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Shaping high school science education with tech industry in action for sustainable development

Barbora Bruant Gulejova, STEM Ambassador (University of Bern, Albert Einstein Center for Fundamental Physics LHEP / CERN – ATLAS experiment; EPFL); Founder of “Youth @ STEM for Sustainable Future”

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The SPS contributes to increasing the “Swissness” of the national STEM [1] expertise, which is instrumental to keep the world-leading position of the country in innovation and economic progress [2], by supporting the pioneer project “Youth at STEM for Sustainable Future” Youth@STEM4SF. This groundbreaking innovative outreach project aims to effectively inspire high school students, especially girls to become future STEM specialists and scientifically literate society leaders; and to shape the science school curricula in Switzerland and abroad to make a significant impact in fostering better awareness about the value of science for society and for sustainable decision making.

Despite the demand for STEM-related jobs growing faster than in other sectors, there is a worrisome decline in the interest of youth, particularly among girls, in pursuing careers in these fields. This trend is counterproductive and alarming, given that the demand for STEM skills in the workforce of the European market was expected to triple from 8 % to 23 % between 2015 and 2025 while the employment in STEM-related sectors was predicted to rise by only about 6.5 % [3]. This implies a significant shortage of people with the skills needed to drive the 4th industrial revolution and solve the UN Agenda 2030 / Sustainable Development Goals - SDGs [4]. While physics-based industries significantly contribute to European socio-economic progress [5, 6], the persistent challenge of recruiting high-quality engineers is exacerbated by a substantial gender gap. In most countries, women remain underrepresented in academic STEM fields (below 20% in post-graduate physics positions, 22% in AI). In 2019, women made up just 19 % of inventors, and only 2 % of venture capital for tech went to women-led start-ups [3].

One reason for this issue is the prevalent misperception that basic research, especially physics, is complex, abstract, uninteresting, exclusive, and lacking appealing career prospects [7]. Moreover, the general awareness and appreciation of the role of science in our society is rather

low [8, 9]. Much of these stereotypes can be attributed to the disconnection of high school science curricula from real-life applications and societal challenges [10], and a substantial historical lag (depending on the subject up to a century) between school content and cutting-edge scientific knowledge [11].

One should not count only on extra-curricular activities offered by the scientific community to bridge this gap. Often with content catering to students already inclined towards STEM, their impact is limited also by the awareness, motivation, and time constraints of science teachers, facing difficulty in introducing new subjects within curricula.

Innovative approaches in physics / STEM education and outreach are required. Contextualizing these disciplines within real-life scenarios, especially applications with societal and environmental relevance (well represented by SDGs), proves to be a potent tool for fostering students' interest and appreciation in physics [12, 13]. Medical applications from particle physics [14 - 17], for instance, are particularly inspiring for girls who may be undecided about their career paths [18 - 20].

New engaging science education content is crucial, but not enough. A top-down approach officially endorsing and integrating it into the science school curricula, including training of science teachers (inter)nationwide, is vital and provides an effective implementation of new subjects and teaching methodologies. Therefore, the issue can be effectively solved only by a systemic transformation of science education at the high, middle, and even primary school levels. Such a mission can be best tackled only as a collaborative endeavor of a multi-stakeholder community, including scientific, education, and policy-making, but also industrial actors. The significance of coordinated efforts to raise awareness about the role of science in society has been acknowledged through recent declarations, such as



the UN International Year of Basic Sciences for Sustainable Development (IYBSSD) in 2022/2023 [21, 22] and the International Decade of Sciences for Sustainable Development (IDSSD) from 2024 to 2033 [23].

Clearly, in this context, sustainable development is the key strategic entry point to create an appreciative dialogue of scientists with society, including shaping the official school science education. Even if teaching sustainability is becoming gradually compulsory in high schools, not only in Switzerland [24], due to the lack of science teaching resources on sustainability, the subject is typically addressed only during geography and economy lessons, strengthening the wrong perception of being unrelated to physics and STEM.

The new Swiss high school education plan PEL [25, 26], emphasizes the inclusion of multidisciplinary skills, sustainable development, applied sciences, career decision capacity, and innovative modular teaching formats like thematic days. For these aspects, inherently included as an additional layer to existing STEM education and outreach activities, the Youth@STEM4SF project has been recognized as a perfect pioneering case of implementing the new PEL by the national competence center for sustainable development education, foundation education21 [27, 28].

