BIOS POLICY BRIEF

Bioinformatics and Computational Biology Knowledge and Skills Enhancement as a step towards responsible citizenship

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Content

Robust culture, knowledge and skills in Computational Sciences – namely in medicine and molecular biology – and suitable strategies for disseminating validated information are critical pillars against anti-science social and economic-driven activities and against fake-beliefs. Bios Project now has a coherent third year plan to lead to success and to search financial sustainability outside the lifetime of the project

1. Introduction

BioS project aims to act as a "policy entrepreneur" in support of the use of Computational Biology by medical doctors in the provision of healthcare services, beyond the national borders of the eight specific EU member-states. The Bios Project and the developed course have the potential of becoming mainstreamed and giving input for improving education and training systems. Accordingly, future outcomes and results from its implementation in most or all EU Countries (in the framework of foreseen sustainability and exploitation) can feed into the Open Method of Coordination in the fields of Education and Training, as well as in Social Policy, for most or all EU Member-States.

Debunking is nowadays a critical aspect of science and science dissemination. If dissemination actions are not appropriate and accurate, communications may backfire – increasing an audience's long-term belief in fake-science and fake-news. Backfire effects can occur if a message spends too much time on the negative case, if it is too complex, or if the message is unnecessarily threatening. Robust culture, knowledge and skills in Computational Sciences – namely in

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medicine and molecular biology – and suitable strategies for disseminating validated information are critical pillars against anti-science social and economic-driven activities and against fake-beliefs.

The BioS Project creates a broad and sustainable informed network of interested parties and stakeholders, spanning from the national to the international level, thus generating a wide, long-term, systemic impact. All geographical levels will benefit from such outlined multi-stakeholder cooperation, for allowing the promotion of Bioinformatics literacy, knowledge and skills and its application in the delivery of healthcare services by medical doctors. The impact on professional behavior will include the enhancement of data-driven-innovation mind-set, networking, synergies, and exchanges. The EU and national levels of health professional settings will improve their competence, export potential, promote innovation, exchange best practices and mutual learning on change-driven challenges, equipping end-users with high quality knowledge and skills and with the ability of using e-learning sustainable approaches and mechanisms that are even more complex.

The Bios Project system will then be integrated into local high-value civic and enterprise infrastructures to implement each application to maximize exploitation potential. The support of these diverse applications, through a common open source code-base as well as a unified infrastructure, i.e. the friendly platform chosen and the architecture of the Bios Course, is a unique benefit of the project. Bios Project will pave the way for wider adoption of our system in products that seek to conform to high scientific standards and equity principles.

1.1. Framework

As the world becomes more inter-connected and competitive, and research and technological know-how expands, new opportunities as well as more complex challenges arise. Overcoming these challenges will require citizens to have a better understanding of science and technology if they are asked to actively participate in science informed decision-making and help to solve the problems confronting us in the twenty first century. It will involve inputs from specialists and from stakeholder groups.

Now, Europe faces a shortfall in science-knowledgeable people at all levels of society and the economy. Over the last decade, there has been an increase in the number of students leaving formal education with science qualifications. However, there has not been a parallel rise in the numbers interested in pursuing science related careers.

Science education research, innovation and practices must become more responsive to the needs and ambitions of European society and reflect its values. It should support citizens of all ages and talents in developing positive attitudes to science, and reflect the science that citizens need. Identified solutions must meet the highest ethical standards and help ensure sustainable societies into the future. This is a good time to expand opportunities for science learning, in formal, non-formal and informal settings. It is necessary to help all citizens acquire the necessary knowledge of and about science to participate actively and responsibly successfully throughout their lives.

Society, including learners at different educational levels, should be involved more in collaborative activities. This because collaboration is a key to success in today's world and the collaboration skills need to be assessed and evaluated. Social skills in broad are a target in itself in the learning

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process, including science learning. These skills are a prerequisite for other activities planned to improve science learning and ensure sustainability of open science.

The policy briefs here not only present the rationale, challenges, objectives and guidelines for a new approach on science education, but offers the descriptions and main information of a broad range of best practice case studies, not only from European projects but also international models or concepts. The above detailed items and some of the below specified topics are comprehensively addressed in the 2015 report to the European Commission of the expert group on science education for responsible citizenship.

2. Why Science Education?

Knowledge of and about science is integral for preparing our population to be actively engaged and responsible citizens, creative and innovative, able to work collaboratively, and fully aware of and conversant with the complex challenges facing society. It helps us to explain and understand our world, to guide technological development and innovation, and to forecast and plan for the future.

