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Overcoming the STEM Gender Gap: from School to Work

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Abstract: Despite improving education and better performance, women in Italy remain largely under-represented in the technical-scientific tracks. This form of segregation, due to both enduring gender stereotypes and the peculiar structure of the Italian education system, tends to exclude women from the more requested professions. The lack of further education policies and targeted interventions in support of a transition from school to work for young people, makes for endemic school-work mismatch affecting the entire students supply chain by creating a dual male-female labour market in the economy 4.0. The purpose of this work was to develop a best practice in order to bridge the gender gap in the STEM area, both at school and later in the workplace. Results of the action research project named "STEM Women: A Challenge for the School, an Opportunity for Businesses, a Search for Talents", covered the Piedmont Region. An operational network was set up, including representatives from universities, public institutions, schools and technology enterprises. A survey involving a sample of 572 high school students, evaluated male and female STEM preference, quality of teaching and orientation for future employment. To promote female self-confidence in personal scientific ability and help in deciding to choose a career in STEM, researchers and female leaders from technology Companies were asked to hold meetings at high school level, and visits to STEM firms were organized. In the final stages of the research project, a public meeting was held to enable male and female students to discuss the cultural, economic and social implications of increased female presence in the STEM professions.

Keywords: STEM gender gap, school-work transition, skill mismatch, gender bias

Introduction

The term "smart", with its polysemic implications, is the keyword for society 4.0, defined as the combination of Third Industrial Revolution linked to ICT and Fourth Industrial Revolution associated with robotics, artificial intelligence and IoT. Smart cities and communities, smart factories, smart production, smart energy, smart work, and smart people, all describe a world in which the relationships between people and technology will become increasingly closer and immersive. In order to keep up with 4.0 transformations, in addition to adopting new technologies it will be necessary to bridge the gap in digital and technological skills, to redefine professional paths, establish new relationships between business, school and institutions and enhance the capacity for self-activation and cooperation among all those involved. New increasing challenges and expectations will render transition from school to work even more crucial. In Italy, the peculiarity of the educational and training system accentuates the complexity of the transition process, owing to scarce orientation opportunities, low permeability between technical and humanistic school paths, limited opportunity for exchange between school and the labour market.

Alternating school-work initiatives are still mostly left to the voluntary personal commitment of teachers rather than being the subject of institutionalized programs (Cavaletto et al., 2015; Ballarino, 2013; Pastore, 2015)

Although the *Buona Scuola* reform of 2015 made dual training compulsory for all types of schools, the education system is still unresponsive to labour market requirements, especially in high school tracks. The issues of skills mismatch, skills gap and skills shortage in the Italian educational system are made worse by the gender gap in the STEM (Science, Technology, Engineering and Mathematics) domain. The objective of increasing skills and narrowing the gender gap in these fields is closely related to the decision of developing effective strategies to direct transition from school towards the labour market.

Also, the employment forecasts for the period after 2020 (UnionCamere and Ministry of Labour data, 2018), highlight both an increase in STEM jobs and a shortage of the right profiles to fill them. Salaries and overall employment levels are better in these sectors. Moreover, owing to the low levels of female employment in Italy (less than 50% according to ISTAT data from the beginning of 2019), involving women in technical and scientific training courses and in STEM jobs, is an opportunity for individuals and also for the competitiveness of the country as a whole. Consequently, the issue of how to guide today's female students towards more technology-based courses, from which they continue to be excluded and/or to exclude themselves, has become urgent.

Our aim was to develop a balanced, inclusive, efficient and effective research project capable of enhancing the talents and skills required by the new social and economic scenario. Sociological literature on inequalities in educational opportunities (Bourdieu & Wacquant 1992; Bracciale & Mingo, 2015) recently re-read by studies on the gender digital gap, provided the theoretical framework of this research (Berra & Cavaletto, 2019; Dumais, 2002; Avveduto, 2019).

Identifying strategies and practices for work experience schemes that facilitate an inclusive and fair process on the employment market, requires a strong joint commitment by schools, training establishments, businesses and institutions to create a gender-sensitive project. To this end the following must be considered: characteristics, behavior and attitudes of female and male students, the aims of the education system and its transformations; the expectations and needs of the economic system, its transformations and the actions implemented through public policy to facilitate partnerships between school and work.

This framework is the backdrop for the research, *Overcoming the gender digital gap, Strategies and practices*, conducted in the Piedmont region and involving students, teachers, firms, universities and public institutions[1]. The intention was not only to contribute to the investigation of this crucial topic, but also to identify an action methodology and an operating strategy to overcome this divide. Also, to build scalable and repeatable best practices to define virtuous cooperation mechanisms for orienting female and male students in their training and employment choices, as well as getting them accustomed to employment environments with a high technological and innovation content. A joint effort combining the cognitive aspect (representations on the labour market and occupational scenarios of adolescents) with the formative aspect (providing interpretative tools to teachers and students on Industry 4.0). As shown below, the project involved both a survey and a training intervention to provide elements of knowledge with reference to school-job transition in society 4.0 through a gender lens.

