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New Scientific Approaches in the Construction of Meaning- The role of SWAF in Educational Design

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Abstract: The CREATIONS EU Program aims at creating and producing innovative teaching approaches being recognized as best practices in the European community, by observing the scientific framework of creativity and combining science and art. Responsible Research and Innovation and the principles of Science with and for Society act as a catalyst to new developments on Science Education. In this paper a demonstrator entitled "The Ghost Particle" is presented. This scenario is framed by the scientific, pedagogical framework of Effective Learning Environments, Creativity and Inquiry-Based Approach, the principles of the European Framework of Responsible Research and Innovation and is in line with the Creations Features and the principles of Science with and for Society.

Introduction

Worldwide challenges- A need for a renewed approach on Science teaching models

Over the last few years, there is a need both from political decisions and scientific paradigms to redefine teaching methods and reform educational systems. Nowadays educational systems but also all the members of a school community face lots of challenges (Smyrnaiou et al.2017, 2018). These challenges are firstly relevant to the educational practices and the purposes of school education and they can be categorized in: a) student lack of motivation, b) the scientific outflow, c) old or inappropriate teaching methods and d) difficult scientific notions.

Fostering the principles of Science with and for Society

Europe is confronted with major socio-economic challenges which significantly affect its common future (Hazelkorn et al.2015). These challenges must be tackled in innovative and multi-disciplinary ways based on research and new smart technologies, processes and methods, social innovation mechanisms, coordinated actions and policies that will anticipate or influence major evolutions for Europe. In order to understand, analyze and build inclusive, innovative and reflective societies, Europe requires a response which unfolds the potential of shared ideas for the European future to create new knowledge, technologies and capabilities (Rocard et al., 2007). The aim is to gain a greater understanding of the societal changes in Europe and their impact on social cohesion, and to analyze and develop social, economic and political inclusion and positive inter-cultural dynamics in Europe and with international partners (Owen et al., 2012). New theories in science education focus on developing a pedagogical framework that builds on the essential features of creative learning including exploration, dynamics of discovery, student-led activity, engagement in scientifically oriented questions, priority to evidence in responding to questions, formulations of evidence-based explanations, connection of explanations to scientific knowledge, and communication and justification of explanations. The Science with and for Society principles (SWAFS) are important in addressing the European societal challenges tackled by Horizon 2020 (European Commission, 2012) building capacities and developing innovative ways of connecting science to society. It will make science more attractive, increase society's appetite for innovation, and open up further research and innovation activities. It allows all societal actors (researchers, citizens, policy makers, business, third sector organizations etc.) to work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of European society.

The Responsible Research and Innovation Principles (RRI)

Responsible Research and Innovation (RRI) seeks to involve society in discussing how science and technology can help create the kind of world we want for generations to come. Education and innovation are the key aspects. The RRI framework promotes a transparent process where innovators need to be mutually responsive. With the aim of building an open classroom and innovation system of learning that tackles societal challenges. However, parallel to the large positive impact on human welfare and wellbeing, science and technology sometimes create new risks and ethical dilemmas. RRI involves society in discussing how science and technology can help create the kind of world and society we want for generations to come (Smyrnaiou et al, 2017, 2018). The principles of RRI, according to the European Commission are:

1. Governance addresses the responsibility of policymakers to prevent harmful or unethical developments in research and innovation.
2. Public Engagement implies that societal challenges should be framed on the basis of widely representative social, economic and ethical concerns and common principles on the strength of joint participation of all societal actors - researchers, industry, policymakers and civil society
3. Gender Equality addresses the underrepresentation of women.
4. Science Education faces the challenge to better equip future researchers and other societal actors with the necessary knowledge to fully participate and take responsibility in the research and innovation process.
5. Open Access states that RRI must be both transparent and accessible free.

6. Ethics respects fundamental rights and the highest ethical standards in order to ensure increased societal relevance and acceptability of research and innovation outcomes.

7. Sustainability: RRI indicators contribute to sustainable growth, as the scientific knowledge function as an ecosystem and its effects on well- being.

8. Social justice refers to a) the relationship between the researchers and the research subjects and b) the participation of social groups in benefits arising from research.

CREATIONs European Research Programme

In the framework of the European Project CREATIONS (http://creations-project.eu/), 16 partners from ten European countries develop creative approaches based on Art for an engaging science classroom. CREATIONS will establish a pan-European network of scientists, teachers, artists and students with the aim to improve the skills of young people in STEM (science, technology, engineering, mathematics) and to pool talent to scientific careers. The aims of CREATIONS Program are to give students and teachers opportunities to experiment with many different places, activities, personal identities, and people and simulate the work of the scientist and researcher in the classroom. It promotes a better understanding of how science work and enhances students' science related career aspirations. The program encourages and empowers science teachers to affect change by implementing and promoting inquiry-based science teaching and learning.

