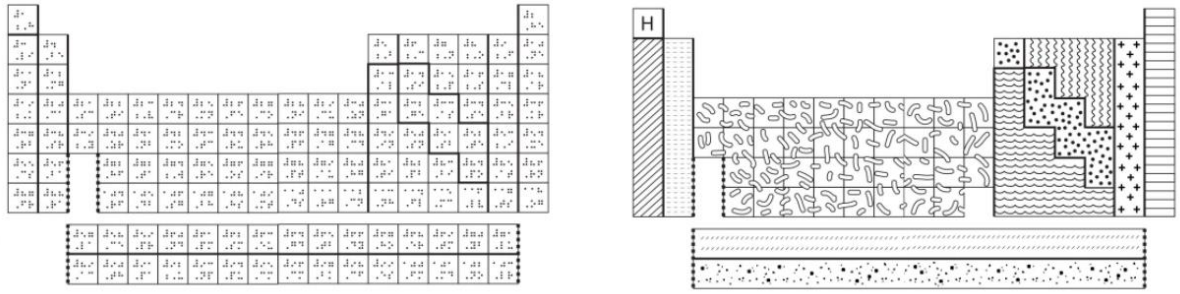

Fig.2 Using Tactile Graphic Image Library's file for the Periodic Table (http://imagelibrary.aph.org/aphb/) we fill up the 112-118 elements (left) and, we created a Periodic Table highlighting the Group of elements (alkalie, halogens e.t.c.) (right). All the tactile material is available here http://bit.do/TPT-2.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

Fig.3 Using 3Doodler Start (left and center). A tactile human hart 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).

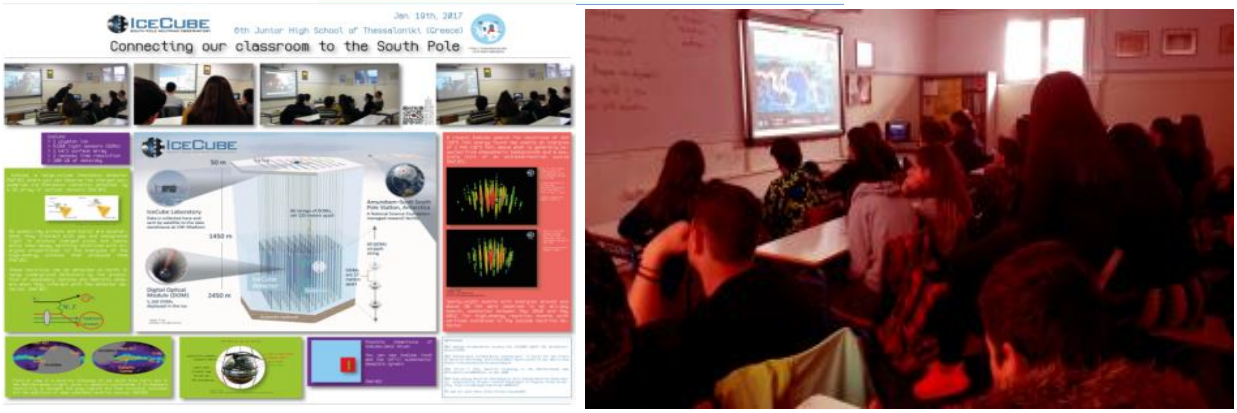

Fig. 4 The poster for our connection with Ice Cude at South Pole (left). During the connection with D. Bożek-Andryszczak and Dr. K. Leptokaropoulos at Krakow (right). Credits 4myfileswordpress.com

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/p6Hte2-1I). 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).

