# ESCALATE

## ITALY – LOMBARDY REGION

# Evidence Base for a Skills Escalator – Data Science (WP4)

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## List of Abbreviations

| | |
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| ESCALATE | Coordinated Higher Institutions Responses to Digitalisation, Erasmus+ KA2 - Cooperation for innovation and the exchange of good practices, KA203 - Strategic Partnerships for higher education |

| | |
|---|---|
| EU | European Union |
| WP | Work Package |

## Useful Definitions[1]

**Digital Skills:** Competences in and / or knowledge of IT tools including computer programs and programming languages.

**Digitisation / Digitalisation of Jobs:** Job automation by means of computer controlled equipment.

**Baseline Digital Skills:** Digital literacy skills that employers ask for in the vast majority of jobs across all sectors in the UK job market. Includes spreadsheet and word processing tools like Microsoft Excel and Microsoft Word, as well as enterprise management software like Oracle or SAP. These proficiencies are increasingly becoming a basic skill requirement for most occupations.

**Skill Rate**: it refers to a measure to quantify the pervasiveness of digital skills in individual professions as it emerges from the needs of the market.

1 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/807830/No_Longer_Optional_Employer_Demand_for_Digital_Skills.pdf

# Executive Summary

This report aims at describing how the Italian partner of the Consortium (Bicocca University) built the Escalator scheme that it is represented in the last page as a result of a study which included 6 different steps:

1. Choosing the GEOGRAPHY LEVEL OF THE ESCALATOR
2. Identifying the SMART SPECIALISATION on which the Escalator will focus
3. MAP THE DIGITAL SKILLS 'PIPELINE'
4. POLICY CONTEXT & ALIGNED INVESTMENTS
5. DEVELOP the actual REGIONAL ESCALATOR
6. PRESENTING the main FINDINGS

Each step listed above is described in the report. In order to provide an executive summary at the beginning of the report we list the choices that have been made to elaborate the Italian Escalator framework:

- The GEOGRAPHY LEVEL OF THE ESCALATOR is the Regional one, focusing on the Lombardy Region which is the territory in which Bicocca University is located and operates.
- The THEME of the Escalator is DATA SCIENCE and consequently the professional profile of Data Scientist.
- The DIGITAL SKILLS related to the DATA SCIENCE topic were obtained analysing the Job Vacancies related to the Occupation "Data Scientist". For the digital skills linked to the lower educational level of the Escalator (e.g. primary school) we deepened the digital skills trying to simplify the complexity of skills by deriving the underlying skills: for instance, a particular programming language like "Python" could be simplified in the basic "coding skill".
- The policy context, defined after having detected the regional and national "education and skills' strategic priorities" in the ICT sector, was investigated through a series of interviews with policy-makers, employers, and education providers.

# Background to the ESCALATE Project

The ESCALATE project was the subject of a successful application to Key Action 2 – Cooperation for Innovation and the Exchange of Good Practices – of the Erasmus+ programme submitted by West University of Timisoara to the Romanian National Agency. The project has been developed by six partners from five EU countries, namely five universities and an independent company, which specializes in foresight and prospective - strategic studies for the public and private sector.

The official start of the ESCALATE project is 01.11.2019 and it is a 24-months project with the end date being 31.10.2021.

The aim of the project is to assist universities in implementing activities designed to increase the levels of digital competences for employability, upskilling, according to a growing range of employment generated by the digital economy, aligned with the needs of and opportunities offered by the job market and linked to professional profiles.

The primary focus is to understand digital education disruption and to enable open-source technology and innovative solutions for both educators and students, leading to increased learning-outcomes that meet the learning needs of students whilst also being relevant to the job market and societal needs (creating a 'better' digital future).

Our target groups are higher education institutions (HEI), education providers, teachers, learners for existing and new digital skills provision. Indirect target group consists primarily of those citizens with low levels of digital skills at risk from digitalization facing a keen need to acquire the digital knowledge and use of digital technologies, but also job market forecasters such as job market observatories.

The project has two linked objectives. Firstly, to help universities understand the scale and depths of the challenges they face from digitalisation - to enable them to formulate effective policy and education system governance - by developing and making freely available new methods and techniques in digital skills acquiring, fore sighting and forecasting. We will explore the state-of-the-art before developing and testing the new materials across 6 major themes.

Secondly the project will trial the potential of a new innovative framework (a Digital Skills Escalator) across a selected region in each partner country to test its potential as a tool to be adopted with the double purposes of (a) identifying where there is unmet demand and subsequent need for new digital skills provision and as a means of building a more holistic offer from education providers. This report addresses this objective focusing on the Lombardy region and in particular the city of Milan.

The University of Exeter has summarized existing practices and lessons learned from their work developing the Exeter Data Analytics Skills Escalator and has passed this onto partners who will then build policy and stakeholder relationships to enable testing of the model in their own region and policy landscape.

This report will be presented at Partner Meeting 3 where a methodology for utilising the findings with policymakers will be devised. This is likely to include meetings, regional reports, workshops, and events.

## The Concept of a Skills Escalator

Escalators are relatively new developments that seek to achieve the following two related, but not identical, aims.

1. To ensure a region has sufficient citizens skilled in a particular field/sector critical to economic success.
2. To ensure that the skills and training needed to enter or progress in this field/sector are available locally, at all levels.