[1] This is the Alfieri Project funded by Fondazione CRT and conducted by the Department of Cultures, Politics and Society of the University of Turin under the supervision of Mariella Berra and with the participation of Giulia Maria Cavaletto and Barbara Demo. The project is the convergence of two schemes: the action research mentioned earlier funded by Fondazione CRT and implemented by the Department of Cultures, Politics and Society of the University of Turin, and the project by the Regional Councillor in charge of equal opportunities for the Piedmont Region, which will run through the academic year 2019-2020. Participating in the working group that supports the project are the Piedmont Regional Counsellor in charge of equal opportunities, Piedmont Region Department of Employment, Education and Professional Training, the University of Turin, the Polytechnic University of Turin, Unione Industriale (with SkillLab) and a network of businesses located in the region and operating in the technical and technological fields.

Theoretical background

4.0 Economy, STEM skills and the gender gap

The relationship between new technologies and the growth in skills is universally recognised as a prerequisite for preventing and/or mitigating the lose-lose effect of technological changes accompanied by high unemployment, a shortage of the required skills and growing inequalities[2]. The employment scenario for the period after 2020 points to an increase in STEM jobs and a shortage of suitable profiles to fill these vacancies, especially among women.

Although female students from more recent cohorts have shown better school performance, lower drop-outs and repetition rates (ISTAT BES, 2014; INVALSI, 2016;) than their male peers, there is still a wide gender gap in mathematics and computer science (Amici et al., 2016; Tomasetto et al., 2012). The trend in gender disadvantage covering "hard sciences" shows signs of reversal far from encouraging. Women are not adequately represented in these fields, in both high school and degree courses, with significant repercussions in terms of employment. All national and European data show that women are completely absent from entire segments of the employment market and professional profiles including Data Protection Officer, Digital Information Officer, Cyber Security Expert, Big Data Engineer, Mobile Application Developer, Data Scientist, Expert in Agile Methodologies and Internet of Things Expert.

Two opposite assumptions help to interpret current trends, namely "standardisation" and "stratification". The first shows that the IT and science skills gap will gradually diminish. The second points to increasing levels or the ongoing status of gender inequality. The role of schools is key to reducing the gap by establishing a more inclusive and fairer environment. In these dynamics, the orientation and approach to market segments and professions of the Economy 4.0 are crucial, for both students and teachers, still too often linked to stereotypical models.

The process of enablement-orientation and transition through work experience

The ongoing gender divide in training and professional choices is one reason to reflect on the educational and orientation models of school and educational syllabuses, from primary school to secondary school, university and be-

[2] On this subject see https://www.weforum.org/reports/the-future-of-jobs-report-2018; https://www.weforum.org/press/2018/01/reskilling-revolution-needed-for-the-millions-of-jobs-at-risk-due-to-technological-disruption/. The recent DESI (Digital Economic Index) 2018 report placed Italy in 25th place out of 28 countries. More specifically, in terms of human capital, Italy fell from 24th to 25th place.

yond. In Italy, the *Buona Scuola* reform made it mandatory for all categories of schools to introduce a total of 200 hours of work experience (Alternanza), including in humanities and science high school, which had previously been on the sidelines of the process, and 400 hours in technical and vocational schools. At the time of this research such were the rules of Alternanza between school and jobs. Subsequently, the number of hours was changed by the Conte government[3]. Due to the difficulty of implementing the dual training system, from school year 2019-2020 Alternanza was replaced by the PCTO reform (Percorsi per le competenze trasversali e l'Orientamento), which involved a significant reduction in compulsory hours for all school supply tracks.

Italian schools also have to cope with small businesses, which are technologically backward and unable to provide proper and useful training support.

Nevertheless, there is growing openness between schools and the workplace This change in attitude by enterprise towards training and education is in line with a new vision of educational systems called on to help students acquire skills, knowhow and strategies through participation in communities of practice (Cavaletto, 2013).

School and business are encouraged to develop formal and informal learning experiences for both male and female students (Di Nubila, 2004). Increasing institutional projects aim to overcome gender stereotypes. Examples of these are the ministerial programmes "Il mese delle STEM" (STEM's month) and "D'estate si imparano le STEM" (Learning STEM in summer), and business-led schemes like Nuvola Rosa (Pink Cloud) and NERD.

