SUNRAISE - Stem UNlimited Raise thanks to Arts at School in Europe

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PR1: Analysis of the achievement of STEM skills in EU and the need for a more interactive approach

NATIONAL REPORT
ITALY

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GENERAL INFORMATION ABOUT THE COUNTRY ACCORDING TO THE LATEST STATISTICS AVAILABLE (POPULATION, EDUCATION SYSTEM, NUMBER OF SCHOOLS AND STUDENTS)

Italian population: 58 million people

Students enrolled in a school course are 8.5 million in Italy (10% are foreigners).

Among the most relevant data to be noted are the high rates of school dropout between 18 and 24 years: 15.6% among boys and 10.4% among girls.

As for the choice of upper secondary school, most girls choose high school, while boys prefer technical or vocational schools. Among girls, 26% opt for scientific high school, 21% for technical high schools, 20% for other high schools and 16.7% for professionals. Among boys, 42.7% choose a technical institute; 23.9% the scientific high school; 20.8% go to a vocational school and 6.5% choose other high schools.

Education in Italy is compulsory from 6 to 16 years of age, and is divided into five stages: Kindergarten, Primary school, Lower secondary school – middle school, Upper secondary school – high school, University.

Education is free in Italy and free education is available to children of all nationalities who are residents in Italy. Italy has both a private and public education system.

In 2018, the Italian secondary education was evaluated as below the OECD average. Italy scored below the OECD average in reading and science, and near OECD average in mathematics. Mean performance in Italy declined in reading and science and remained stable in mathematics. Compared to school children in other OECD countries, children in Italy missed out on a greater amount of learning due to absences and indiscipline in classrooms. A wide gap exists between northern schools, which perform near average, and schools in the South, that had much poorer results.

22.117 Kindergarten	720 Humanities and antiquity Lyceum
17.678 Primary school	882 Foreign Languages Lyceum
8.453 Secondary school – middle school	1.750 Techincal institute (economy)
469 Fine Arts high school	2.022 Techincal institute (technology)
1.719 Mathematics and Science Lyceum	1.838 Professional Institute (service industry)
858 Psychology and Pedagogy Lyceum	807 Professional Institute

In 2019 the results of Italian students in mathematics have improved: above the international average in the fourth grade, aligned to the average in the eighth grade. The average results are significantly higher than in the past. Still, the students can't stand it. Girls (even the best ones) score worse than boys, and the older they grow, the less they tolerate the subject.

This clear picture of Italian fourth- and eighth-grade students results from the TIMSS (Trends in International Mathematics and Science Study) 2019 survey presented today, December 8th, and which, we emphasize, does not take into account the pandemic period.

The TIMSS 2019 Survey

The TIMSS survey is an international survey promoted by IEA (International association for the Evaluation of Educational Achievement) which measures the learning of mathematics and science in the fourth and eighth grade.

Results in mathematics

In the eighth grade, in 2019, italian students obtained an average score of 497 points on the total mathematics scale, in line with international results (500).

However, compared to other countries, the score of Italian students was lower not only than that of students from the Asian area, but also that of several European countries.

For eighth-grade students: the results in different areas of the country have highlighted better students' skills from the North-East and the North-West than both that of the other macro-areas, and than the national average.

Furthermore, the distribution of scores was found to have a higher degree of variability in the southern areas than in the northern ones.

In the latter, the span between the most skilled and least skilled students is 211 points; in the south, the span ranges from 230 to 244 points.

Even in the eighth grade, boys score better than girls at math. Boys outperform girls in numerical skills, data reading and cognitive processes involved in solving mathematical problems.

Results in Science

For the eighth grade, the results of TIMSS 2019 paint a picture of Italy where the general performance in science of our students is similar to that of other students at the international average level. This survey also shows a geographical gap, with the North achieving the highest results and the South having results below national average. Compared to the results in several other countries, Italian students able to solve problems of a high or advanced level are still few.

Italy's results are substantially stable in the latest surveys, in which the improvement achieved in 2011 compared to 2003 was kept.

Seemingly, the relative strengths of our students are biology and earth sciences, while chemistry and physics are two areas that need more attention.

There are worrying data on the preparation of Italian students: the OECD PISA Report (Program for International Student Assessment) shows that it has worsened in the last ten years.

(OECD includes 57 participating States from Europe, Central Asia and North America).

The Pisa Report is an international survey that periodically measures the literacy, mathematics and science skills of 15-year-old students from 79 participating states, including 37 OECD states. 11,785 students from our country, belonging to 550 schools, took part in the test.

Results

According to this report, 15-year-old Italian students cannot read and 1 out of 4 does not pass science class.

Their science and reading skills are lower than those of their peers ten years ago.

Specifically, in science, they scored 21 points lower than their peers in OECD countries and 13 points lower than the previous survey carried out in Italy.

One in 4 students in Italy does not reach the basic level of scientific skills; the figure in OECD countries is 1 in 5.

In mathematics, they score 487 (in 2015 it was 490) compared to an OECD average of 489.

According to the OECD report, one in 4 students does not reach the basic level of competence in mathematics, with a percentage that exceeds 30% in Southern Italy.

In all three areas, the performance was lower than that of countries such as Belgium, France, Germany, the Netherlands, Poland, Slovenia, Sweden and the United Kingdom.

In 2018, the European Space Agency (ESA) and the Italian Space Agency (ASI) commissioned the National Association of Natural Science Teachers (ANISN) to implement the ESERO (European Space Education Resource Office) project in Italy, which is ESA's main educational project in the field of primary and secondary school education in Europe.

Specifically, ESERO uses Space as a powerful and stimulating context for teaching and learning STEM curricular subjects (Science, Technology, Engineering, Mathematics).

One of the first steps of the ESERO project was the study of current state-of-the-art STEM teaching and learning in Italy: this study on teaching began at the end of 2018 and was eventually updated in 2020, with the results of the OECD TALIS 2018 survey.

ESERO ITALIA is a joint program of the **Italian Space Agency (ASI)** and the **European Space Agency (ESA)**, with the support of a wide range of national organizations both in the field of education and in the aerospace sector.