The former can be understood as a driver of economic success and the latter is more concerned with inclusive growth. As a project we are looking specifically to develop Digital Escalators where the skills at the 'lower end' of the qualifications can be quite generic but will link into a very specific key sectoral need at the higher end. Linked to a City or Region's 'smart specialisation'.

A good example of this is the existing Exeter Data Analytics Skills Escalator is relatively broadly defined. It encompasses topics such as:

- Statistical understanding
- Digital and programming skills
- Use of AI and high end algorithm development for the analysis of 'big data'
- The translation of environmental intelligence into new products and services and local growth.

The Escalator is a framework that aims at mapping a pipeline of skills, or perhaps more accurately a 'funnel of skills', linked to a specific smart specialisation sector. The fact that a significant proportion of individuals may apply these skills usefully outside the prioritised smart specialisation sector is not problematic. Having a relatively broad and some might say flexible focus (in which the 'environmental' focus can be picked up or dropped, as convenient) enables engagement across a wide range of educational and other partner organisations and access to a wider range of opportunities.

The Escalator Model is not intended to be a fixed journey from school to Higher Education and CPD but instead is designed for people to enter and leave when necessary. Its purpose is to promote discussion, engagement and coordinated partnership activity.

# The Policy context in our city/region

## Important national priorities influencing the chosen sector

This report aimed to define the Escalator Model for Data Science in Lombardy, in particular in Milan, given the growing importance of this topic in companies and educational institutions in this Region.

A Data Scientist is a high-level professional figure who knows how to integrate knowledge relating to techniques, languages and information technologies with knowledge of statistical analysis techniques, methodologies and environments, applying them to management, analysis and use processes for business, administrative and social purposes of digital data. This professional figure will be increasingly central in public and private organizations that need to analyse data and information from a vast set of sources for their strategic objectives and development processes.

Several forecasts for the next thirty years assign data-intensive services, such as applications accessible on mobile phones, to over 70% of the labour market. According to several research works, a growth in the job offer in Big Data is expected again for the next few years, against 19% for the entire Information Technology (IT) sector and 6% globally. In developed countries, the Data Scientist occupies professional positions with remuneration that is at the top of the IT professional categories. Many of the successful start-ups in the world are in the Data Science area.

The Italian Government only recently supports the profession of Data Scientist by a few initiatives. Some of these are not directly aimed at the development of Data Science, but to the development of the subjects or topics that lead to Data Science.

One of these is the following: during the Pandemic in 2020 the Department for Equal Opportunities (under the patronage of the Council of Ministers) promoted, through a specific action, the creation of in-depth courses in STEM (Sciences, Technology, Engineering and Mathematics) for children between 4 and 19 years of age[2]. In the announcement, it is emphasized that skills in STEM subjects play a central role in the social, cultural and economic revitalization of the country. Therefore, Italy's Government encouraged their study, especially by girls, while encouraging the resumption of educational activities, severely limited during the early stages of the COVID-19 health emergency.

An institutional action directly aimed to Data Science is instead that promoted by the Ministry of Education, University and Research (MIUR), to start promoting PhD courses dedicated to Data Science[3]. First step was the creation of a Working Group with the aim of developing a long-term national strategy that brings together all the scientific groups present in Italy and structuring a national program of research doctorates on this topic. Resources were found to finance research doctorates and joint projects between the various entities involved in the Artificial Intelligence (AI) sector. Five thematic areas identified, to date, for the national doctoral program: Artificial Intelligence and Data Science, AI and cyber security, AI for health and life sciences, AI and industry 4.0, AI for environment and agriculture.

Before these, the initiatives of courses and educational paths for Data Science were developed by the individual universities, as will be seen in the paragraph dedicated to the educational offer.

[2] http://www.pariopportunita.gov.it/news/pubblicato-lavviso-stem2020-percorsi-educativi-nelle-materie-del-futuro/

[3] https://www.miur.gov.it/web/guest/-/intelligenza-artificiale-miur-al-via-il-gruppo-di-lavoro-per-una-strategia-nazionale

## Smart specialisations

Data Science was chosen as a smart specialisation because of its growing importance both nationally and regionally. At the national level we can mention the National Strategy for Digital Skills that inserts Data Science as a strategic skill among the objectives to be achieved by 2025: "strengthening and integrating specialist skills in the fields of information technology and computer engineering (data science and big data, artificial intelligence, cloud, cybersecurity, software development technologies, the architecture of processing systems), statistics, modelling, technologies and management techniques to support digital transformation and Industry 4.0 (Internet of things, embedded systems for the integration of Information, Telecommunications and Electronics technologies), robotics, high-performance computing applications, connectivity, service science, management of technological systems and their integration within the industry and public sector"[4].

## Data Scientist professional profile and skills

The present section provides data derived from the Observatory of Digital Skills[5], which monitor the demand for several professional profiles in the ICT area including the Data Scientist profession deriving. Figure 1 represents the increasing demand to employ Data Scientists in the Italian job market. The number of job advertisements almost doubled from the last quarter of the 2020 to the first of the 2021.