Numerous international studies conducted on work-based learning (WBL) or work-related learning (WRL) have demonstrated the effectiveness of actions in which the world of education and the world of work cooperate to create learning environments and facilitate pupils' discovery of the workplace through the development of useful soft skills and important relations with the outside world (Hopkins, 2008). The connection between the learning content and the contexts in which it applies is the value added obtained from bringing together schools with the work environment. For interpreting what connects schools, the market and the institutions, a valuable contribution comes from the theory of the third generation of activity, according to which there is no such thing as isolated or individual learning, indeed

[3] As recommended by the European Commission (EC, 2010; EP, 2000), Italian legislation was first introduced in 2003 for technical and vocational schools, subsequently extended to other types of schools with Law no. 107/2015, providing for classroom-based theoretical training and practical work experience in the workplace. The aim of this compulsory project was to bring all students of the last three years of high school into the workplace, so as to acquire experience when searching for work in the future. As set out by the reform, starting from the 2019-20 school year, the completion of school-work alternation hours should be a mandatory requirement for admission to A-level.

only interconnected learning. Students learn, organizations learn, institutions learn through processes of continuous interconnection, in a network system (Thuomi-Gröhn, 2007). The common denominator for all players is their joint participation in, and construction of, a shared goal. This process, summed up in recent studies and educational and organizational research as poly contextuality and boundary crossing, highlights guidelines to steer the difficult transition from school to work (Akkerman & Bakker, 2011; FitzSimons, 2012; 2008).

According to these indications, students should be guided towards a plurality of environments and should overcome the boundaries of their own environment, while having the opportunity to recontextualise differences, priorities and aims, and acquire knowledge and skills from other contexts (Griffiths & Guile, 2003). Schools, business and institutions should interact, within their own specific interests and aims, in an organic goal-oriented system where all participants share the methods for achieving the goal. The aim of transmitting knowledge and building skills that can be used and distributed fairly in the job market, entails changing curricula, teaching methods and using new instruments and technology applications. Particularly significant is the transition from methods based on codified knowledge (know what) towards other types of "useful" knowledge (know who, know why, know how and know with whom), which provide an appropriate response to the demand for soft and hard skills coming from the workplace, with a view to overcoming the gender divide (Cavaletto, 2013).

Gender STEM divide and gender representation

Structural, social and cultural factors contribute to explaining the digital gender gap. In sociology of work and organization literature, the difficulties and behavioural responses of women employed in environments traditionally male-dominated find an explanation in tokenism and strongly asymmetric work groups theories (Moss Kanter, 1977). Three main theories explain women's position in the labour market: human capital, discrimination and gender construction identity. The theory of human capital states that a shorter career path and less competitive positions produce a lower human capital and penalize women (Blau & Kahn, 2017). The discrimination theory highlights the fact that, although gender differences in education have been reduced, and in some cases overcome, the position of women in the labour market is affected by their preference for jobs and occupations that enable a balance between work life and home life or that are considered more suited to their characteristics and their personal interests. According to this theory, women tend to prefer professions they identify more with, because they are motivated by positive judgements on their social utility, or by criticism of the prevailing work organization models (Akerlof & Kranton, 2000). Often, choices are influenced by continuing prejudices towards occupations considered more suitable for males or less socially desirable (Accornero & Meraviglia, 200). Thus, training and professional choices are often based on gender stereotypes internalized over a long period of socialization and training enacted by the family and school, and which help establish a condition of weakness and disadvantage for females.

These aspects emphasize the cultural aspect of the issue. Gender socialization (explicit or implicit within family and school) as well as wider social pressures, are almost functionally aimed at maintaining a social order in which conflict must be limited and minimized. A complete change of roles mainly in the family, but also within organizations, would constitute an identity challenge with two possible interpretations. Firstly, the social actors are placed in a condition of disorientation and fragility, deriving from the social complexity and fragmentation of roles (Bovone, 1999). Secondly, individuals have the opportunity to build their own path and identity through self-socialization (Maccarini, 2016) - a process characterized by pro-activity, communicative capacity and decision-making - in which the subject becomes central (Scanagatta, 2002).

Thus, the gendered nature of disposition (habitus) that influences a person's actions shapes the view of opportunity structure that women and men perceive as available to them. Different socialization experiences between girls and boys in their school system may lead to different positions in society.

The research

Description and methods

The project entitled "Overcoming the STEM gap - Strategies and Practice", involved high schools, technical and vocational tracks in the Piedmont region (4 high schools and 6 technical and vocational schools). Experimental activities saw the participation of students, humanities and science teachers, university researchers, representatives from businesses and the Piedmont regional councillor responsible for equal opportunities (Consigliera di Parità).

The research consisted of four stages as follows:

1. Online survey with questionnaires for all students
2. Classroom-based training on the transition to Economy 4.0 transformations in the labour market, the occupational landscape
3. STEM Tour for students in businesses participating in the project
4. Public speaking events (debating for and against) on specific topics.