The Ghost Particle Demonstrator

This pedagogical scenario implements the Inquiry Based Science Education (IBSE) approach as an effective educational framework that aspires to attract students to an authentic scientific search and search process. In their effort students will be supported by computational models and simulations that contribute to the explanation and assimilation of demanding scientific concepts (Smyrnaiou, et al., 2012). Students' involvement with HYPATIA (Kourkoumelis et al.2014) enables them to study the fundamental particles of matter and their interactions through the observation of graphic representations / realizations of the products by particle collisions. These products are derived from "events" detected by the ATLAS detector in the new, world-wide, LHC accelerator located in Geneva at the European CERN Particle Physics Laboratory. Students 'commitment to role play / dramatization is based on physical representation of transport (Smyrnaiou et al.2016). In addition, the scenario was implemented through the application of the CLIL (Content and Language Integrated Learning) approach, with the main objective of highlighting the communicative approach (interactive approach, argumentation) adopted in foreign language teaching to discover learners' learning and engagement in scientific environments (Lemke,2009). Students act as scientists and develop research questions. In the context of the scenario, students are involved in manipulating experiments with computer-based simulations. The scenario has already been applied to a public school targeting high school students aged 12 to 14. Three teachers from different disciplines participated in the scenario implementation: (1) Physics teacher, (2) English teacher to implement the CLIL approach, (3) Artist Teacher. The script took place within four weeks - a two-hour lesson each week - and was completed with student presentations on the subject area of the history of particle physics, the principles of neutrinos and how the current detectors worked. In addition, the students created an artistic exhibition with their work on the arts to promote their perceptions of subatomic particles and their respective principles.

References

Hazelkorn, E., Ryan, C., Beernaert, Y., Constantinou, C. P., Deca, L., Grangeat, M. & Welzel-Breuer, M. 2015. Science Education for Responsible Citizenship: Report to the European Commission of the Expert Group on Science Education.

Kourkoumelis, C. and Vourakis, S. 2014. HYPATIA-An online tool for ATLAS event visualization. Physics Education, 49, (1), 21-32.

Lemke, J.L. 2009. Teaching All the Languages of Science: Words, Symbols, Images, and Actions.

Owen, R., Macnaghten, P., & Stilgoe, J. 2012. Responsible research and innovation: From science in society to science for society, with society. Science and public policy, 39(6), 751-760.

Rocard, M., Csermely, P., Jorde, D., Lenzen, D., Walberg-Henriksson, H., & Hemmo, V. 2007. Science Education NOW: A renewed pedagogy for the future of Europe, Brussels: European Commission. Luettu.

Smyrnaiou, Z., Moustaki, F., Yiannoutsou, N., & Kynigos, C. 2012. Interweaving meaning generation in science with learning to learn together processes using Web 2.0 tools. Themes in Science & Technology Education, 5(1/2), 27-42.

Smyrnaiou Z., Georgakopoulou E., Sotiriou M., Sotiriou S. 2017a. The Learning Science Through Theatre initiative in the context of Responsible Research and Innovation. Journal on Systemics, Cybernetics and Informatics (JSCI), 15 (5), 14-22.

Smyrnaiou Z., Sotiriou M., Sotiriou S. & Georgakopoulou E. 2017b. Multi- Semiotic systems in STEMS: Embodied Learning and Analogical Reasoning through a Grounded- Theory approach in theatrical performances. WSEAS transactions on Advances on Engineering Education, 14, 99-114.

Smyrnaiou, Z., Sotiriou, M., Georgakopoulou E., Papadopoulou, E. 2016. Connecting Embodied Learning in educational practice to the realization of science educational scenarios through performing arts, International Conference "Inspiring Science Education", Athens.

Smyrnaiou Z., Georgakopoulou E., Sotiriou M., Sotiriou S. 2018. Constructing Scientific Notions: Students' and Teachers' Conceptual Change through a Responsible Research and Innovation Initiative, Co-Create! 2018, Co-creation of curricula, tools and educational scenarios for building soft competences for personal development, and employability, Science Centre AHHAA in Tartu, Estonia.

The Directorate-General for Research and Innovation of the European Commission. 2012. "Responsible research and innovation - Europe's ability to respond to societal challenges".