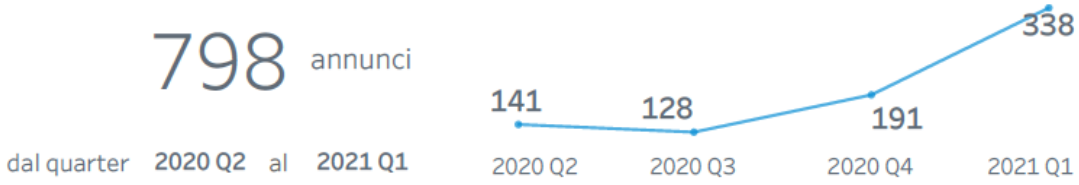


Figure 1: Number of job advertisements in Italy*[6]

Figure 2 shows in detail the demand to employ Data Scientist by economic/job sectors, for each sector (i.e. administration and support, consulting, financial and banking, commerce, transport and logistic).

[4] https://repubblicadigitale.innovazione.gov.it/assets/docs/national-strategy-for-digital-skills.pdf
[5] https://competenzedigitali.org/scheda-professione/data-scientist/

[6] **Source: our elaboration from the Observatory of Digital Skills report (2019)*

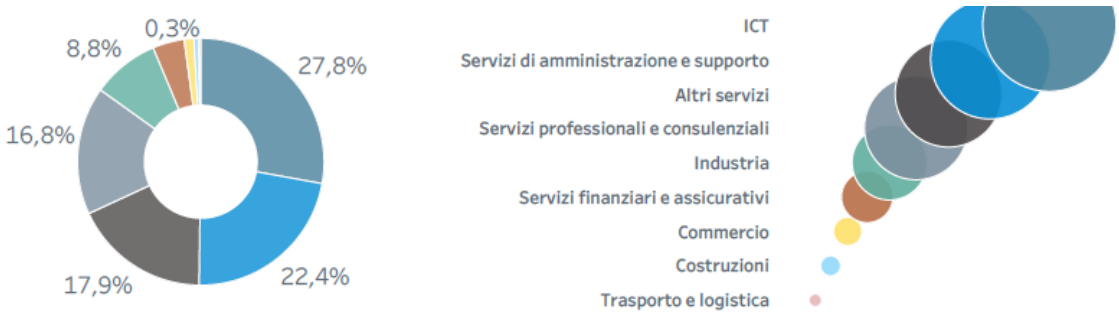


Figure 2: Analysis by economic sector*

Figure 3 shows the distribution of the demand for Data Scientists across the Italian national territory. A relevant data is the high percentage of demand for this specific profile in the North West area of Italy that include the Lombardy region.

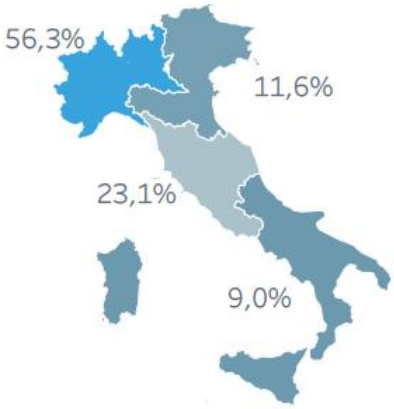


Figure 3: Analysis by territory*

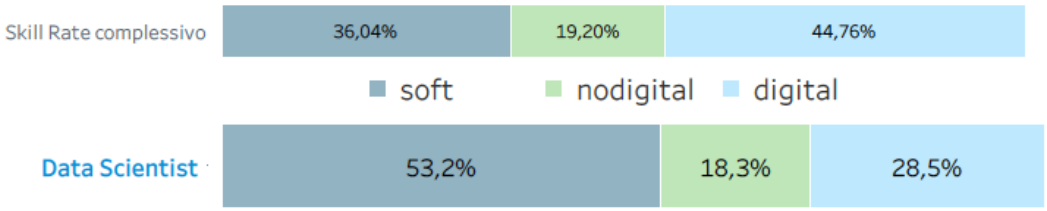


Figure 4: Skill Rate in 2019*

The Skill Rate (Figure 4) provides a percentage indication of the pervasiveness of soft, not-digital and digital skills within an ISCO profession in terms of frequency and relevance of the skills present within the profession. It is important to clarify that the intention of the Skill Rate is not the general profiling of occupations in terms of skills, but the measurement of the pervasiveness of digital skills in individual professions as it emerges from the needs of the market.

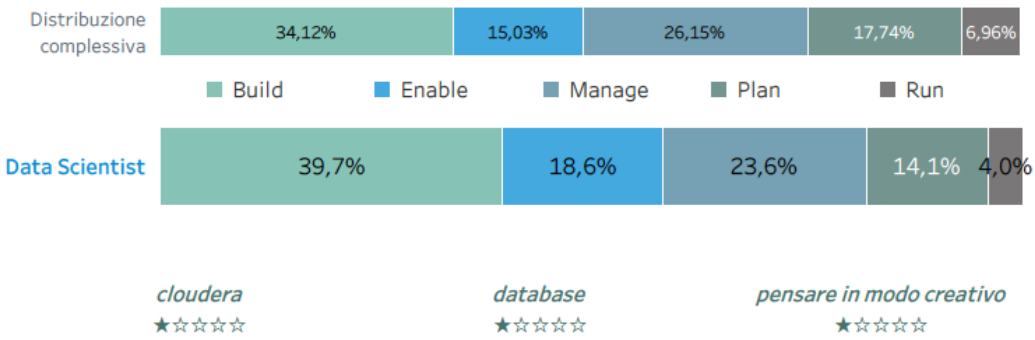


Figure 5: Skills Analysis in 2019*

Different areas of e-competence (e-CF) derived from ICT processes are reported in Figure 5, while figure 6 shows for each area the percentage of different skills required to Data Scientist professional profile, namely: Build, Enable, Manage, Plan and Run. As shown in the picture for the Build skills are required different percentages of the following skills: Plan (design and planning), Build (development, integration and testing), Run (exercise), Enable (support and enable), Manage (economic management and technique). For more information go to the webpage **http://www.ecompetences.eu/it/**