The results of the questionnaires were evaluated, providing some hints for the other project stages.

In the first stage, questionnaires investigated the previous and current school careers of male and female students, the suitability of technology and science teaching, as well as its relevance to the labour market, prospects for higher education, career projects, gender differences in study and employment pass and how they are represented.

In the second stage, six hours of classroom-based training to highlight the gender divide and its effects, dealt with the following issues: transition to the post-industrial economy, employment landscape, organizational transformations in Industry 4.0, assessment of the relationship between educational and training profiles and inclusion in the job market. The last of the six classroom hours was dedicated to meeting "STEM witnesses": two women in each school, from different cohorts (one aged under 40 and one over 50), who were invited to talk about their STEM career (since educational choices and professional experience) and to interact with students.

The third stage consisted of a four-hour visit to a company partnering in the project for all schools. The tour included: introduction of the company, description of production processes, presentation of the organizational chart, a visit to the production plant and a roundtable with students and STEM personalities.

The fourth and final stage of the project was a public speaking event, on five topics relating to the social, economic and cultural implications of new technologies and their gender impact, with arguments for and against made by delegations from the schools, followed by a debate between schools[4].

The action research required to use a mixed methodology including survey and qualitative analysis (with participant observation during students' visits to companies, focus groups with teachers and representatives from companies in the final event with the students).

To interpret the results, we referred to our own "model of the 5C"[5], which describes the indispensable resources and the objectives of future workers, with C for K(C)nowledge (Conoscenza), C for Competence, C for Cooperation, C for Competition, and C for Consciousness.

The first stage of the research (lessons in schools) covered two Cs, i.e. knowledge and consciousness. Knowledge defined as the sharing of contents on the history of organizations, market transformations and industrial revolutions. Consciousness developed from the meeting with STEM testimonials

[4] The following topics were proposed to the students: Soft skills and Industry 4.0: Can and should they coexist? Ethical technology: Implications of the extensive use of technologies 4.0; New jobs, new ways of working and new working hours: The impact on women's careers? Choosing STEM: A matter of gender?; School for inclusive growth and the transfer of digital skills?

[5] The 5C model is defined as such because in the Italian language the five activities / objectives of the project begin with the letter C: Conoscenza, Competizione, Cooperazione, Consapevolezza, Competenza

and sharing of their experiences. The second stage focused on two other Cs: Competence and Consciousness. Competence, as the STEM Tour highlighted, is the relevance, for the labour market, of transversal skills, assessed by companies, as well as certification of knowledge and qualifications issued by the school. Awareness, because talks and round tables with the STEM workers in the company have favoured a realistic shot in the representation of what is the labour market. The last stage was the Public Speech gym: a comparison between arguments and counter arguments, followed by debate, presented by delegations of students per school on five topics. Why a moment of peer debate? To describe two other Cs, namely cooperation and competition, through topics for and against.

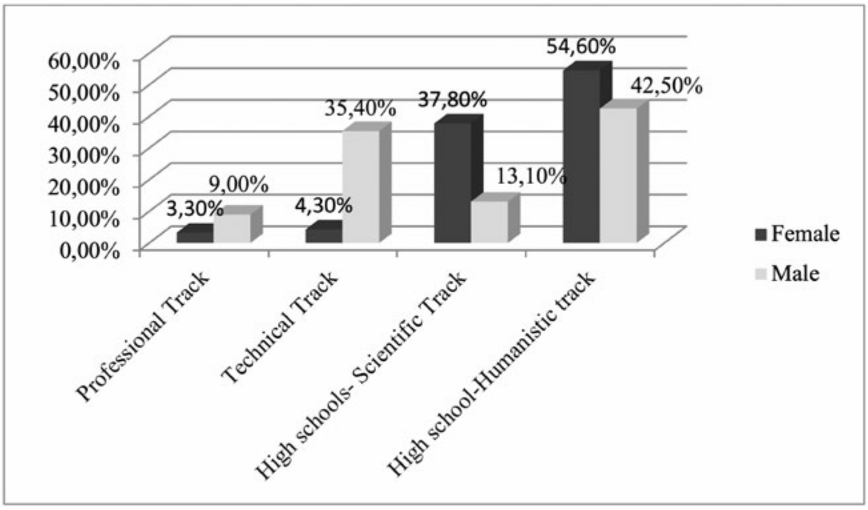
Learning from the field: the students' voice

The online questionnaire was answered by 572 students across 10 schools in Piedmont, including 304 girls, 268 boys, that is 53.1% and 46.9% respectively of all interviewees. The respondents were mainly third form (16 to 17-year-olds) and fourth form (17 to 18-year-olds) in the various schools (65.9% were third-year students, 26.6% were fourth-year students), with one second-year participating class (15-16 year olds, 7.5% of respondents). Most students interviewed were born in 2000 (25.7% of the sample) and 2001 (57% of the sample). In addition to these, 7.2% were born in 2002 (mainly second-year students), 9.8% were students who had repeated a year (and were therefore behind in their school career; a trend in line with the national average) and 0.4% of students were "ahead". Interviewees were Italian citizens (93.4%) and the remaining were foreign citizens from several countries (mostly Romania**).**