ESERO is mainly aimed at training the community of **teachers**, who represent the main link to students. ESERO ITALIA offers, free of charge, **certified training events for primary and secondary school teachers** in **STEM** (Science, Technology, Engineering, Mathematics) curricular subjects, **innovative teaching materials**, adapted to national STEM school programs, **interdisciplinary projects** and educational events.

The activities of **ESERO ITALIA** are led, starting from 2021, by a consortium of institutions, selected by **ASI** and **ESA** and active in the sector of the fostering of scientific culture. The consortium is led by the **"Leonardo da Vinci" National Museum of Science and Technology in Milan** and includes the **Idis Foundation-City of Science of Naples**, **Infini.To Planetarium of Turin, the MUSE Museum of Science of Trento, Museo del Balì of Saltara (PU) and Psiquadro scarl of Perugia.**

The study is based on the following surveys:

1. 2018 OECD TALIS survey

2. 2016/17 INVALSI National Surveys

3. 2015 OECD PISA survey

4. 2015 IEA TIMSS and TIMSS Advanced surveys

The TALIS survey (Teaching and Learning International Survey) is certainly the largest survey promoted by OECD to investigate various aspects of the teaching profession, aiming to develop international indicators to guide school policies of participating countries. The survey, which is repeated every 5 years, reached its

third edition in 2018, wherein the data collected with an extensive questionnaire addressed to teachers will be used to distinguishing STEM teachers from others. The questionnaire was administered to 3,612 secondary school teachers (ISCED 2), of whom 714 were teaching STEM subjects.

Different Approaches to STEM Education

The Ministries of Education and representatives of industry and universities in **fourteen European countries have coordinated to collect data on Stem education**. Questions were asked about the role of STEM in the education system, renewal projects related to STEM education, the situation relating to the development of professional skills of STEM teachers and the development of specific teaching and learning tools.

The collected data were enriched with interviews with industry and university representatives to have some feedback and points of view from the field.

The results show that one of the main reasons for improving STEM education is the need to **attract more students and teachers to STEM studies to provide the job market with resources adequate in quality and quantity, starting from primary education**.

To keep up with the rapid pace of technological innovation, the European education systems needs a better vertical integration of their STEM policies with better relationships between schools, universities and companies; moreover, it needs better horizontal integration to develop a balanced approach between the different STEM subjects.

In Italy, few people attain a university degree, fewer still in scientific subjects.

In this general framework, the rate of young graduates in science, which is also very far from the European average, must be watched closely.

In the EU, about 21 out of every 1.000 young graduates attain a degree in subjects such as science, mathematics, IT and engineering.

In Italy, this figure is 16.4 per thousand people between 20 and 29 years.

It's a rate quite far from the EU average, but above all from the level of major European countries.

In **France** and the **United Kingdom**, the rate is above 25. In **Germany**, it is 24.4. **Spain and Poland** are above 20. General rates on country populations follow the same trend.

Stem Legislation in Italy

There are no specific laws regulating Stem teaching; however, there are many initiatives that promote the approach to a new teaching of scientific subjects. Such initiatives come both from the Ministry of Education and from private entities, both of which foster projects to encourage a new approach to scientific subjects.

Stem in School Curricula

In order to encourage the study of Stem subjects, public and private initiatives are being encouraged that strengthen and make more effective this study through the training of teachers and the implementation of useful technological tools (PCs, lab equipment). The Ministry of Education is preparing to implement a **STEM skills development plan** backed by **1.1 billion euro in funds from the PNRR (National Recovery and Resilience Plan).** "We will soon issue a call for tenders to allocate over one billion euros to enhance the study of STEM, to foster scientific culture and to guarantee equal opportunities and equality," said Minister Bianchi.

STEM subjects (Science, Technology, Engineering and Mathematics) and computer science will be promoted in all school cycles, from kindergarten to high school, with a **focus on female students** and with a full interdisciplinary approach.

A strictly teaching-related goal is **fostering scientific culture** and the mindset needed for a different approach to the development of computational thinking in schools, even before teaching specific disciplines. "In our classrooms, we build equality of rights and equal opportunities, as required by our Constitution," Minister Patrizio Bianchi added. "We are committed to strengthening the educational mission of the education system, to offer diversified growth and training opportunities, promoting the interest of our girls and boys into the so-called STEM disciplines, i.e. science, technology, engineering, mathematics, because we want every youth to be able to deal with all fields of knowledge and make their own contribution without the burden of prejudice. A society is alive and healthy if it manages to make room for everyone's intelligence."

Initiatives Already Funded

Regarding the dissemination of STEM disciplines, in year **2021** the Ministry has already made available to schools **over 100 million euros to create new laboratories and spaces dedicated to these subjects** within classrooms, and to promote innovative teaching methods. **More than 6,500 institutions benefitted from funding.**

Teacher Training for Stem

Stem teaching, and stem learning by students, is generating more and more interest and, consequently, the proposals for teacher training are also increasing. Many active subjects in the field are promoting interventions, scientifically credible and which combine theory with the practice and implementation of technology and tools functional to physics, science and mathematics.

An Example: LS-OSA

The LS-OSA national project is part of a series of interventions implemented both to further the enforcement of the National Guidelines for High Schools and the Guidelines for Technical and Professional Institutes and to promote and develop laboratory teaching and skill-oriented teaching in schools.

The project was launched in May 2013 to provide teachers of scientific disciplines with the necessary support to set up, propose to the class and manage experimental activities, which are an essential tool for stimulating the students' approach to scientific reasoning and research.

The idea set forth by the project over the years is **a laboratory not as premises in which to carry out experiments, but as a mindset trained to observe everyday phenomena, highlight their relevant aspects, connect them in causal relationships and then translate these relationships into quantitative, mathematical relationships, through measurement and data analysis.**

"Rustic Laboratory"

Building on this idea, the project has mainly developed "rustic laboratory" activities: a laboratory that does not require advanced infrastructure and instrumentation, but common, easily available materials. Since its conception, **the LS-OSA project has proposed a working approach that requires teachers and students to adopt a research-minded attitude, to get actively involved, to deal with the unknown and the unexpected.** It certainly requires more effort, but is equally more effective and stimulating, more suitable for building scientific skills and mindsets for our children and for us along with them.