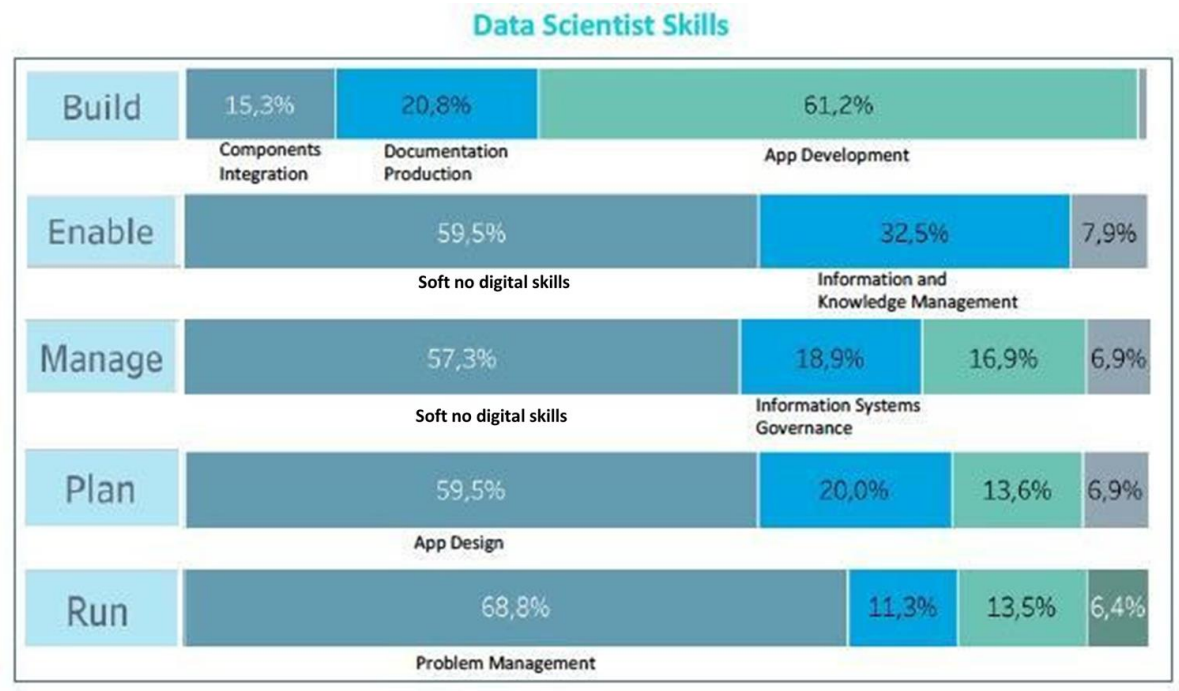


*Fig.6 Skill Rate for Data Scientist**

Overview of the main skills requested to Data Scientists

Based on the results described in the report of the Observatory on ICT competences[7] (2019) In the following, we provide an overview of the skills, attitudes and tasks mainly required to a Data Scientist, such as tasks related to machine learning and deep learning, to execution of analytical mathematical calculation, as well teamwork, creative thinking and vision to analyse problems to detect opportunities.

- Machine learning: the use and development of computer systems that are able to learn and adapt without following explicit instructions, by using algorithms and statistical models to analyse and draw inferences from patterns in data**.**
- Deep learning**:** is an area of machine learning whose goal is to learn complex functions using special neural network architectures that are "deep" (consist of many layers). General machine learning questions should be tagged "machine learning". Including a tag for the relevant software library (e.g., "keras", "tensorflow","python","fast.ai" etc) is helpful.
- Algorithms: the self-contained step-by-step sets of operations that carry out calculations, data processing and automated reasoning, usually to solve problems.
- Execute analytical mathematical calculations: apply mathematical methods and make use of calculation technologies to perform analyses and devise solutions to specific problems.
- Unstructured data: the information that is not arranged in a pre-defined manner or does not have a pre-defined data model and is difficult to understand and find patterns in without using techniques such as data mining. Also, called with the label “data analytics”.
- Working in teams: working confidently within a group with each doing their part in the service of the whole. Understanding and respecting the roles and competencies of other team members.
- Teamwork principles**:** the cooperation between people characterised by a unified commitment to achieving a given goal, participating equally, maintaining open communication, facilitating effective usage of ideas etc. Also, called with the labels “teamwork concepts”, “teamwork methods”, “teamwork approaches”.
- Business ICT systems: the software packages, hardware devices and new technologies used in supporting business processes such as Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), mobile devices and network solutions.
- Cloudera: Cloudera Inc. is a Palo Alto’s enterprise software company which provides Apache Hadoop-based software and services.
- Database: the classification of databases, that includes their purpose, characteristics, terminology, models and use such as XML databases, document-oriented databases and full text databases.
- Think creatively: generate new ideas or combine existing ones to develop innovative, novel solutions. Includes people performing activities outside the artistic or aesthetic contexts. Also, called with the alternative labels “anticipate needs”, “visualise completed project”, “seek out questions”, “visualise completed work”, “show originality”, “brainstorming”.