2.1 Science Education is vital

To promote a culture of scientific thinking and inspire young people in using evidence-based reasoning for decision making, as opposed to values and reasoning processes that are less reliable or that are only based on beliefs or feelings;

- To ensure citizens have the confidence, knowledge and skills to participate actively in an increasingly complex scientific and technological world;
- To develop the competencies for problem-solving and innovation, as well as analytical and critical thinking that are necessary to empower citizens to lead personally fulfilling, socially responsible and professionally-engaged lives, promoting solidarity at national, European and global level;
- To inspire children and students of all ages and talents to aspire the careers in science and other occupations and professions that underpin our knowledge and innovation-intensive societies and economies and in which they can be creative and accomplished;
- To enable public, private and third-sector organizations, based in Europe, to find appropriately skilled and knowledgeable people, and to promote and nurture an innovative Europe-wide environment where companies and other stakeholders from around the world want to invest, work and live;
- To empower active and responsible participation in public science communication, debates and decision-making as active engagement of European citizens in the big challenges facing humanity today.

Science learning helps us to interpret and understand our world, to manage risk and put uncertainty into perspective, to guide technological development and innovation and to forecast and plan for the future. It improves job prospects, cultural awareness and our ability to act as well-informed citizens in solidarity with citizens around the world. For some people, science refers only to knowledge of physical systems, living systems, earth and space systems and technology. Sometimes, it refers specifically to STEM (science, technology, engineering and mathematical) disciplines. Too often, science is seen as something separate from all other subjects or disciplines in education, disconnected from people's lives beyond school.

However, science influences all parts of our lives and our decision-making processes. Along with language and artistic literacy, knowledge of science and mathematics is the basis for personal accomplishment and responsible citizenship, social and economic

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development, and a benchmark of innovation, entrepreneurship and competitiveness in our global world. A more integrative approach is required. We need to link science or STEM with all other subjects or disciplines at all levels of education. This means taking other disciplines as a starting point to introduce scientific thinking and inquiry approach, and also learning through science. This also means strengthening links and interaction between formal, non-formal and informal science education. Accordingly, the focus should shift from STEM to STEAM (within which the A usually shows link to Arts but it can also be defined in a way that it includes ALL other disciplines and informal science education).

This can help to make science more attractive to young people, increase society's appetite for innovation, and open up further research and innovation activities. Making science education and careers attractive for young people is an ambitious goal, since it targets to drastically improve science and technology-literacy in our society.

Europe needs more scientists. Failure to encourage sufficient numbers of students and adults to sustain their interest in science – into and through technical, vocational, undergraduate and graduate/ doctoral studies – could undermine the success of Europe 2020 strategy and the future. A high level of scientific literacy among European citizens is both a democratic and economic necessity, since a rigorous understanding and use of scientific knowledge in decision-making are required. The skills gap between future jobs and actual STEM candidates or graduates is alarming in many European Countries. Future welfare through smart innovation calls for STEM skills that should be applied in different disciplines beyond science. Science and Technology is an important part of our European cultural heritage and should as such be passed on to the next generation.

2.2 Science Education is vital

Formal learning: learning that occurs in an organized and structured environment (e.g. in an education or training institution or on the job) and is explicitly designated as learning (in terms of objectives, time or resources). Formal learning is intentional from the learner's point of view. It typically leads to validation and certification.

Non-formal learning: learning which is embedded in planned activities not always explicitly designated as learning (in terms of learning objectives, learning time or learning support), but which contains an important learning element. Non-formal learning is intentional from the learner's point of view. It can take place in museums, science camps/clubs, science fairs and festivals, visiting and working with industry, fab labs etc.

Informal learning: learning resulting from daily activities related to work, family or leisure. It is not organized or structured in terms of objectives, time or learning support. Informal learning is mostly unintentional from the learner's perspective.

2.3 Open schooling

Open Educational Resources provide a strategic opportunity to improve the quality of education as well as facilitate policy dialogue, knowledge sharing and capacity building. Open Educational Resources are teaching, learning or research materials that are in the public domain or released with an intellectual property license that allows free use, adaptation, and distribution.

The BioS Course is a paradigm of basic open educational resource, with translational implications in all science domains and in all fields of life, health and medical sciences.

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3. Methodologies for a responsible Bioinformatics Science Education in Europe

The Bios Course is taking into account and encompassing all the below detailed strategies for teaching Bioinformatics.