Youth@STEM4SF leverages the unexplored inspirational avenue by showing science in action for society and sustainable development. It achieves this through engaging with industry and role models from diverse STEM backgrounds of both genders. The industrial community has an important role to play in contextualizing science, by showcasing concrete applications, technologies (directly or indirectly aligned with SDGs), and the vast array of STEM-related career opportunities (70 % beyond academia!). The project is anchored in an innovative outreach concept recommended by the European Committee for Future Accelerators ECFA [28] based on a proposal by the author [29] in 2018, where a broad population would be reached thanks to the synergy with industry and knowledge transfer, involving captains of industry as ambassadors for physics and STEM education. After a 5-year conceptualization phase in collaboration with the international multistakeholder community, including experts from various intersections of Big Science with business, outreach, education, physics teachers, industries, educational authorities, and the UN, Youth@STEM4SF

emerged from the 4S+ concept [30] under the umbrella of IYBSSD. The aimed feasibility for all stakeholders has been proven by the successful inaugural Swiss pilot, with financial backing from SPS, SCNAT, education21, and Rotary [31], and a substantial push from the Swiss Industry Liaison Office with Big Science Infrastructures [32]. To build a Swiss brand to be implemented abroad in the scale-up phase, this has been realised during the first Youth@STEM4SF days at Gymnase Bugnon-Sevelin in Lausanne on 11 May 2023 [33] and an upgraded version (with a more interactive format) on 13 March 2024. During these two thematic

days, both within and outside of school premises, nearly 100 students (around 16 years old) with 3 science teachers have been inspired by 12, including 5 female, role models. First, during an interactive session, a Youth@STEM4SF founder and female physicist with EPFL and CERN background connected physics and STEM with SDGs through concrete examples of applications from particle, nuclear physics and Swiss research-industry ecosystem. A wide range of examples of possible career paths with STEM diploma, also beyond academia, was shown. Later during the workshop at school and dive-in tours in the companies, the engineers & scientists of both genders from pioneering tech industries, ABB and EPFL spin-offs Solstis and DAPHNE, shared information about their career paths. They inspired the audience by highlighting crucial decisions, exciting journeys and stories, always reflecting on the pivotal role of their STEM background and transferable skills in creating value for society.

With the support of IUPAP, and Italian partners [34], the first international edition of Youth@STEM4SF took place as an official pre-event of upcoming Big Science Business Forum 2024 [35], in Trieste on 18 March 2024 with a regional counsellor level opening. Almost 100 participants from Italy and Slovenia enjoyed the inspirational presentations and a roundtable on “Big science meets industry”, replacing company visits with 8 inspirational role models representing the successful interface between research and industry, and an interactive visit to natural science museum [34].

The impact of the program was systematically assessed through pre- and post-questionnaires and interviews, focusing on key performance indicators such as awareness, attitude, and interest in STEM studies. Initial results are highly encouraging: 30 % more students can envision a STEM career after the program, while in particular large increase was observed by girls. Thanks to the relatable female role models, girls find physics and engineering more accessible. Additionally, half of the students wish to serve as ambassadors for science in their future non-scientific careers. Students felt empowered for physics careers: “I am much more confident about security in the job market as a physicist, and I can see many different opportunities to explore. It would be wonderful to have such lessons at schools.”

Youth@STEM4SF day always closes with a brainstorming interactive session, where students reflect in groups on their favourite examples of science applications for SDGs, and the engaging ways how to learn about these at school, using digital tools, like simulations, applications, or games. A good example is the game on cancer hadron therapy, where different types of particles are shot at cancer cells. This session is a warm-up for the motivated students to work on the subject officially in the framework of the maturity work and/or to take part in the Youth@STEM4SF competition with the possibility of winning an internship in a tech company or delivering a speech at the UN Youth Forum. The valuable input from students and teachers will be also used for the co-creation of missing high school resources integrating sustainable development to science curricula, in the framework of a new ResponSE project with EPFL and the University of Bern [36], aiming to design inquiry-based learning Open Educational Resources, e.g. [37]. This is part of the Youth@STEM4SF scale-up within IDSSD, where more data will be gathered for robust statistical analysis, encompassing to larger number of Swiss schools (private, public / IBO [38], gymnasiums, vocational), age groups, and geographical coverage. This would widen the number and variety of participating industries, and thus the scope of science and societal aspects.

To enhance the impact of the inspirational tech industries as recommended by the ECFA [28], a proposal has been officially made to establish a network of physics- and STEM-based industries, serving as ambassadors for STEM education. The proposal garnered first support from three leading companies - ABB, CAEN, and DAPHNE. It was put forth following the high-level multistakeholder roundtable at the recent EPS Forum 2024 in Berlin [39], in alignment with invitation by UNESCO, the UN lead body for IDSSD, to take coordinated action aimed at raising the awareness about science and encouraging young people, especially girls, to join STEM fields. This pledge will be extended to more industries at the upcoming BSBF 2024 in Trieste [35].

All relevant stakeholders from science, schools, or industries, are invited to join the mission to reshape science school curricula to meet the challenges of the 21st century, which will continue to be pursued as a multistakeholder collaborative endeavour under the umbrella of IDSSD.

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