[7] https://competenzedigitali.org/osservatorio-delle-competenze-digitali/schede-delle-professioni-ict/

- Analyse problems for opportunities: identify and anticipate problems to choose a course of action, come up with appropriate solutions or even identify opportunities for further development.
- Manage data collection systems: develop and manage methods and strategies used to maximise data quality and statistical efficiency in the collection of data, to ensure the gathered data are optimised for further processing.
- Manage ICT data architecture: oversee regulations and use ICT techniques to define the information systems architecture and to control data gathering, storing, consolidation, arrangement and usage in an organisation. Also, called with the label "define enterprise data architecture".

## Education and skills' strategic priorities aimed at Data Science sector in Lombardy region and the city of Milan

### Education Offer in Data Science

In Italy, the importance of training the figure of the Data Scientist has been received at different levels by universities. The educational offer was largely created within the IT and IT engineering departments, which very frequently offer one or more thematic courses on topics closely related to Big Data. These courses are available for students engaged in "traditional" study paths, mostly master's, but also for first level degrees and doctorates. On the other hand, the presence of such courses within degree courses of different areas is not widespread. The intrinsic multidisciplinary nature of the topics and the variety of objectives chosen in the various universities are reflected in frequent collaborations between different departments and in a certain variety in the structuring of the training offer.

In all the courses considered there was the participation of students with very heterogeneous backgrounds. Significantly, the difficulty of successfully participating in these paths by students with humanistic education was highlighted: the main obstacle is the lack of basic knowledge required as prerequisites for participation, but also the orientation of the courses currently available, mostly focused on the economic sphere. In general, the difficulty of welcoming students was highlighted due to the rigidity of the requirements for admission to master's and master's degree programs: even students from scientific fields (e.g. medicine) often possess mathematical skills very far from those achieved during a three-year IT course and are therefore excluded from the admission requirements to master degree.

Another factor that has been indicated as a brake on training in this area is the lack of IT infrastructures necessary to process quantities of data comparable to real cases, as well as, in some cases, the difficult availability of data of sufficient quality and size.

The following are some examples of degree courses in Data Science offered in Italy:

Collegio Carlo Alberto, Turin, Master in Data Science for Complex Economic Systems (MADAS)[8]. The course offers theoretical and hands-on knowledge in advanced analytics – big data, machine learning network analysis, and agent-based simulation – and applies it to modelling, management, forecasting and policymaking in innovation, urban and consumption systems. MADAS faculty and partners ensure high academic standards and strong ties with the industry. (12-month program)

Politecnico di Milano, Master in Business Analytics and Big Data[9]. Business Analytics and Big Data master program is an innovative programme based on a holistic educational experience, where theory and practice are fully interlaced through the continuous support of companies and international partners. Furthermore, being in constant relationship with the Big Data Analytics & Business Intelligence Observatory of Politecnico di Milano, the course is at the forefront of research on ICTs for big data analysis and management. (12-month program, CS Rank: 37)

Università degli studi di Genova, Master in Computer Science - Data Science and Engineering[10]**.** The backbone of the program is 3 core units on advanced data management, machine learning, and high performance computing. Leveraging on the expertise of our faculty, the rest of the program is organised in four tracks: Business Intelligence, Health & Life Sciences, Pervasive Computing, and Visual Computing. (24-month program, CS Rank: 275)

Università Commerciale Luigi Bocconi, Milano, Master in Data Science and Business Analytics[11]. This program is designed for students having a strong bent for Computational, Statistical, and Mathematical Sciences and a genuine interest in working with data. Students will be taught cutting edge techniques for extracting impactful information from large data sets and for effectively communicating them to influence the strategic decisions of the organizations where they will work. (24-month program)

Sapienza Università di Roma, Master in Data Science[12]. Provides a solid and modern preparation, allowing graduates to understand and manage the many aspects of carrying out a complete data analysis, including its acquisition, management, and statistical analysis. (24-month program, CS Rank: 75)

Università di Padova, Master of Science in Data Science[13]. The program intends to build Data Scientists whose solid technical background is complemented by a multidisciplinary preparation on various fields in which big data emerges. Graduates will be able to master tools coming from Engineering, Computer Sciences, Statistics and Mathematics for collecting, managing and analysing big data, to translate their work into highly valuable information. (24-month program, CS Rank: 125)

[8] https://www.carloalberto.org/wp-content/uploads/2018/11/MaDassyllabusPythonintro.pdf

[9] https://www.som.polimi.it/course/master/babd-master-in-business-analytics-and-big-data/

[10] https://courses.unige.it/10852

[11] https://www.unibocconi.eu/wps/wcm/connect/bocconi/sitopubblico_en/navigation+tree/home/programs/master+of+science/data+science+and+business+analytics