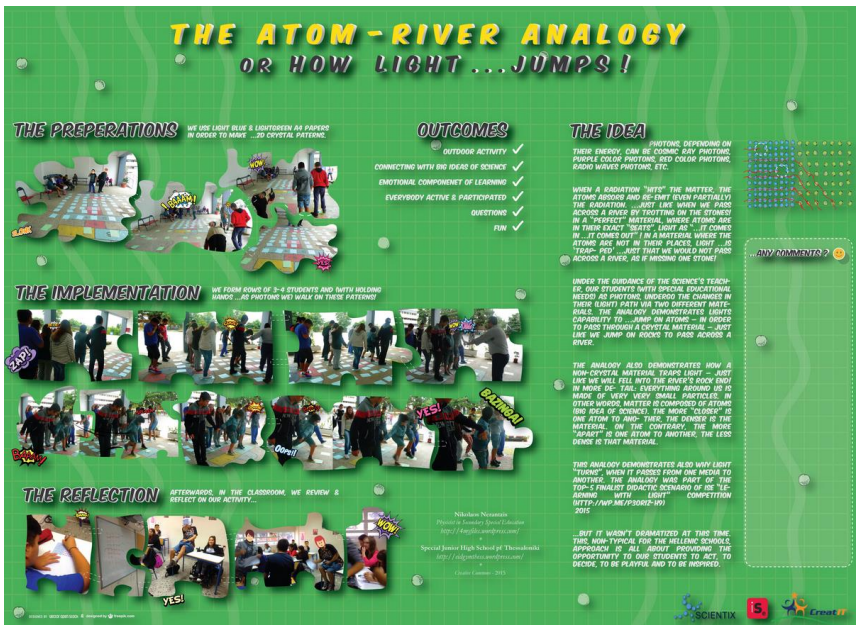

Fig.6 The poster for the atom ≈ river analogy, presented at CREAT-IT 2015 "Creativity and education futures" at Ellinogermaniki Agogi. Credits 4myfileswordpress.com

'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 4myfileswordpress.com

‘Scientists in Yesterday, Today, Tomorrow’ - 2018

At 1st 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

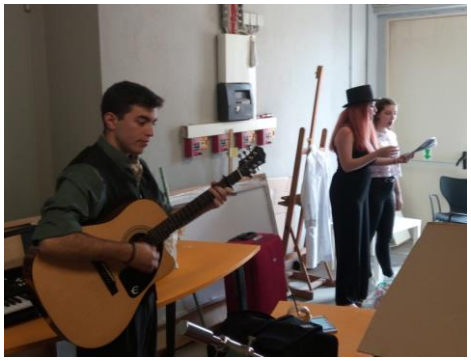


Fig.7 From our play “Scientists in Yesterday, Today, Tomorrow” in LSTT event, at NOESIS, Thermi, Thessaloniki. Credits 4myfileswordpress.com

‘Betelgeuse, a journey to the unknown’ - 2020

This year, at 1st 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

SCIENTIFIC METHOD	*'BRIDGES'*	*IBSE*
	• 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) • We also gave to our students the links (LSTT, http://lstt.eu) of former science theatre plays, in order to see previous and current students' plays.	**Curiosity**
Question	• Three Questions raised, during our initial discussion: Q#1 How common or how extreme are the lives of scientists? Q#2 What about biases? Our school textbooks are 'full' of men scientists Q#3 On how we will implemented such a project.	**Question**
Hypothesis **Prediction**	• Students present their (initial) ideas, proposals and explanations.	**Explanation** **Prediction**
	• 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. • 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 https://bit.ly/On-Betelgeuse). • Special interest on future travels and science fiction (Brotherton, 2017). • We decided to use 'last year's' scenario 'Betelgeuse, a journey to the unknown'.	**Investigation**
Testing	• Preparation for using green screen technique - very intriguing and 'novel' use of smart phones! • After the re-opening of the school (because of the COVID-19 pandemic) we implement our play and took a video. • Video editing	**Evidence**
Analysis	• Our video can be found at LSST site and in an our blog post (http://wp.me/p3oRiZ-iI). • This Article gave us the opportunity to communicate further more our work.	**Communicate**

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).

References

[1] Act 4692/2020, *in Greek*, Νόμος 4692/2020, *Αναβάθμιση του Σχολείου και άλλες διατάξεις*, ΦΕΚ 111, τ.Α΄,12-06-2020, Άρθρο 1,

[2] Ananiadou, K., Claro M., (2009), *21st Century Skills and Competences for New Millennium Learners in OECD Countries*, OECD Education Working Papers, No. 41, OECD Publishing. http://dx.doi.org/10.1787/218525261154, (retrieved 15 Jul. 2020).