The general data from the questionnaire confirm the main trends and dynamics in Italy regarding the choices and school performances of male and female students (AlmaLaurea and AlmaDiploma data across several years). In terms of gender distribution of students across different schools, Graph 1 shows a significant presence of female students in both humanities and science high schools, whereas the concentration of boys is higher in scientific and technology courses. In the last two types of schools (vocational and technology) girls are very few.

Choosing a high school is a crucial step towards choosing a profession, even in an open context like the Italian school system where different schools do not necessarily determine specific occupational opportunities. Nevertheless, choosing one type of institution over another is not without consequences, because it exposes the student to a higher probability of entering certain careers.

Graph 1 - Distribution by gender across high schools.



Explain choices: families, marks and disciplines

In order to explain current educational paths, the questionnaire explored two domains: marks in the previous path, and cultural characteristics of families. The marks obtained at the end of lower secondary school confirm the trend of the main national surveys, i.e. students get better results on average. Table 1 shows a concentration of female students in the excellence range (marks equal to or higher than 9). But these results can also be related to the education status of parents, mothers in particular. The importance of the role of parents' education in the final grade at lower secondary school also appears in other ways. In fact, children of graduate parents have easier access to high school paths, whereas those with less qualified parents are more likely to be in the vocational or technical tracks. These local data match the national data. School careers are cumulative stories, i.e. success facilitates access to academic chains, whilst failure leads more easily to professional paths.

Table 1 – Marks at the end of the lower secondary school

	MARK =or > 7	MARK= 8	MARK = or > 9	TOTAL
FEMALES	23,7%	28,9%	47,4%	100,0%
MALES	35,1%	35,1%	29,9%	100,0%
TOTAL	29,0%	31,8%	39,2%	100,0%

The track differentiation probably continues after graduation, highlighting extremely wide variations between high school, technical and vocational tracks and, in some cases, between genders. On average, the propensity to continue studying is higher for female students (98.2% in scientific high school, 95.7 in classical studies, 69.2 in technical and 80% in vocational training) than for male peers (93.9% in scientific high school, 94.3 in classical high school, 62.1 in technical and 20.8 in vocational training). Thus, the effect of the track compared to the prospects of tertiary education is overshadowed by the (positive) thrust of (female) gender. Among those who, regardless of track, wanted to continue their studies (Table 2), the preferences for tertiary paths were divided as follows: 34.9% scientific paths, 23.1% humanistic/political/social, 28.7% other types of training, not necessarily university.

Therefore, at the aggregate level, regardless of track, students mainly showed scientific orientations regarding tertiary education. However, when gender is factored in, results change.

Female students showed a strong preference for the literary field or other (unspecified) paths, (this confirming the disorientation still evident in the penultimate year of high school compared to subsequent choices); the preference of young people for the technical scientific field and other paths (including ITS, which instead got 0% from girls) is indicative of a gender gap in training and vocational choices.

Table 2 - Preferences of students by gender and path

	SCIENCES	BIO MEDICAL	HUMAN SCIENCES	LAW AND ECONOMICS	OTHER	TOTAL
FEMALES	7,0%	21,8%	17,6%	14,1%	39,4%	100,0%
MALES	37,9%	16,5%	3,9%	16,5%	25,2%	100,0%
TOTAL	20,0%	19,6%	11,8%	15,1%	33,5%	100,0%

There is also a relationship between marks by discipline in the secondary school and the choice of the subsequent paths: looking at marks in our survey, the investigation reveals that girls achieve better results than their male peers in both science and humanities; 81.2% of female students had marks of at least 7 out of 10 in humanities and 70.9% in science and mathematics (compared to 65.3% and 65.4% for males respectively). Girls are also ahead in the excellent marks bracket: 39.9% averaged marks of 8 out of 10 and over compared to 24.2% of boys; and 36.8% showed excellent marks in science and mathematics, compared to 32.1% of their peers.

Thus, these results contradict the stereotype that female students are less inclined and less capable in scientific subjects. The male and female students in our sample were also highly aware of the fact that technological skills, particularly computer-related skills, are very important for employment. However, there is a significant difference between the attitudes of boys and girls: 25.7% of female students did not consider that area of study important compared to 13% of their male counterparts. The negative responses of female students may be due to less familiarity with the workplace and with the demands of the labour market. In this sense, orientation and a closer relationship with businesses, as well as interdisciplinary teaching methodologies between technological and scientific subjects might help correct such unrealistic representation.