INFORMATION ON EDUCATION AVAILABLE IN THE COUNTRY FOR STUDENTS WITH SPECIAL NEEDS

School integration of pupils with disabilities is a strong point of the Italian school, which aims to be a welcoming community in which all pupils, regardless of their abilities, can experience individual and social growth. The full inclusion of pupils with disabilities is a goal that the school of autonomy pursues through intense and articulated planning, making the most of internal professionalism and the resources offered by the territory.

The teacher for support activities is a specialized teacher assigned to the class of the pupil with disabilities to foster the integration process. He/she is therefore not the disabled pupil's teacher, but a professional resource assigned to the class to meet the greater educational needs that his/her presence entails.

Each teacher has full didactic and educational responsibility for all the pupils in his or her classes, including therefore those with disabilities. He/she must contribute to the planning and achievement of the set objectives, didactic and/or educational, and will be called upon accordingly to evaluate the results of his/her teaching. Since the pupil with disabilities follows customized and/or individualized learning paths, the actual tasks of the class teacher must necessarily be defined within the framework of an Individualized Educational Plan (IEP).

The IEP describes each year the educational and didactic interventions intended for the pupil, defining objectives, methods, and assessment criteria.

Since the assessment of pupils with disabilities is referred to the IEP, both in terms of objectives and methods and assessment criteria, this document must clearly contain all the elements that will then make it possible to effectively assess the results of the educational action. The IEP is drawn up at the beginning of each school year and is then subject to verification. It is drawn up jointly by the school and the Services (Psycho-Social Services Team) with the collaboration of the family.

In each school institution there is an Institute Handicap Working Group, an inter-institutional group, open, therefore, to all the agencies that have competences on this issue: school, parents, ASL (local health care unit company), Local Authorities and, possibly, also representatives of the associative reality of the territory.

Italian legislation recognizes dyslexia, dysorthographia, dysgraphia and dyscalculia as Specific Learning Disorders (SLD), assigning the national education system and universities the task of identifying the most appropriate teaching and assessment methods so that pupils and students with SLD can achieve educational success.

The personalised teaching plan (PDP) is the planning document with which school defines the interventions it intends to implement for pupils with special educational needs that are not related to disability. The school can draw up such a planning document for all pupils with Special Educational Needs if it deems it necessary. For pupils with SLD, Specific Learning Disorders, a customized planning document (the PDP, precisely) is de facto compulsory.

Compensatory tools for pupils with SLD are didactic and technological tools that replace or facilitate the required performance of the deficient skill.

These tools relieve the pupil or student with SLD of a performance made difficult by the disorder, without making the task easier from a cognitive point of view. The use of such tools is not immediate and teachers - also on the basis of the indications of the school contact person - will take care to support their use by pupils and students with SLD.

It is harder and it takes more effort to find projects specifically dedicated to Stem education supporting disabled students. There is attention to this topic but, where possible, it is still left to teachers and principals to manage. There are some proposals, but mostly offer to teachers to equip themselves with tools for inclusive teaching.

The Ministry of Education offers courses for teachers.

Some examples

A group of researchers, professionals, public servants and people with disabilities presented at the University the news in this area and discussed the best strategies to guarantee access and use to people with disabilities thanks to the European Association for the Development of Assistive Technologies.

"Without assistive technologies, even the most basic ones, people with disabilities cannot improve their autonomy and emancipate themselves, they cannot live better and become a resource."

Professor Leporini, whose research is in the field of accessibility and specifically Human-Computer Interaction (HCI), spoke at the conference on the first day with a report on the state of the art and the possible choices regarding support technologies to include in STEM (Science, Technology, Engineering and Mathematics) laboratories.

"In humanities curricula - the Professor of the University of Pisa explains - people with different disabilities have always managed to study and even reach academic degrees, but in STEM this is still difficult."

The English acronym STEM groups together the so-called scientific subjects (Science, Technology, Engineering and mathematics) where "the limited availability of accessible texts - she continues - but, above all, the lack of accessibility not so much to the premises but rather to the instruments and materials in laboratories, effectively prevents these people from studying efficiently and therefore graduating in their respective disciplines." Going back to the accessibility of STEM, I ask what both herself and some other experts (T. Murillo Morale from Austria, K. Yamaguchi from Japan) could say at the conference on the same topic. "The situation that is positively evolving concerns some software packages - she replies - able to write, and therefore then read and/or make recognizable, mathematical and scientific formulas in the broader sense. However, there are still miles to go, especially on the fruition of mathematical and scientific texts where accessible versions are not yet easy to find, not even through the speaking books that allow you to have various texts read aloud."

Dr. Leporini works in the Research Area of the National Council of Research of Pisa in the "Human Interfaces in Information Systems" (HIIS) laboratory and teaches in numerous training courses, including at the Computer Science Department of the University of Pisa, for the Tuscany Region and other public and private individuals who also involve it simply for seminars on accessibility issues.

The main research areas concern methods and tools for the analysis, design and development of interactive applications, intelligent interfaces, interfaces for Ubiquitous applications, MultiModal Interfaces, Accessibility, Usability Engineering and models for HCI.

OUT OF SCHOOL NATIONAL OR REGIONAL ACTIVITIES/PROJECTS SUPPORTING STEM EDUCATION

Since 2006, Stem has gained great relevance in schools and universities, from teaching the related subjects to raising awareness for their study both in students' and teachers' curriculums. There is a renewed interest

towards actions, planning, and programming concerning the approach to scientific subjects, starting from kindergarten and all the way to high school.

Examples of projects supporting STEM education in Italy:

- GIRLS CODE IT BETTER

Free extra-curricular workshops to introduce girls in secondary schools to STEM subjects. This is the aim of Girls Code it Better, an initiative of Officina Futuro Fondazione W-Group set up in 2014-15

Through projects in secondary schools, Girls Code it Better allows female students to experience digital and entrepreneurship pathways first-hand through workshops. During the workshops, young girls can immerse themselves in stimulating didactics in favour of effective design that can guide them consciously.