[12] http://datascience.i3s.uniroma1.it/it

[13] https://www.unipd.it/en/educational-offer/second-cycle-degrees/school-of-science?tipo=LM&scuola=SC&ordinamento=2017&key=SC2377

Università di Milano Bicocca, Master in Data Science[14]. The objective is to train high-level professionals who are able to integrate knowledge related to techniques, languages and information technologies with knowledge on the techniques, methodologies and environments of statistical analysis, applying them to the processes of management, analysis and use for business, administrative and social purposes of digital data. (24-month program, CS Rank: 375)

The list shows that 3 out of 7 offers are concentrated in Milan, two are public Universities (Politecnico and Bicocca) and one is private (Bocconi). The Bicocca's Master was the first in Lombardy explicitly dedicated to Data Science. Furthermore, University of Milan-Bicocca (in collaboration with the CRISP Research Center) offers a 1st level Master degree in Business Intelligence and Big Data Analytics[15], now in its 10th edition, whose output profile is very similar to the Data Scientist.

## Employment in Data Science

The Data Scientist market is experiencing an incessant rise, which goes together with a pushed digitization of the professions. The BigData@MIUR Report of 2016[16] foresaw a growth in the job offer in Big data by 23% per year until at least 2020. Research by CRISP-Bicocca revealed that there has been a real explosion of job opportunities offered to Data Scientists, with an increase of 104% in 2017. According to that research, Lombardy leads with 48% of job offers in the field of Data Science on the national territory, followed by Lazio with 17%, Piedmont with 9% and Emilia Romagna with 8% (Figure 7).