[3] Bogner F.X. Sarah Schmid S., Dieser O., (2013), *PATHWAY, D3.3 The PATHWAY to Inquiry Based Science Education (UBT)*, Available at: http://pathway.ea.gr/content/pathway-booklet [Accessed 15 July 2020]. See also the rest PATHWAY's available at: http://pathway.ea.gr/pathway-resources.[Accessed 15 July 2020]

[4] Boser U. (2017) *Learn Better: Mastering the Skills for Success in Life, Business, and School, or, How to Become an Expert in Just About Anything*, ISBN: 1623365260,9781623365264, Rodale Books.

[5] Brotherton M., (2017), Science Fiction by Scientists – An Anthology of Short Stories, ISBN: 978-3-319-41102-6, DOI 10.1007/978-3-319-41102-6, Springer

[6] Cimatti B., (2016) *Definition, development, assessment of soft skills and their role for the quality of organizations and enterprises*, International Journal for Quality Research 10(1) 97–130 , DOI – 10.18421/IJQR10.01-05, ISSN 1800-6450 (retrieved 15 Jul. 2020). See also an interesting article available at: https://trevormuir.com/2019/02/07/soft-skills/ and another one available at: https://www.ihhp.com/blog/2019/08/29/soft-skills-are-the-essential-skills/. [Accessed 15 July 2020]

[7] Delors, J., Al Mufti, I., Amagai, I. A., Carneiro, R., Chung, F., Geremek, B., . . . Nanzhao, Z. (1996). *Learning: the treasure within; report to UNESCO of the International Commission on Education for the Twenty-first Century*. Paris: UNESCO. Available at: https://unesdoc.unesco.org/ark:/48223/pf0000102734. It is also available at: https://bit.ly/3gZHB2e or https://www.eccnetwork.net/resources/learning [Accessed 15 July 2020]. See also: Tawil S, Cougoureux M., (2013) *Revisiting 'Learning: The Treasure Within': Assessing the influence of the 1996 Delors Report, UNESCO* Education Research and Foresight, Occasional papers, ISBN 978-92-3-001132-1, Available at: https://en.unesco.org/themes/education/research-foresight/revisiting-learning. [Accessed 15 July 2020] Also available at: https://bit.ly/2Ztk5Vt at ResearchGate.net [Accessed 15 July 2020]

[8] Driver R., Squires A., Rushworth P., Wood V., (1994), *Making Sense of Secondary Science: Research into Children's Ideas*, Routledge.

[9] Future Classroom Lab (FCL) (2019) *Building Learning Labs And Innovative Learning Spaces, Practical guidelines for school leaders and teachers*, Available at: https://fcl.eun.org/guidelines, [Accessed 15 July 2020] See also a few interesting edutopia.org online articles available at: http://goo.gl/R6Rdv4, http://goo.gl/v3FMbp, http://goo.gl/IErjwN, http://goo.gl/pGzBo1 [Accessed 15 July 2020]

[10] Future Classroom Lab (FCL) (2017) *Guidelines on Exploring and Adapting Learning Spaces in Schools*, Available at: https://fcl.eun.org/guidelines,[Accessed 15 July 2020] See also a few interesting edutopia.org online articles available at:http://goo.gl/R6Rdv4, http://goo.gl/v3FMbp, http://goo.gl/IErjwN, http://goo.gl/pGzBo1 [Accessed 15 July 2020]

[11] Feynman R., (1963-5) *The Feynman Lectures on Physics*, *Basic Physics 2.1*, Available at: https://www.feynmanlectures.caltech.edu/, by the California Institute of Technology, Michael A. Gottlieb and Rudolf Pfeiffer [Accessed 15 July 2020]. See also Feynman's videos on scientific method available at: https://fs.blog/2009/12/mental-model-scientific-method/ . [Accessed 15 July 2020]

[12] Goldstein S. Naglieri J. A. (2013), Edt. *Interventions for Autism Spectrum Disorders Translating Science into Practice*, ISBN 978-1-4614-5301-7, Springer. p. 88.

[13] Griffin P., Care E., (2015) *Assessment and Teaching of 21st Century Skills - Methods and Approach*, ISBN 978-94-017-9395-7, Springer, p. Vii

[14] Helge K. (2004), *in Greek*, *Οι γενιές των κβάντων, η ιστορία της φυσικής του 20ου αιώνα*, ISBN13 9789607778819, Εκδότης ΚΑΤΟΠΤΡΟ.