In the clubs, the free afternoon extra-curricular workshops in lower secondary schools (45 hours) and upper secondary schools (35 hours), 20 girls guided by a coach-teacher, a teacher from the school, and a coach-maker, a figure with technical skills, tackle a topic and develop a project involving the development of a technical instrumental area chosen from:

- Electronic boards and automation;

- Design, modelling and 3D printing;

- Web design and web development;

- App programming and gaming;

- Virtual and augmented reality;

- Videomaking;

"While the demand for professionals in the field of digitalisation is growing, the percentage of ICT specialists in Italy, where only 49% of women work, is stuck at 14.8%," comments Costanza Turrini, creator and manager of Girls Code it Better. "Many research, moreover, state that already in primary school many boys and girls assimilate the idea that talent is a male quality. This stereotype begins to shape interests early in childhood and is likely to contribute to narrowing the range of future career choices, especially for girls. The programme was born precisely out of a desire to encourage the thinkability of paths close to aptitudes, with great appeal to the world of work and not necessarily linked to gender models and the roles socially assigned to women".

Started in the 2014/2015 school year, the programme has implemented 309 clubs, involving more than 6,000 girls and 155 schools in 14 regions around Italy. In the current school year, 80 clubs have been activated, for the next one the target is 150.

- In summer you learn STEM

Ten days of training dedicated to: coding, educational robotics, science, engineering, mathematics, and computer science, for twenty girls and boys from classes of IC Rizzo who will dedicate the afternoon hours to STEM workshops and activities.

The "In summer you learn STEM" summer camps are the result of the call for schools that aims to promote scientific culture among primary and secondary school students and to overcome stereotypes and prejudices that fuel the cultural gap on these subjects among students, influencing their educational path and subsequent orientation in professional choices.

Furthermore, by encouraging schools to be open in the afternoon, the aim is to meet the needs of families and enrich the schools' extracurricular offer.

Thanks to the project, schools such as IC Rizzo were able to ask for the collaboration of external subjects such as Explora, with specific competences in STEM subjects (Science, Technology, Engineering, Maths) and included in the list of bodies interested in collaborating on initiatives for the promotion of equal opportunities in STEM subjects, published by the Department for Equal Opportunities.

- BOTSTEM (kindergarten)

Although STEM programs are increasing rapidly in number, they focus on high school and after-school activities. While these approaches are being considered by policy makers, research in this field and its adaptation to teaching in kindergarten and primary school is still lacking.

These stages of development are a crucial period for determining future career paths and for correcting social misconceptions and prejudices about science and technology.

BOTSTEM's goal is to develop new tools through inquiry-based teaching, robotics and coding to improve the current teaching methods for STEM subjects. BOTSTEM is focused on, and fully in line with, formal education programs and their aims for kindergarten and primary school.

Specifically, BOTSTEM aims to:

1) improve the learning and skill, and therefore the potential performance, of students in STEM, particularly in Natural Sciences and Mathematics, through innovative methodologies and resources, open-source software/hardware, inquiry-based projects and programming languages (IO)

2) develop more engaging tools for students (educational games, robots, learning coding in a playful way, and suitable for methods implementing these tools)

3) improve the quality and integration of lifelong learning for teachers through virtual learning environments (VLEs) that allow for more flexible and cost-effective peer learning

4) optimize the public image and perception of Science and Technology, overcoming the prejudices that children internalize in early childhood through early intervention in integrated STEM, with an approach based on gender equality.

- Project STEM 4 Future (high schools)

Objectives

STEM 4 Future is a free educational project created thanks to the multi-year support of Boeing Italia and the collaboration with Luigi Bocconi University (Milan) and Politecnico di Bari. The initiative is aimed at high school students with the aim of stimulating the interest of new generations in STEM subjects (Science, Technology, Engineering, Mathematics), the so-called "subjects of the future". The project offers an

excellent opportunity to combine PCTOs (Pathways for Cross Skills and Orientation) with orientation towards university education and working life. In doing so, we favor a horizontal, interdisciplinary approach to sharing knowledge and experiences between peers (peer education). Moreover, the project will be focused on promoting equal opportunities through stimulating the inclusion of women (diversity & inclusion) in the world of STEM subjects.

The fifth edition of this project will involve ten high schools from five Italian regions: Lombardy, Tuscany, Lazio, Campania and Puglia.

Implementation

Students participating in the STEM 4 Future project will be involved in a series of interactive activities from October to May for a total of 30 hours of PCTO. Through engaging theoretical and practical modules, workshops and exclusive educational events, the participants will acquire skills in the field of Robotics and Artificial Intelligence. Career Days will be held by experts and professionals within the schools to guide students through university and professional career choices.

Moreover, STEM 4 Future uses digital platforms ever since its fourth edition. In fact, some activities will take place in streaming so as to allow direct interaction while maintaining physical distancing according to COVID-19 regulations. This will also be an excellent opportunity not only to enhance the technological skills of the students themselves, but also to involve a greater number of professional testimonials.

Finally, students will be asked to participate in a creative competition by realizing of a group project to be presented at the closing event of STEM 4 Future.

The winning crews will be rewarded with an exclusive Boeing Experience, organized by ScuolAttiva in collaboration with Boeing, during which they will take part in work simulations within the company's facilities, to get in touch with the highest professional profiles in STEM

- MACROAREA STEM PROJECT (primary schools)

By motivating students in learning by encouraging asking questions and seeking answers with and without teachers and adults, the project focuses on the strategies and procedures of "making science". The project's actions are therefore focused on laboratory teaching in which children are always active participants in a stimulating and collaborative learning environment. Students should be supported in the gradual construction of concepts and knowledge needed for understanding the phenomena being studied, by identifying items and relationships. The protocols are open to experience and take into account the students' contributions and choices, with a view to making and tinkering.

Students will therefore be guided to discovering the close connection between science, technology, art, mathematics and practical aspects of daily life - and therefore to understanding the usefulness of these disciplines, the beauty of proceeding by trial and error as so often happens in life. They will experience the emotional and fun parts of mathematics through creative activities and exciting challenges, and the connections between maths, logic and games, through conversations triggered by "stimulus objects" and "review challenges" in small groups.