This aspect is connected to what was achieved at the STEM Tour research stage, where the possibility of observing closely what is happening in the labour market, has induced critical reflection on the stereotype linked to certain jobs, and stimulated critical appraisal of the Self and its life chances.

Regardless of the science education received at school, this is another crucial element of transition to the workplace, considered satisfactory by fewer female students (56.2%) than male students (68.3%). Possibly it is an indication of teaching methods not in tune with the difference in learning styles between boys and girls (Tamanini, 2007). Considering the type of school attended, girls choosing the humanities high schools, where more emphasis should be placed on subjects like science, technology and mathematics and work experience schemes, are more critical.

What types of jobs?

Another interesting variable for understanding representation of students about the labour market is knowledge of future jobs, which shows that boys and girls are still generally under-informed, as shown in Table 3. There is also an appreciable difference between how informed boys and girls are about certain professions, according to gender stereotype: girls are better informed about jobs such as web communications experts, human relations managers and social marketing, which all involve relational and social skills, more congenial to females.

Students' answers highlighted a further problem at the final qualitative stage, especially as regards the focus groups with teachers. A process of socialization to the legitimacy of one's own expectations still strongly gendered persists, even if often implicitly.

Table 3 – Knowledge of boys and girls about professions

	ALL (N= 572)	ONLY MALES (N=268)	ONLY FEMALES (N=304)
Agile Methodologies Expert	9,1%	12,3%	6,3%
Big Data Engineer	16,6 %	19%	14,1%
Data Scientist	18,4%	23,9%	13,5%
Digital Information Officer	34,3%	37,3%	31,6%
Administration Manager	48,1%	51,5%	45,1%
Internet of Things Expert	51,6%	59,7%	44,4%
HR Manager	57,3%	51,1%	62,8%
Artificial Intelligence Expert	62,1%	74,3%	51,3%
Mobile Applications Developer	64,3%	75%	54,9%
Cyber Security and Data Protection Expert	70,3%	72,4%	68,4%
Social marketing expert	76,4%	73,5%	78,9%
Web Comunication Expert	83,2%	82,1%	84,2%
Robotics Expert	84,8%	86,2%	83,6%

It is not yet clear why, despite good school marks in scientific disciplines and awareness of the importance of technological and scientific training for employment, upon entering the workforce students are faced with the stereotype that identifies the most technological and scientific professions as being more suited to men.

Table 4 shows the jobs students were asked to report on, and the percentages of those considered "more suited to women". The picture that emerges confirms the stereotypes and the widespread social acceptance of horizontal occupational segregation.

For this reason, the STEM Tour stage provided an opportunity to deconstruct the persistence of a gender stereotype regarding women's technical and scientific professions.

A stark polarisation was noted between the ideas of male and female interviewees concerning the underrepresentation of women in the technology and science fields.

Table 4 – Suitability of professions for women

PROFESSION	**% OF WOMEN**
Airplane pilot	1.2%
Video game developer	1.4%
Computer scientist	1.6%
Nuclear engineer	1.6%
Military	1.6%
Mechanic	1.6%
Electrician	1.9%
Designer of photovoltaic systems	2.4%
Installer of telecommunications devices	3.3%
Expert in agricultural productions	4.0%
Heart surgeon	8.4%
Creator of a start up in the ICT sector	11.5%
Biotechnologist	12.6%
University professor of maths and physics	17.8%
Climate change analyst	18.0%

For female respondents, as shown in Table 5 (55.3% of girls interviewed) women are no longer underrepresented, suggesting that the stereotype has been overcome; albeit with 41.1% of girls admitting underrepresentation and suggesting that it is due to women being less interested in these fields (it is not clear whether induced by the processes of socialisation or spontaneous). The percentages are reversed for male respondents who admit that stereotypes and inequality are ongoing (only 28.4% do not believe women are still underrepresented).

Table 5 – Reasons for the underrepresentation of women in technological and scientific professions

	I DON'T THINK IT'S STILL LIKE THIS	**THEY ARE LESS INTERESTED IN THOSE SUBJECTS**	**THEY ARE DIFFICULT PATHS FOR A WOMAN**	**TOTAL**
FEMALES	55.3%	41.1%	3.6%	304
MALES	28.3%	63.1%	5.6%	268
TOTAL	42.70%	51.40%	6.00%	572

This highlights the emergence of the stereotype as early as adolescence and its internalisation. Participation in the different options provided by the education system shows that it is a fertile ground for gender equality; unlike the employment market, where the remaining limitations and resistance are probably due to representations of the status of adulthood and different roles (starting with parenting roles) having different impacts on male and female perceptions.