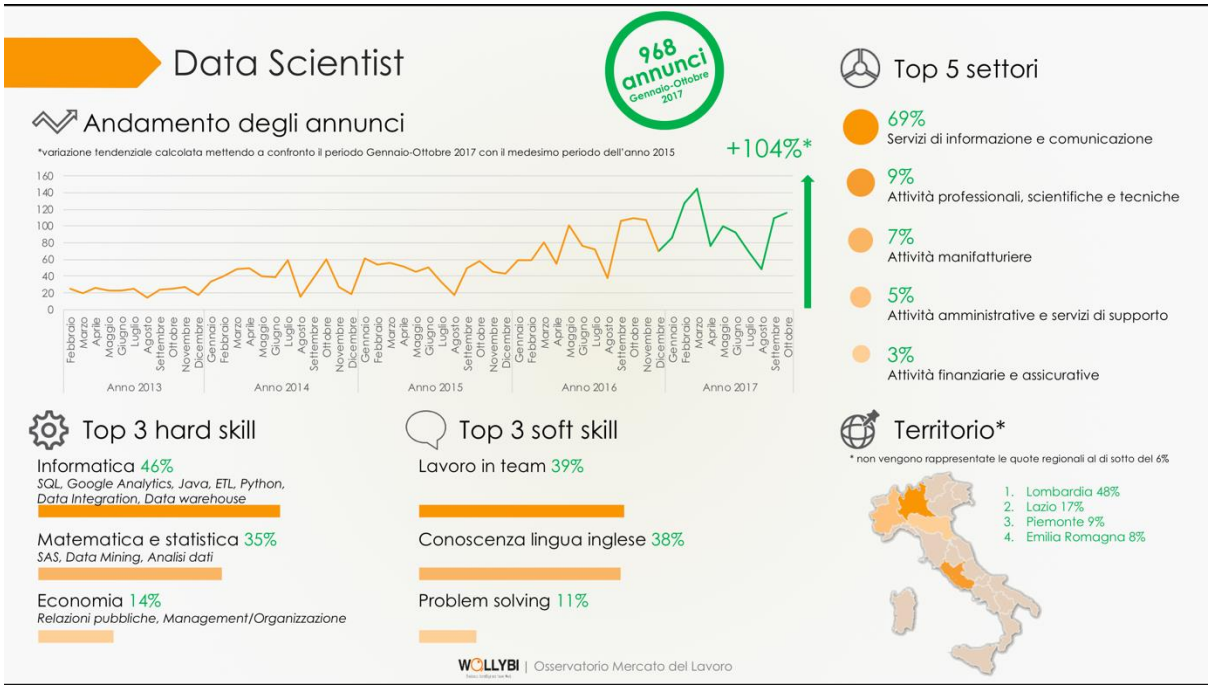


Figure 7: Data Scientist trend of announcements in 2017

[14] https://datascience.disco.unimib.it/en/

[15] https://www.crisp-org.it/bimaster/

[16] https://www.miur.gov.it/-/big-data-rapporto-del-gruppo-di-lavoro-del-miur

The growing demand for skills in the IT sector and new technologies is struggling to obtain a qualitatively and above all numerically satisfactory response.
From the employment point of view, as highlighted in the recent report drawn up by the Big Data & Business Analytics Observatory of the School of Management of the Politecnico di Milano[17], there is a strong and outstanding demand for specialists in the so-called 'Data Analysis'. It is the same Italian digital companies interviewed who report this: the difficulty of finding Data Scientists (detected by 53% of companies) is one of the main obstacles to development. There is a need for training and even a giant like Microsoft is well aware of this and is now focusing on Italy to cultivate the digital specialists of the future.
Microsoft's Chief Legal Officer Brad Smith announced: "the intention to strengthen the partnership with the university by opening a laboratory dedicated to Artificial Intelligence and Big Data", the third after the two launched at the Federico II University of Naples and at the Polytechnic of Bari. With this new investment, Microsoft will contribute to forming, in collaboration with CRUI (Italian University Rectors Conference), a total of 100 new Data Scientists.
"In a historical moment of economic stagnation, Big Data and Artificial Intelligence represent a huge opportunity for our country - said Silvia Candiani, CEO of Microsoft Italy -. Unfortunately, Italy is suffering from a strong skills mismatch, or a gap between the skills required by the labour market and those available. There is a lack of qualified professionals in the ICT sector where in 2020 it is estimated that 135.000 new positions will open that cannot be covered. It is therefore essential to invest in advanced training and help our young people to acquire the skills they will need for the jobs of the future"[18].
In 2020, the Covid-19 pandemic put a strain on Italian companies, highlighting the importance of data and the ability to make quick and incisive decisions in times of crisis. However, several companies that were about to start investing in Big Data and Analytics or to improve their technology were forced to postpone their plans for financial reasons dictated by necessity.
Nonetheless, the Big Data & Analytics market still records a growth of 6% in 2020, bringing the turnover to over 1.8 billion euros, but significantly slowing the pace compared to the + 23% and + 26% observed, respectively, in 2018 and 2019[19]. According to the research conducted by the Observatory of Politecnico di Milano[20], it is mainly large companies who invest in Big Data and Analytics solutions, where 96% declare that they have continued to enhance corporate data assets and 42% started experimenting with solutions or gaining Advanced Analytics skills. Therefore, the gap widens between mature companies, which have continued the transformation and acquisition of data skills, and novice companies, more likely to freeze their projects and stop investments in Big Data & Analytics in moments of crisis. Despite this, the trend remains positive also for SMEs, where only 32% said they had not invested or started Analytics projects, compared to 38% in 2019.

[17] https://www.osservatori.net/en/research/active-observatories/big-data-business-analytics
[18] https://www.openinnovation.regione.lombardia.it/it/b/573/ilnododatascientistinitaliaelasfidadipolitecnicodimilanoemicrosoft
[19] https://www.dataskills.it/big-data-analytics-italia-2021/#_ftn1
[20] https://www.osservatori.net/en/research/active-observatories/big-data-business-analytics

## Aligned Investments

Beside the investment from higher education institutions such as public Italian universities previously mentioned, The Silvio Tronchetti Provera (STP) Foundation and Pirelli have actively contributed to the definition of the contents of the Master's Degree course in Data Science at the University of Milan Bicocca since its activation in 2017. The STP Foundation and Pirelli have collaborated in nurturing contacts between the University and the corporate world, in line with its constant goal of encouraging young people to obtain scientific degrees. In the case of the Degree in 'Data Science' it was an important contribution to the digital transformation that is profoundly changing the traditional paradigms of businesses and constitutes an important opportunity for growth and development.

"Data Science is assuming an increasing importance for the job market with young people already confronting it today. For this reason, we have decided to support the new Master's Degree in Data Science and to encourage students who have distinguished themselves more through the study grants awarded today", underlines Marco Tronchetti Provera, President of the Silvio Tronchetti Provera Foundation[21].

The Foundation funded several times scholarships and study grants for the most deserving students of the degree course[22].

## Methodology

To design the Italian Escalator framework, which is focused on the Data Scientist professional profile and its skills, we adopted a methodology based on both quantitative and qualitative methods for data collection. The choice is motivated by the purpose to complement qualitative data with useful information to deeply understand the origin of eventual skills gap, how to overcome them and to detect possible opportunities to support the innovation of the educational offer.

A preliminary analysis on the demand for Data Scientist at job market level was conducted by consulting the data provided by the Observatory on Digital Skill in the ICT sector at the CRISP research center of the University of Milan-Bicocca. This first step of analysis was useful to support our choice to research the ICT sector and on the specific professional profile of the Data Scientist.

A second phase of data collection was conducted by running a structured questionnaire[23] designed with the aim to engage teachers, educators and stakeholders directly involved in the delivery of the educational offer from primary school to post university levels in the Lombardy region. To achieve this latter goal, the questionnaire was sent by email to a sample of educators, teachers and professors from different educational levels to include respondents from primary school to university. The questionnaire timeline went from June to July 2021.

A third phase of data collection was conducted by performing unstructured interviews. The interviews were addressed to a group of respondents who previously fulfilled the questionnaire (i.e. referents from primary school who adopt the MAB method; university professors who design and realize the SVELAMI-B project, a project dedicated to "STEM for children'' and focused on gender inclusiveness), and referents from career advisory services of the University Milano Bicocca.

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[21] https://www.liberoquotidiano.it/news/economia/23476746/fondazione-silvio-tronchetti-provera-premia-studenti-piu-meritevoli-corso-laurea-data-science.html

[22] https://www.fondazionetronchetti.it/new/it_IT/dettaglio.php?id_categoria=3&id_sottocategoria=20&id_contenuto=50

[23] The questionnaire is available at the following link: https://docs.google.com/forms/d/1u0fAsg8MQlIGobB4Tyx9-zI3g-D1DGocxHIAanGejKY/edit

Subsequently the data collection phases, we built the Escalator describing the educational offer for each step of the scale, identifying gaps and proposing actions to overcome the identified gaps.