Within this project, students will have the opportunity to express themselves fully through techniques learned thanks to the observation and analysis of the works of Leonardo da Vinci, a figure represents the Universality of Science, which everyone can access to without distinction of gender, culture or ability, therefore has no borders nor exclusions.

Where STEM indicates scientific subjects (Science, Technology, Engineering and Mathematics), STEAM introduces A for Art to indicate an interdisciplinary approach that widens its reach and partially overlaps with humanities and arts.

Examples of projects supporting STEAM education in Italy:

- Prometheus project

Through immersive theater experiences, *"capable of arousing emotions of sublime and profound wonder, allows boys and girls, mainly between 13 and 16 years, at risk of dropping out from school, to experiment with new ways of learning about science. These emotions, as even Aristotle claimed, represent the real engine of knowledge"*, says Andrea Gaggioli. But there's more: *"In one of our studies, we discovered that wonder can also have an empowering effect on creativity, making our thinking more flexible and less stereotyped."*

This approach defies stereotypes also regarding the iconic figures of science, such as "the scientist", who is not presented as cold, lonely and calculating, living in bare and aseptic laboratories, but as a person excited and thrilled by and through knowledge. *"Emotions are not an accessory, but the key element with which we characterize the scientific research process,"* Alice Chirico explains.

Just think *"not only about the moment of scientific discovery but also, and above all, about the time spent researching,"* she adds.

The moments of eternity *"are those moments in which we seem to grasp, or even just touch, if only with a finger, this infinite space in which we are all immersed and towards which we're usually indifferent and distant"*, says Chirico, who maintains that emotions and wonder are the channels that can bring young people closer to STEAM.

"When we live these moments - Alice Chirico continues - *something in us trembles and tries to take on a completely different, new, transformed shape. Therefore, why not create opportunities for wonder in every context of our life, starting from school, moving our working life and the world of science?"*.

With this approach, young people not only can approach scientific disciplines in a totally different way, but they could advocate themselves this sense of wonder in us "grownups", infecting us and helping us get back in touch with something we often put aside growing up.

- STEAM-H – Improving STEM learning experience in primary schools through a STEAM-based multidisciplinary approach

The European project (Italy is one of the partners) aims at supporting teachers and educators in understanding the potential of using a STEAM approach and organising and implementing STEAM activities in primary schools to improve student learning experiences and teachers' ability to deliver them effectively.

The STEAM learning approach offers a real opportunity to address these needs. It aims at engaging students in a multi- and interdisciplinary learning context, breaking down barriers that have traditionally existed between different classes and subjects, and offers learners opportunities to make new connections.

The STEAM-H project is seeking to generate particular impact for primary school teachers/educators (Primary target group) and primary school students, particularly potentially disengaged or disadvantaged

students, and students with low STEM performances (final beneficiaries) through the creation of original materials, activities and training modules to support the implementation of STEAM activities.

RESULTS FROM RESEARCH CARRIED OUT BY THE SUNRAISE PARTNERS – ITALY

RESULT OF THE SURVEY – INFORMATION ON THE METHOD OF CONDUCTING THE SURVEY (TO HOW MANY PEOPLE/INSTITUTIONS AND TYPES OF INSTITUTIONS THE INVITATIONS WERE SENT + STATISTICAL INFORMATION FOR EACH QUESTION SUPPLEMENTED WITH GRAPHS

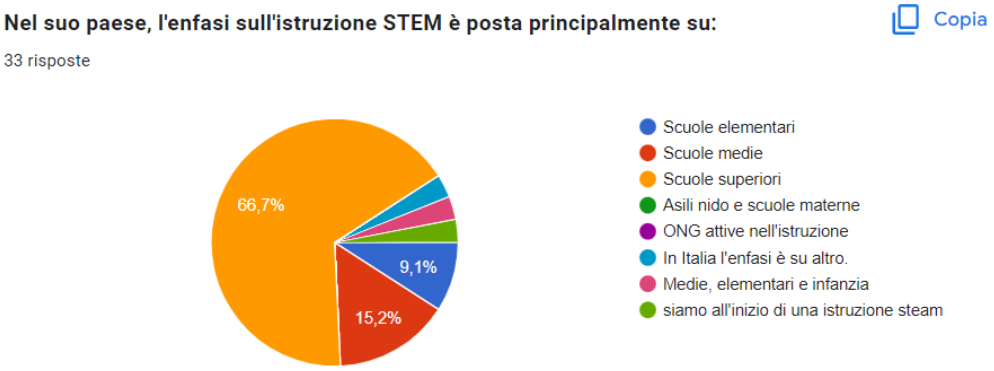
35 responses

34 out of 35 respondents know what STEM is and are able to decode its acronym (Science Technology Engineering Mathematics). The school subjects/scientific disciplines included in STEM education in Italian schools are, with different denominations depending on the level (first or second level secondary school) and type of institution (Technical Institutes, Vocational Institutes, Licei etc) : Integrated Sciences (Physics, Chemistry, Biology, Earth Sciences), Electronics, Electrotechnics, Computer Science, Mechanics, Technology and Graphic Representation Techniques, Applied Science and Technology, Information Technology, Mathematics, and other technical disciplines with different denominations present in Technical and Professional Institutes.

However, 17.6% do not know the difference between STEM and STEAM. The remaining 80.2% know how to decode the acronym and also specify the fact that with these approaches it is not simply a matter of lumping subject titles together but are inclusive methodologies that embrace skills and teaching subjects in a way that resembles real life, based on competences, reality tasks and disciplinary transversality.

AT THE ITALIAN LEVEL:

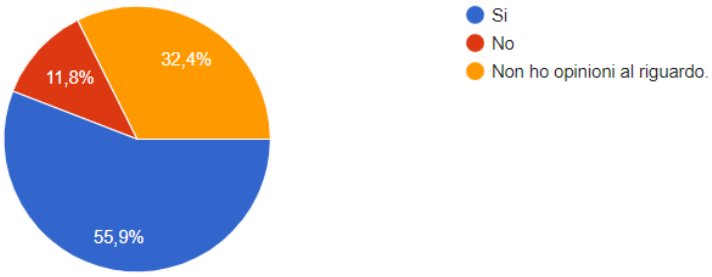
The majority of respondents believe that, at the Italian level, the emphasis on STEM education is mainly placed on high schools (66.7%) and middle schools (15.2%).



