

Incorporating creativity and interdisciplinarity in science teaching: the case of "Art & Science across Italy"

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Art&Science across Italy is an INFN/CERN project for the Italian High School students (16-18 y.o.). More than 10.000 students joined since the 2016. Creativity and vision capability are common to many disciplines and are involved in artistic and scientific thinking and activities. Scientists and artists are often asked to see and think beyond the perceivable reality, to imagine aspects of things and events, which can be better seen from an unusual perspective.

The main idea is to put in practice the basic concept of the STEAM field in which neither STEM nor arts are privileged over the other, but both are equally in play. Therefore, our aim is to engage high school students with science using artistic languages, regardless of students' specific skills or level of knowledge

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1. Creativity in science education

Educational systems worldwide are adapting to rapid societal changes. Creativity is an important aspect of human development as it can significantly contribute to students' flexibility to handle changes in a rapidly evolving environment [1].

In recent years, creativity has been found to be an invaluable tool in science education. The potential of creative teaching, learning strategy fostering creativity in science, and the role of the science curriculum in the formation of creative minds have been explored [2].

Braund M. and Reiss M. J. have identified three levels at which science teaching and learning can be enhanced by arts [3]: a *macro-level*, where arts and sciences as subjects are structured and "packaged" in curricula, a *meso-level*, engaging learners through art-related STS (Science, Technology and Society) contexts, and a *micro-level*, where arts are used to draw pedagogical practices in science.

The STEAM (Science, Technology, Engineering, Arts, Mathematics) educational framework can be seen as a macro-level integration of STEM subjects with arts [4, 5]. Despite their importance, STEM subjects are viewed by students as lacking creativity and unrelated to images or aspirations [6]. Moreover, STEM are not an integrated reality in high schools [7]. The integration with arts into an holistic and transdisciplinary teaching can provide alternative to conventional multidisciplinary views of STEM and Arts while avoiding artificial combinations (or separations) of subject disciplines [4].

Creativity can also be seen as an alternative language to engage learners towards science. Science teaching requires dedicated symbolic and semiotic systems of representations which are far from the natural language. Moreover, science redefines everyday words with subject-specific meanings (e.g. «work» in physics). Therefore, science is often seen by students as *learning a foreign language* [8], where subject-specific communication modes can create significant language barriers. Art and creativity can help students breaking down these barriers. For example, communicating scientific ideas by painting and drawing can improve observation, pattern recognition and enhance visual thinking.

Inspired by the STEAM educational framework, the Art & Science Across Italy (A&S) project aims at engaging students towards science by using the language of arts.

2. The INFN/CERN project "Art&Science across Italy"

The A&S project [9] is organised and founded by the Italian National Institute for Nuclear Physics (INFN) and CERN, in the framework of the ERASMUS+ European program [10]. The project targets high school students with the mandate of achieving wider student engagement with science through the use of art as an universal language [12]. The potential of art and creativity in communicating scientific ideas is exploited to overcome limits imposed by students' educational performance and dispositions towards science. The students involved in the A&S project are asked to create original artworks representing a scientific topic of their choice. The best artworks compete in a local and then national contest, thus introducing the element of the competition as an added incentive for the students' engagement.

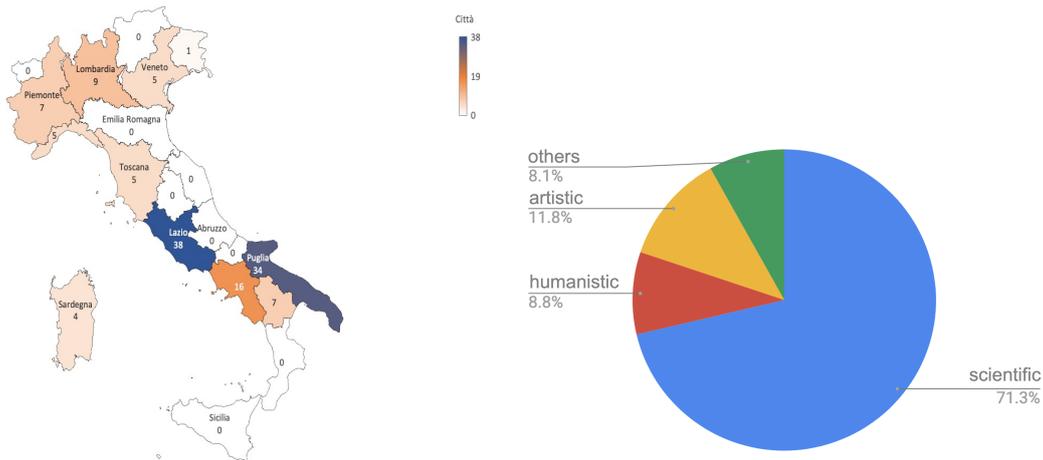


Figure 1: Left: Distribution across Italy of the high school institutes involved in the third edition of the A&S project. Right: types of high school institutes participating to the project.