The lack of knowledge of male and female students regarding the transformations that will affect the workplace in the near future, and the lack of information on the demand for work, both contribute to continuing stereotypical opinions concerning professions and profiles (also gender-related) of those concerned. These results confirm on the one hand the need for schemes supporting gender equality in education and consequently in employment and, on the other the need for closer and more systematic interaction opportunities between schools and the employment market.

Another theme of investigation was social desirability of occupations. Table 6 shows the desirable job characteristics divided by gender and articulated among those related to materialistic and post-materialistic needs.

Table 6 – Materialistic and post materialistic job elements
MATERIALISTIC ELEMENTS

	WAGE		**POWER**		**CAREER**		**PRESTIGE**		**VISIBILITY**	
	A little/ nothing at all	Much or very much	A little /nothing at all	Much or very much	A little/ nothing at all	Much or very much	A little/ nothing at all	Much or very much	A little/ nothing at all	Much or very much
FEMALES	28,9	71,0	66,5	33,6	18,5	81,3	57,6	42,4	66,1	73,9
MALES	20,1	79,9	50,0	50	14,9	85,1	41,8	58,3	53,0	47,0

POST MATERIALISTIC ELEMENTS

	SPARE TIME		CLOSE TO HOME		SATISFACTION	
	A little/ nothing at all	Much or very much	A little/ nothing at all	Much or very much	A little / nothing at all	Much or very much
FEMALES	26,9	73,0	59,5	40,5	4,0	96
MALES	28,8	71,3	67,2	32,8	8,2	91,8

The gender factor is very important: power matters a lot more for males than for females, whereas visibility has the opposite effect. The data on post-materialistic elements are very similar, job satisfaction being very important for everyone, as is leisure time. The variable more desirable for both males and females is "satisfaction", indicating that work is considered a constitutive element of individual identities.

Finally, both males and females are generally optimistic about the future, given that according to students' opinion (40.3% and 35.5% respectively) the employment scenario will see an increase in skilled labour. However, a realistic representation points to a decrease in job availability regardless of the level of qualification, this being a perception of female students (32.2% against 27.2% of males), which reveals their greater fragility on the labour market. Overall, interviewees were realistic about their chances of employment, only 27.6% of female students thinking that the future would offer them more opportunities than in the past, compared to 28.7% of the students. Hence the perception that before completion, the transition to the fourth industrial revolution will be difficult and far from straightforward.

A partnership of actors: lights and shadows

The creation of a cooperative network of businesses, schools, universities and institutions was a prerequisite for the success of the project. However, several critical areas need to be considered when designing processes for the school-work transition.

Reflecting on the steps of the research, overall schools (teachers) are satisfied and positive about the project, as emerged during focus groups and from the questionnaires. Compared to stage one, classroom training has been polarized as regards effectiveness of intervention between high schools on the one hand, and technical and vocational tracks on the other. In the former, training was well received in terms of both content and modalities, with active participation by students; in the latter, effectiveness was much lower, with less interest and greater difficulty in retaining concentration. This provides a useful starting point to reflect on. Training was designed and provided by university researchers, with a modulation in different study paths, but with substantially unchanged content. High schools show a strong proximity to methods and vocabulary that will be used at university; conversely, for technical and vocational tracks, there was a prevalence of the "practice knowledge" in their activity, compared to theoretical training. The lack of technical and vocational schooling was also noticed by businesses during the STEM Tour. Even with better technical preparation, companies appreciated high school students as they were considered "more complete", from the point of view of knowledge, transversal skills and codes of conduct. The number of lesson hours decided at the start of the project were based on the need to provide students with notions, information and knowledge about topics (the labour market, its characteristics, occupational scenarios, etc.) completely beyond the scope of their schooling: therefore an indispensable passage.

This aspect, even if different for the various school tracks, highlights the continued lack of a link between school and the workplace. The transition therefore continues to be critical precisely because the representations of demand, scenarios and opportunities of the workplace are still unrealistic. Also, the difference between school courses requires further thought, with a view to develop permeability between labour market and study paths to conquer prejudices and stereotyped representations.

Thus, the STEM Tour was considered to be highly educational, showing students up close what the business world actually is, the complexity of organisations, how the different roles and functions are interrelated and what skills are needed. Moreover, meeting female leaders working in male-dominated sectors helped reflect on the job and career opportunities for female students, and on the importance of overcoming existing gender prejudices and establishing collaborative relationships between men and women. The STEM tour also highlighted the significant divide between teaching and the labour market, innovation and the production processes of Industry 4.0. The resulting effects translate into ineffective and sometimes even misleading orientation practices. Orientation, a little practiced activity, is further downgraded due to the lack of information and updating by the teaching staff.