The majority of respondents recognize that STEM education is fundamental to meeting the needs of a changing world and to the technological and scientific advancement of society.

L'istruzione STEM è importante nel suo paese? Può fornire dettagli nella prossima risposta.

34 risposte



According to more than half of the respondents, STEM education is important for Italy because:

Society is strongly influenced by the enormous development of science and technology and today's learners cannot learn with approaches that are out of step with the times: it would be like speaking two different languages. The teacher is no longer a mere transmitter of knowledge, but a facilitator of learning.

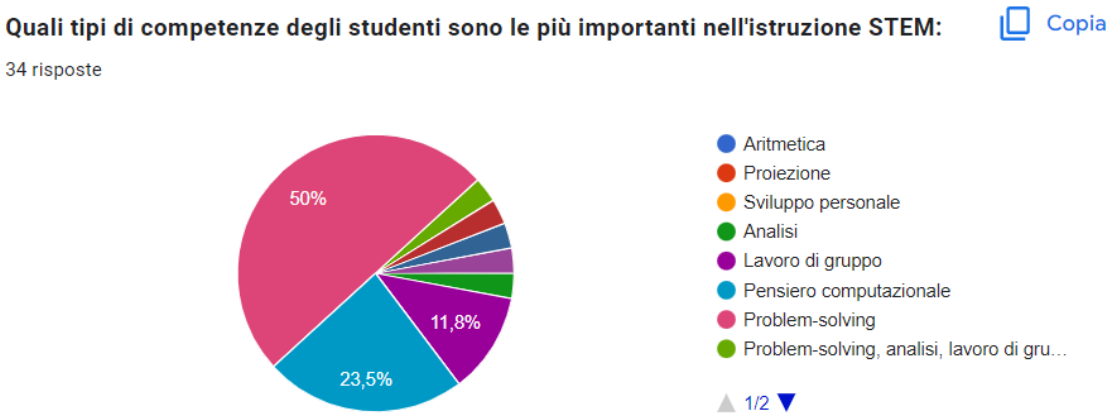
In Italy, both the world of private companies and the world of institutional bodies, as well as the Ministry of Education and the Ministry of Research are pushing in this direction. In an increasingly complex and fragmented working world, STEM education favors the acquisition of transversal skills (e.g., computational thinking and problem solving) that can make it easier to enter the working world and face the challenges of the future.

The answers to the importance of STEM could therefore be many: from enhancing computational thinking in pupils by focusing on real-world applications in a problem-solving perspective, to the possibility of fostering and strengthening gender equality, to providing an effective educational tool to enhance equality and promote differences, within the school community, as individual opportunities to grow together by developing those transversal skills that lead to a harmonious personal and professional identity. They constitute a key set of competences that are today fundamental for the understanding of numerous mechanisms underlying civic and social life.

Those who answered NO believe that:

The Italian didactic tradition, with its Gentile imprint, is rather based on the pre-eminence of humanistic subjects. And also, that, yes, there is talk of STEM, but the right drive, mentality and tools to apply the STEAM approach are effectively lacking.

According to the respondents, the types of student skills that are most important in STEM education are: Problem-solving (50%). Computational thinking (23.5%) and Teamwork (11.8%)



Most

Most respondents (61%) have a shared opinion (neither agree nor disagree) that school staff actively engage with students with disabilities to help them in STEM education. The remainders are divided between agree and disagree, probably also in relation to personal experiences within the institutions where they work. 31% disagree with this statement and believe that staff are also not active due to lack of accessibility of tools to teach STEM to students with DSA or 104, lack of trained staff (not only curricular teachers, but also support staff). Those in agreement (8%) believe there is an opportunity to use new tools and technologies and to activate active and highly inclusive teaching strategies and methodologies.

Example of support solutions provided to students with disabilities for better STEM education: The action of the teacher must not be that of a facilitator in the educational process of students with disabilities but must design activities in which the propensities of these students emerge so as to build a strongly collaborative environment based on positive interdependence. The pupil with disabilities must be seen as a fundamental resource for the group.

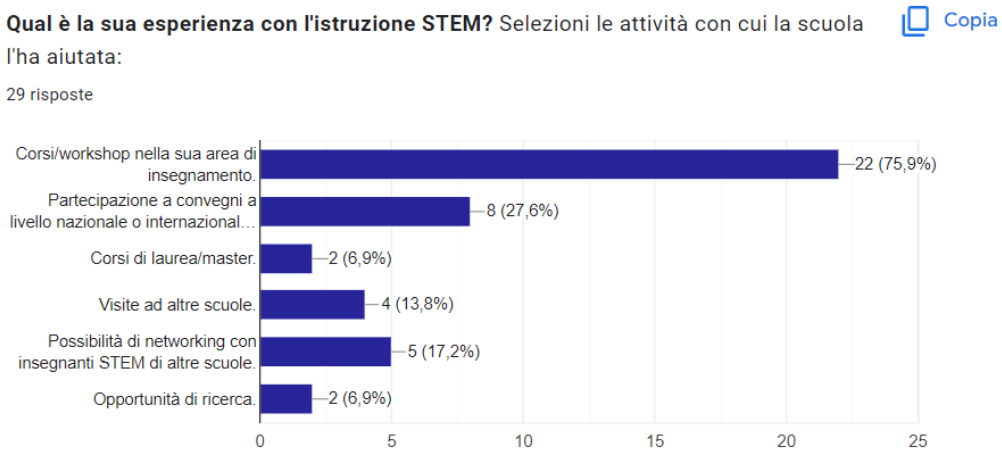
In any case, half of the respondents believe that school staff are not very knowledgeable in their STEM teaching areas. The other half have no definite opinion (neither agree nor disagree); only a small proportion believe that the knowledge is there.