3.1 Inquiry-based Science Education (IBSE)

Inquiry approaches to science education is any complex process of sense-making and constructing coherent conceptual models where students formulate questions, investigate relationships and phenomena, build new understandings, meanings and knowledge, communicate their learnings to others and apply their learning productively in unfamiliar situations. Inquiry-oriented science education engages students in: i) authentic, problem-based learning activities where there may not be one correct answer; ii) experimental procedures, and reflective activities; iii) teaching – learning sequences where emergent student autonomy and self-regulation are emphasized; and iv) discursive argumentation and communication with peers ("talking science").

3.2 Problem-based Learning (PBL)

Problem-Based Learning is an instructional method of active learning centered on the investigation and resolution of real-world problems. When students identify the problems they investigate, they have a greater potential to stimulate young people's interest in science issues and the potential of solving problems with science. The problems should be identified by the problem solvers and the students as active (self-regulated) learners should be heavily involved in this. Problem-Based Learning is driven by open-ended, unstructured and undefined problems with several solutions. The students can work in small collaborative groups as self-directed, active investigators while the teacher adopts the role as facilitator guiding the students in their investigations.

3.3 Practical work on Research Projects in Science Education

Practical work includes tasks in which students observe or manipulate real objects or materials in the laboratory, fieldwork or in the classroom, and it is often an integrated part of IBSE or PBL. It can develop a scientific attitude, such as open-mindedness and objectivity. However, scientific findings do not automatically emerge from the practical work itself. Therefore, reflections over the findings and conversations among students or between teacher and students are essential to make links between observations and scientific findings.

4. Gender aspects in Bioinformatics Science Education

Gender equality is a priority in Science Education and involves two main focus of interest:

1) gender inclusive participatory approaches (which challenge gender stereotypes and stimulate equal participation of girls, boys, women and men in science activities and in science careers); and

2) the Integration of Gender Analysis into Research (IGAR, which is aimed at avoiding gender biases in the production of science).

The gender inclusive approach is mainly aimed at encouraging girls and young women to enter academic and research careers in all scientific fields, especially in those related to engineering and technology. The European Parliament resolution of 9 September 2015 on women's careers in science and universities, and glass ceilings encountered (2014/2251(INI)) calls on the Commission and the Member States to promote:

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- educational programs which encourage synergies and positive links between STEM subjects and the arts and humanities and promote a gender perspective, facilitating the role women can play in making these links;
- positive female role models at all levels of education, including compulsory schooling and through to further and higher education and postgraduate level, and also in informal education and youth work. The European Parliament recognizes that promoting positive female role models includes taking measures to emphasize the historical and contemporary achievements of women in science and technology, entrepreneurship, and decision-making positions; such measures may include specific focus on International Women's Day, Science Weeks, and making use of existing best practice from Member States and across the world).

5. Conclusion

The BioS Project consortium includes appropriate set of partners for tackling the public. It is of paramount relevance that the consortium has already established regular and frequent contacts by newsletter, social media engagement, public scientific meeting, international and national congresses, and formal lectures, to other developers to engage them in Bios Project and build an own developer community. Each partner also has its own individual exploitation plan. The academic partners exploit the project in several ways. By offering courses and seminars related to Bios Project, they reach and attract students and other researchers and get them involved with the ideas of the project, thus helping to build a community around Bios Project. The Universities may offer the Bios Course, with its related topics valuable and fully reusable for graduate students to write their talks and dissertations, and employ PhD students who also work on these topics. The enterprise-educational partners offer and propose the course activity mainly by providing effective tutoring and training support. Finally, Bios Project now has a coherent third year plan to lead to success and to search financial sustainability outside the lifetime of the project funding.

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BioS at a glance

Project Name: BioS: Digital Skills on Computational Biology

Consortium: Steinbeis University Berlin (SHB), Enios Applications Idiotiki Kefalaiouchiki Etaireia (e-NIOS), OLYMPIC TRAINING AND CONSULTING LTD (OT), Skybridge Partners, Bioinformatics Barcelona Association (BIB), University of Patras (UPAT), European Medical Association (EMA), European Recreation and Health Valley (EUREHVA), BG Klinikum Murnau gGmbH (BGU Murnau), FOR SRL, HiDucator Ltd, EPRALIMA_Vocational School of Alto Lima, C.I.P.R.L. (EPRALIMA), German Oncology Centre (GOC)

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Website: https://www.bios-project.eu/

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