[15] Heywood D., Parker J. (2010), *The Pedagogy of Physical Science*, ISBN 978-1-4020-5270-5, Springer, pg.12.

[16] Hinton C., Miyamoto K., Della–Chiesa B., (2008). *Brain Research, Learning and Emotions: implications for education research, policy and practice*. In European Journal of Education, 43(1).

[17] Martínez A.A. (2011) *The Truth about Darwin's Finches, Einstein's Wife, and Other Myths*.

[18] Mitchell G.W., Skinner L.B., White B.J. (2010) *Essential Soft Skills for Success in the Twenty-First Century Workforce as Perceived by Business Educators*, Delta Pi Epsilon Journal, v52 n1 p43-53 Win 2010, Available at: https://bit.ly/2CF5AoI [Accessed 15 July 2020]. See also two interesting articles available at: https://trevormuir.com/2019/02/07/soft-skills/ and https://www.ihhp.com/blog/2019/08/29/soft-skills-are-the-essential-skills/.[Accessed 15 July 2020]

[19] National Curriculum (2003), *in Greek, ΔΕΠΠΣ και ΑΠΣ Δημοτικού – Γυμνασίου, ΦΕΚ 303, τ.Β'/13-3-2003, Υπουργική Απόφαση Αριθμ. 21072α/Γ2*, Available at: http://www.pi-schools.gr/programs/depps/ [Accessed 15 July 2020]

[19] Nerantzis N., Afouxenidou A., Kazantzidis N., (2018), *in Greek,* Νεράντζης Ν., Αφουξενίδου Α., Καζαντζίδης Ν., (2018) Υποστηρίζοντας Μαθητές με Προβλήματα Όρασης, Πρακτικά συνεδρίου "Σχολείο ανοιχτό στις κοινωνικές και παιδαγωγικές προκλήσεις", ISBN: 978-960-89999-7-8, σελ .447-453. You can see this presentation in English Supporting & Teaching Visual Impaired Students, September 2018, DOI: 10.13140/RG.2.2.12244.65921, Conference: Scientix Conference 3, Available at https://www.researchgate.net/publication/327390053_Supporting_Teaching_Visual_Impaired_Students.[Accessed 15 July 2020]

[20] Nerantzis N. (2016a), *Students with any kind of difficulties*, Blog post, Available at: http://wp.me/p3oRiZ-oQ .[Accessed 15 July 2020]

[21] Nerantzis N. (2016b), I teach physics, Blog at Scientix blog, Available at: https://blog.scientix.eu/2016/08/i-teach-physics/ [Accessed 15 July 2020]

[22] Nerantzis N., Riviou K. (2015), *Science Teaching In Secondary Special Education*, Proceedings of the European Distance and E-Learning Network Open Classroom Conference, Athens, 18-21 September 2015, ISBN 978-615-5511-06-6. p. 19-31.

[23] Nerantzis N., Mandiliotis, S. (2015). *Lasers & Bubbles* Available at: http://wp.me/p3oRiZ-h9 [Accessed 15 July 2020]. See also the content available in https://eidgymthess.wordpress.com/2015/10/17/how-light-jumps/ and http://wp.me/p3oRiZ-h9 and http://wp.me/ p6Hte2-14 [Accessed 15 July 2020].

[24] Nerantzis N. (2014), *Posters as educational material for science education* [Secondary Special Education (Greece)] , 2nd Scientix Conference which took place on24 – 26 October 2014 in Brussels, Belgium, Available at: http://wp.me/p3oRiZ-cc [Accessed 15 July 2020]

[25] Nerantzis N. (2014), *in Greek*, Νεράντζης Ν., (2014), *Μία διδακτική πρόταση για τα απλά ηλεκτρικά κυκλώματα συνεχούς ρεύματος στις Φυσικές Επιστήμες (για τη Γενική & την Ειδική Αγωγή & Εκπ/ση)*, *in Greek*, Available at: https://bit.ly/38WjtLa at Photodentro repository [Accessed 15 July 2020]

[26] Nerantzis N., Bezergiannidou Aik., Mandiliotis S., (2013) *A didactic proposal to introduce the concepts of "energy flow", "wave", "oscillation" and "disorder"* . Available at: http://wp.me/p3oRiZ-1R and http://wp.me/p3oRiZ-1Q [Accessed 15 July 2020]. The didactical proposal was awarded with the 3rd prize at IEP's / PATHWAY's contest on IBSE entitled "The Pathway to Inquiry Based Science Teaching".