Furthermore, the marked difference between schools affects the ability to achieve successful school-to-work transitions. Work experience being compulsory by law, schools are required to look for certifiable opportunities to be included in student portfolio, often based on bureaucratic requirements. The small number of participating schools in each school year is due to the financial and organizational unsustainability of the project and to the small number of businesses capable of supporting students, reflecting a lack of awareness within schools, among teachers and principals, regarding occupational transformations and their gender implications. Also, the different paths of high school have different degrees of proximity to the labour market: if for technical and vocational tracks traditionally there are educational opportunities in the field, for high schools the experience is totally new. And whereas such proximity to the market for all supply chains is important, the peculiarity of high schools as places of theoretical training by definition cannot be over emphasized. A label that dies hard.

Relationships with companies are affected by the characteristics of businesses and their internal structure, previous experience on similar projects and the willingness of HR departments to get involved in the projects. Alongside enterprises already working with schools in the field of social responsibility and sensitive to the issue of gender equality (sometimes with active Women's Networks), there are companies with less experience but "curious" and willing to rethink their role in the community. Incidentally, participation in the project was not without cost. Businesses were asked to identify female STEM witnesses and to take part in regular meetings to organize, evaluate and implement the project. At the end of each monthly meeting, tasks included feedback to the subsequent meeting. Such tight operational schedule required each company to involve one or more HR functions and specific areas of company structure (usually IT, communications, etc.). The relationship between companies and schools is itself crucial. Although contacts take place mainly within the technical and professional supply chains, in reality companies demand high school students, because of their greater skills and higher job flexibility.

Another critical issue concerned the various organizational and procedural restrictions for the public and private sectors. The former is subject to slow, formal and highly bureaucratic procedures, whereas the latter operates autonomously and can make quick decisions. Schools have curricular and other restrictions, related to internal procedures, formal approvals and certification. On the contrary, being able to act freely businesses were asked to adapt to the needs of the other partners. This difference, both in timing and in the approach to decision-making and translating them in practical terms, caused additional work when organizing shared events.

Despite sharing the final objective, i.e. combating the gender stereotypes that discourage women from taking up STEM careers, the strong commitment of teachers and business representatives notwithstanding, there proved to be different ways of achieving results, which needed mediation and direction from two external players, namely the university and the Regional Councillor responsible for equal opportunities. These institutions covered the role and empirical research was the element of joint participation.

Conclusions

The project involved school policies regarding work experience and the transition from school to work, as well as gender equality policies. Schools are the terrain on which equitable interventions and actions against gender stereotypes can take place. However, they attract little state funding. The effectiveness of projects aimed at taking action against the preconditions of gender inequality, is based on two requirements: continuity over time and early intervention. As this is a social and cultural issue, only action that begins from childhood and continues throughout a person's life can produce appreciable results.

The data collected indicate that the process of exchange between school and work is much more relevant than mere employability, covering a field in which definition of identity, recognition within a group, belonging to a system of shared rules, conventions and expectations are put to the test. Thus, interventions carried out in this stage of training and educational path of individuals, i.e. near the transition from school to work, may have limited effectiveness, because the roots of stereotypes date back from an earlier age.

Another aspect in the transition from school to work concerns the teaching methods used in scientific subjects and the creation of an interdisciplinary relationship between scientific and arts disciplines. When applying STEM in all schools, one should also consider the role of the humanistic component of academic content (Nussbaum, 2000). Interaction between them can play a significant role in guiding educational choices and promoting the growth of the soft skills needed in the workplace and in society as a whole

Overall, the results of this study point to the gap existing between representation and reality: the labour market as imagined is very different from that of the real world. This critical issue could probably be resolved easily, with more opportunities for interaction and exchange between environments. What would appear more difficult to solve is the problem of stereotyped gender representation, which places a burden on both males and females. For both, this is a replication of the existing order. Maybe we are facing a selective mechanism implemented by the very students, so the scrutiny of all the options available would be a difficult task involving the disruption of established cultural references (including those related to gender identities). Accordingly, some representations and some choices are also due to the fact that, from a rational viewpoint it is more efficient and less expensive to move within one's own comfort zone, supported by one's own socialization, by the references of the social group to which one belongs and by the socially shared representations regarding opportunity and adequacy.

The gender gap issue is much wider than that of STEM gender. Therefore, the goal is not to address only female students, by increasing their awareness of the problem and showing them new opportunities. The aim is to highlight the stereotypes and prejudices shared by all, including male students, by addressing the real dual cause at the root of every stereotype. On the one hand by counteracting self-exclusion, and on the other by highlighting the baselessness of the reasons given to justify segregation, both in occupational and educational terms, but also as a symptom of social imbalance and unequal opportunities. Thus, the cultural and technological conditions contributing to the training and educational processes that help build socio-technical capital, could be broadened. In turn, this would add to shared and widespread innovation enabling the broad social inclusion of the yet partially excluded or those still indifferent to the potential of new technologies and the new economic landscape.

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