The school supported participants in gaining experience with stem education through:

- Courses/workshops in the participant's teaching area (75.9%)

- Participation in conferences on STEM education (27.6%)

- Networking opportunities with teachers from other schools (17.2%)



20% of respondents recognized the government's commitment to allocating resources for schools to build new learning environments/digital learning to apply STEM education. However, there has been much focus on the medium (device) and little on people and their training and support in designing activities.

35% emphasize that there has been little development and that there has been more talk than implementation of innovative activities and methodologies. In addition, the strong regional gap is highlighted and the fact that there are still several problems related to the lack of adequate spaces to do STEAM education and practical activities.

More than half of the participants (54.5%) have never tried innovative methods for better STEM learning.

Those who answered YES, use:

- Jigsaw-based making activities.

- Experiments in the science lab or classroom, use of applications to create games and tools from everyday life (traffic lights, windscreen wipers...), mathematical experiments with graph paper, coloured paper and sheets.

- Gamification.

- Metacognitive activities, aimed at enhancing pupils' awareness, competence-based teaching.

- Game-centred teaching strategies and peer education.

- Coding, robotics, laboratory and open class activities, innovative teaching methods with BYOD devices.

- Reality tasks and simulations of real cases such as retail trade.

- Active participation in multimedia production of topics covered in class.

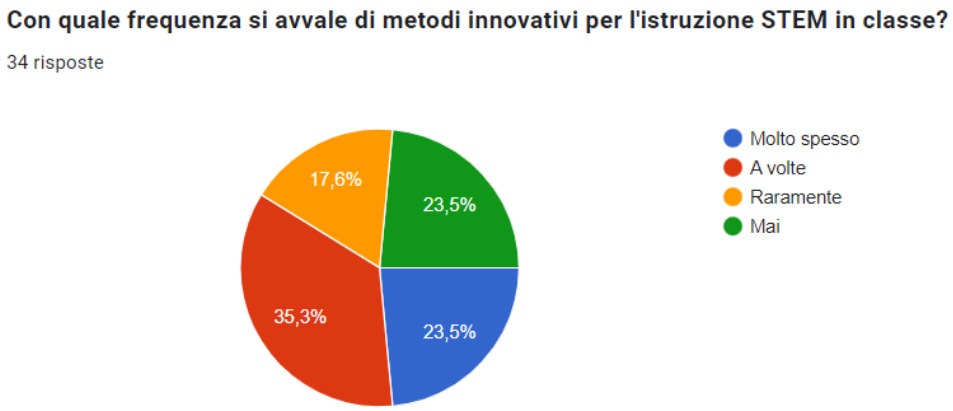
- Realization of didactic experiments through virtual reality.

- Use of methodologies such as CBL, cooperative learning, storytelling.

- Mix of methodologies depending on circumstances and audience.

- Inquiry-based learning, learning-by-doing, problem posing and solving.

Almost 60% of the respondents use innovative methods very often/sometimes. The remainder rarely/never.



Comments or suggestions regarding STEM education in Italy to improve the learning experience:

- It is a type of approach little used within schools partly due to lack of competence of some teachers partly due to lack of instrumentation that even trained, or more willing teachers can use

- I think it could be useful to promote the sharing of practices and applications (in a bottom-up sense). Moreover, in schools, devices made available through calls for tenders and funding must be put in place through an upgrading of the infrastructure that is currently unable to support their effective use

- There is a need to equip all study courses with reinforcement teachers on Stem subjects, so that extracurricular initiatives can be planned

- There is no specific stem-related training for in-service teachers and no training for incoming teachers: think compulsory refresher courses

- The training proposals should be enriched

- It would be necessary to completely rethink spaces, structures, environments, and personnel and above all the curriculum of the disciplines (Stem organized in the school cv)

- Creation of permanent workshops

ANALYSIS OF RESPONDENTS

62.9% are teachers working in the field of STEM education. Mainly they are teachers of math and science (also chemistry and physics), technology, computer science, electronics.

Half of the respondents work in secondary school (middle school) and the other half in secondary school (high school).

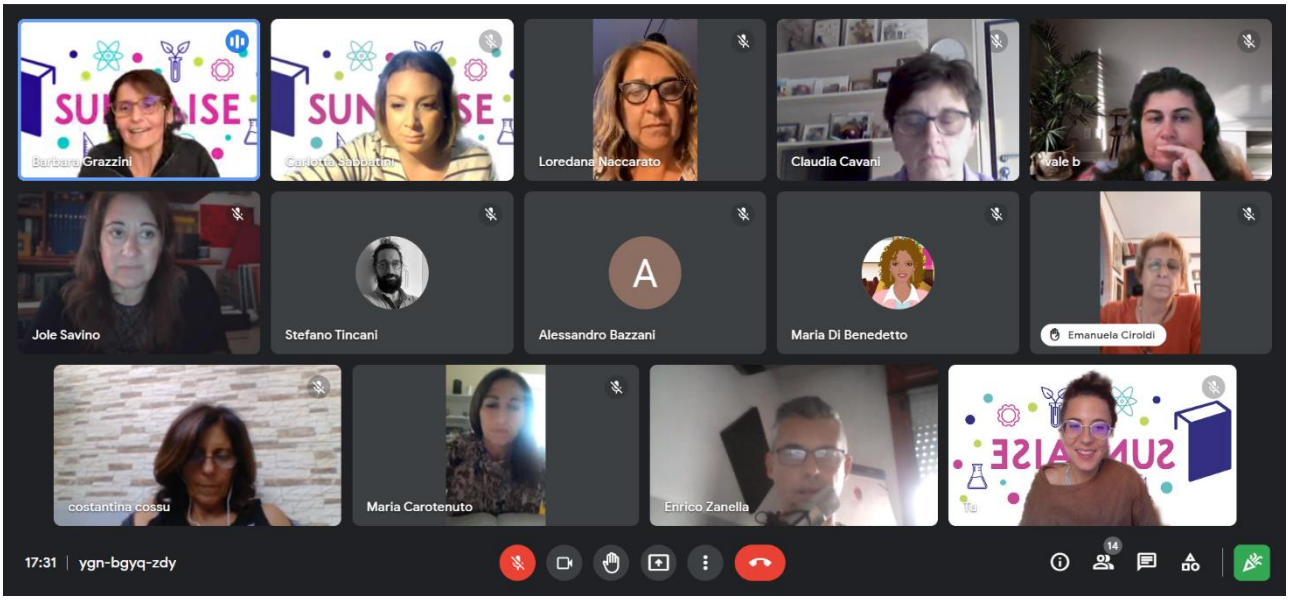
All of the respondents have a master's degree, some have continued their education with a doctorate or postgraduate/master's degree.