[27] OECD, (2013a). What is the impact of the economic crisis on public education spending? Education Indicators in Focus, Available at: http://www.oecd.org/edu/skills-beyond-school/EDIF%202013--N%C2%B018%20(eng).pdf [Accessed 15 July 2020]

[28] OECD, (2013b). PISA 2015: Draft collaborative problem solving framework. Available at: http://www.oecd.org/pisa/pisaproducts/ [Accessed 15 July 2020]

[29] Padeliadou S., Chideridou A., (2013). Being a Parent and not a Teacher: the Case of Specific Learning Disabilities, European Network about Parents in Education 2013, Vol. 7, No. 2, 91-99 ISSN: 1973 – 3518.

[30] Padeliadou & Botsas (2007), *in Greek*, Παντελιάδου Σ., Μπότσας Γ. (2007) Μαθησιακές Δυσκολίες - βασικές έννοιες και χαρακτηριστικά, Εκδ. Γράφημα. ISBN 978-960-89818-4-3,

[31] Paul (2017). *Discovering Better Ways To Learn As An Adult*, Available at: https://ww2.kqed.org/mindshift/2017/08/09/discovering-better-ways-to-learn-as-an-adult/ [Accessed 15 July 2020]

[32] Premaratna Nilanjana (2018) *Theatre for Peacebuilding*, ISBN 978-3-319-75720-9, https://doi.org/10.1007/978-3-319-75720-9, Springer Palgrave Macmillan

[33] Raham R. (2004) *Teaching Science Fact with Science Fiction*, ISBN: 1563089394,9781563089398, Libraries Unlimited.

[34] Segre E. (2001), in Greek, Ιστορία της Φυσικής (Πρώτος Τόμος) Από την πτώση των σωμάτων έως τα ραδιοκύματα, ISBN13 9789605310202, Εκδότης ΔΙΑΥΛΟΣ.

[35] Segre E. (1997), in Greek, Από τις Ακτίνες Χ ως τα Κουάρκ (Δεύτερος Τόμος), ISBN13 9789605310219, Εκδότης ΔΙΑΥΛΟΣ.

[36] Shomei Y., (2005) *Jake in the Sea*, *in Greek* Modern Horizons, Available at: http://s-orizontes.blogspot.gr/p/blog-page_4729.html , ISBN 960-7984-28-5, ISBN-13 2005 978-960-7984-28-9. [Accessed 15 July 2020]

[37] Smyrnaiou Z., Georgakopoulou E., Sotiriou M., Soptiriou S., (2017). *The Learning Science Through Theatre initiative in the context of Responsible Research and Innovation*, Systemics, cybernetics and informatics volume 15 - number 5 - year 2017 ISSN: 1690-4524, pg. 14-22.

[38] Snyder-Young D., (2013) *Theatre of Good Intentions - Challenges and Hopes for Theatre and Social Change,* ISBN 978-1-137-29303-9, DOI 10.1057/9781137293039, Palgrave Macmillan UK

[39] Toura (2017), *in Greek,* Τούρα Β. Χ., (2017). *Το πρόβλημα του Στέμματος*, Πρακτικά 9ης Διεθνούς Μαθηματικής Εβδομάδας, pg. 1055-1065

[40] UNESCO (2020) *Humanistic futures of learning: Perspectives from UNESCO Chairs and UNITWIN Networks*, ISBN 978-92-3-100369-1, UNESCO Education Sector, Available at: https://unesdoc.unesco.org/ark:/48223/pf0000372577/PDF/372577eng.pdf.multi [Accessed 15 July 2020].

[41] UNESCO, (2015). Embracing diversity: Toolkit for Creating Inclusive, Learning-Friendly Environments, ISBN 92-9223-032-8, Available at: http://unesdoc.unesco.org/images/0013/001375/137522e.pdf [Accessed 15 July 2020] .

[42] UNESCO, (2013). UNESCO's Programme of Action Culture of Peace and Non-Violence, A vision in action. Available at: http://unesdoc.unesco.org/images/0021/002177/217786e.pdf [Accessed 15 July 2020].