2.1 The structure of the project

The A&S project involves high school students (16 - 18 y.o.) from different cities in Italy. The national coordination and scientific committee running the project have local representatives for each of the cities involved, to organise local events in close contact with the different high school institutes.

The program of the project covers almost two years and unfolds across four parts: education, creative phase, exhibition, competition and masterclass at CERN as ultimate reward.

The first educational phase is a wide program of lectures and seminars on science compared with arts in a broad sense, drawing a parallel between a cutting-edge scientific topic and any form of art (e.g. high energy particle physics and visual arts). Visits to research laboratories and museums are also organised locally.

During the second phase, the students are asked to create original artworks inspired by a scientific topic of their choice. A dedicated tutorship supported by external experts is set to help the students to look after the artistic side while ensuring the scientific correctness of the message that the artwork is intended to bring. The students are organised in small groups to enhance team collaboration and sharing.

The artworks are then collected into local expositions open to the public, set up in the most significant places of each city (historical buildings, museums, universities). An evaluation committee is appointed to select the seven best artworks from each city, which are then collected into the final national exposition.

The 24 authors of the 8 best selected artworks are awarded a masterclass at CERN, with a rich program of STEAM seminars, hands-on sessions and visits to the experiments.

2.2 Status and summary of last edition

The project started in 2016 and it is entering now in its fourth edition. Until now, A&S involved 10000 students and 200 schools from 12 regions of Italy. The educational phase of the third edition

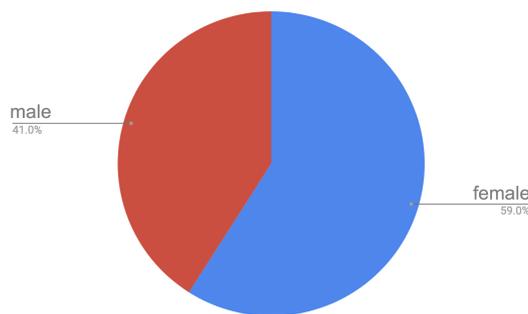


Figure 2: Gender of the students participating to the third edition of the A&S project.

saw the participation of many science communicators and artists, ranging from particle physics to natural science, from architecture to literature and music.

The third edition took place in 2020-2022, involving 13 cities and more than 5600 students from 143 high school institutes, mostly (68%) offering science-oriented education. The pie chart in Figure 2 describes the gender for the students participating to the project. Figure 1 shows the distribution of the institutes involved across Italy, along with the breakdown by type of school.

The first phase of the third edition was heavily impacted by the Covid-19 pandemic, and most of the seminars were held remotely. On the other end, this allowed large participation to local and national seminars. As for the creative phase of the project, in person meetings were allowed between the students and the tutors during the design and realisation of the artworks. The final exposition took place in Naples in May 2022. Figure 3 shows the exposition and the artwork that was awarded first place in the national competition.

Feedbacks from the students involved are collected by means of surveys. The type of high schools and the university field at which they were interested have been used to evaluate if the project engaged all the students to science regardless their attitude. Comparing the type of school of the sample and of the winners they are found to be fully compatible, meaning that all the students have the same probability to have success in the project regardless the type of high school.

3. Conclusions and Perspectives

At the time of the conference, the third edition of the A&S project was in its final phase, involving an unprecedented number of students.

The fourth edition will start at the end of 2022. Since the remote seminars allowed for large participation at national level, it was decided to keep an "hybrid" mode for the future editions, allowing the participation in presence and from remote to all the educational events.

The organisation committee is putting effort in the creation of a wide network of high school institutes, to increase the involvement of all types of schools. The good media feedback and the enthusiastic participation to the project bodes well for the future editions.



Figure 3: Left: final artwork exposition in 2022. Right: best artwork award at the third edition of the A&S project: "Ceci n'est pas un violon", Rondinella B., Chiri C., Chiarello D. from Liceo Scientifico "L. Da Vinci", Maglie (LE).

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