Most of the respondents have a permanent employment contract (88.6%). The remainder have fixed-term contracts.

They have been working in their school/institute since:

THE RESULTS OF THE FOCUS GROUP STUDIES WITH INFORMATION ABOUT THE QUALIFICATIONS OF THE PARTICIPANTS

In Italy, two focus groups were organised. We had respectively 10 and 17 people signed up for the activity. Eventually, the total number of participants was 13. They were STEM teachers from Scuola Secondaria Inferiore (low secondary school – age 11 to 14) and Scuola Secondaria Superiore (high secondary school – age 14 to 19), educators specialized in STEM and STEAM education, educators and artists specialized in performative arts (music and dance).



(screenshot from one FG)

From the various experiences cited by the teachers and educators present, it emerged that the STEM approach is used in an interdisciplinary way and skills from different subjects (stem, but not only, humanities subjects as well) come together. There is a contamination between theory and practice, where often subjects such as science, mathematics, chemistry, an expression of a field of pure research, merge with the tools, resources and skills of technology and engineering, which have instead a more applied dimension.

The STEAM approach, that is, the incorporation of creative thinking and the Arts to the stem approach, is undertaken in some schools, less widespread. It is mainly concerned with Art understood as visual art (art digital, painting, graphics etc.), less as performance art (theater, dance, music). However, art is recognized as functional to the learning of subject science.

For both approaches (STEM and STEAM), potential is recognized and the added value that is brought to classrooms: more stimulated students, engagement from multiple perspectives, increased curiosity, strengthening of the pupil-teacher relationship and among students (peer education dynamics are created), development of soft skills (critical thinking, problem solving etc.) in students, bringing out the talents of students that usually do not emerge with traditional approaches, inclusion of students with learning difficulties. What arise as important is the transversality of the approaches.

The difficulties encountered by teachers which emerge in proposing and implementing STEAM activities are the following:

- Inability to team up with colleagues, lack of cross-curricularity.

- Widespread resistance from teachers because it is thought that these projects delay curricular programs, often labeled as wasting time.

- Despite the effectiveness and interest that these projects stimulate in children, they are often put on the forefront of the school curriculum.

- Not everyone is predisposed to technology or the use of that out of traditional teaching methods (frontal lecture).

- Resistance from families.

During the focus group, given the presence at the meeting of Scià Scià Orchestra's conductor Enrico Zanella, artistic director of the Scià Scià Orchestra of the Cooperativa Nazareno (the orchestra works on the concepts of inclusive music educational methods), experiences and impressions were shared regarding STEAM projects that involved music. The role of music as transversal and inclusive was acknowledged by most of the participants.

One of the participants shared her publication "Musica nelle STEAM Musica nella scienza o Scienza in musica" http://www.rivistabricks.it/wpcontent/uploads/2022/03/02_2022_14_Cossu.pdf on Music and STEAM. A very interesting example of creative and innovative laboratory on the publication, which was directly tried by the teacher participating to the Focus Group was the "DNA dance & protein synthesis": starting from a similarity between the sequence of musical notes and the sequence of amino acids, one can propose to students a collaborative choreographic experience. Teachers and/or dancing pupils, to the sound of music, transform from nitrogenous bases into proteins.

A GENERAL SUMMARY OF THE NATIONAL RESEARCH CARRIED OUT, HIGHLIGHTING THE SUGGESTIONS FOR SUPPORTING STEM EDUCATION WITH ARTISTIC METHODS AND TECHNIQUES

The specific added value of the STEAM approach is the adoption of a multidisciplinary and interdisciplinary approach in which STEM subjects and the Arts (with particular reference to performative arts, in our case music and dance) work together toward a common goal, facilitated by a multiple educational methodologies, depending on the subject or context (flexibility in the methodologies is essential to provide opportunities to engage students from multiple perspectives). The holistic approach that includes STEM subjects and the Arts enables students to perform better in every area of their lives, by understanding STEM as something very much related to the real world, encouraging creativity and innovation and increasing curiosity, making STEM subjects more relevant and inclusive for students who usually find them boring and daunting. It is recognized that arts-based strategies differentiate learning, foster creative thinking and practical innovation, and create an environment that is inclusive and equitable.

From the research carried out, interviewed participants generally believe that using a STEAM approach and teaching students to think critically and creatively can be the key to the development of a society that understands and is fully engaged with the world around it, and in planning and creating a better future. However, there is still a deep-rooted trend to perceive this approach as time-waisting and several teachers still prefer to use traditional methodologies (frontal lectures).

In the coming years, as the report highlights, many of the challenges that Italy will have to face will depend on the ability to innovate teaching and improve learning of Stem subjects (science, technology, engineering, and mathematics). It is crucial for our country to introduce new educational systems in the study of Stem subjects. To do so, we will need a change of aptitudes in teachers' approaches and a greater openness to innovative methods in teaching those subjects, as well as an infrastructural upgrade, a key aspect of creating innovative and technologically appropriate learning environments. A radical change which also needs to be driven nationally, with the promotion of the sharing of practices and applications (in a bottom-up sense), the rethinking of infrastructures and environments, the improvement of school's structures and instruments, and above all the he promotion at all levels of broader initial and in-service training that includes and incentivizes stronger pedagogical preparation also for teachers of STEM disciplines, training them especially in the adoption of diversified and flexible teaching practices, so that they are able to design for their meaningful learning moments, involving them in designing and conducting experiments related to real-life problems.

APPENDIXES

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