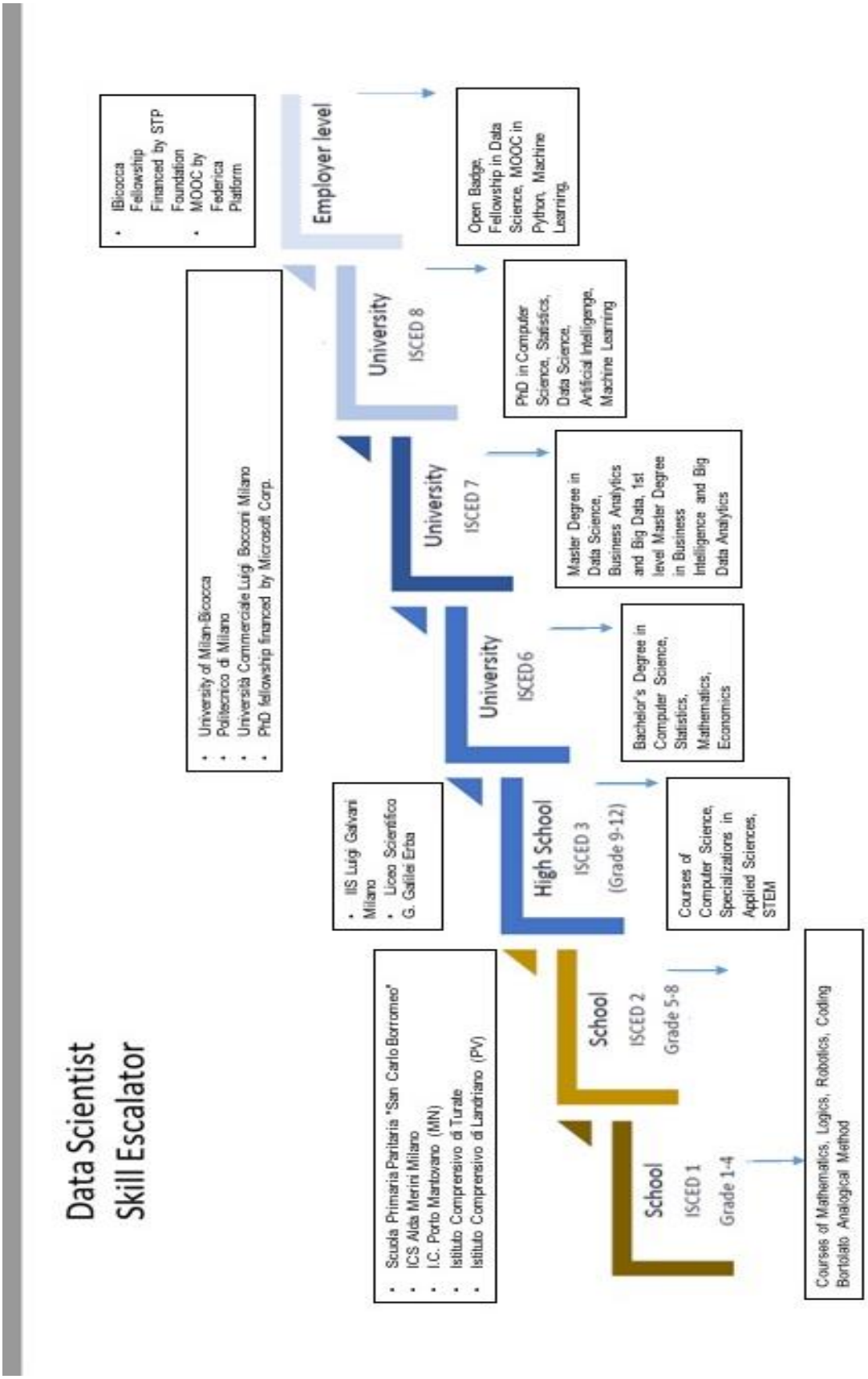
## Escalator partners

In building the Escalator, we had the opportunity to work with several stakeholders from schools and universities. Since the beginning, we had the opportunity to engage professors from the University of Milan-Bicocca (e.g., Marco Gui, Elisabetta Marafioti) who help us in the development of the general context of the framework by providing useful information on education and digital skills. To build each step of the framework we count on the collaboration of educators and professor from primary school to university, and Job Placement service[24]. The work shared with all referents gives us the chance to build up a network of collaboration and interaction useful to update our knowledge on the researched topic. To cite a few examples, by working with the Observatory on Digital Competences in the ICT sector we were able to update information on job offers and demand for Data Scientist in the Italian job market. While the collaboration with the Job Placement office of the University Milano Bicocca, gave us the opportunity to update information on graduates' students' trends in choosing this specific professional profile or who are looking to develop their career in this direction. The collaboration with educators and teachers from school grades gave us the opportunity to monitor the educational offer and identify the gaps between the current offer and students' actual needs.

The main difficulty that we found in building the Escalator was the engagement of referents from Italian governance and policy makers and as well from the economic sector. In further works, we hope we could address this limitation by having the opportunity to engage these specific referents.

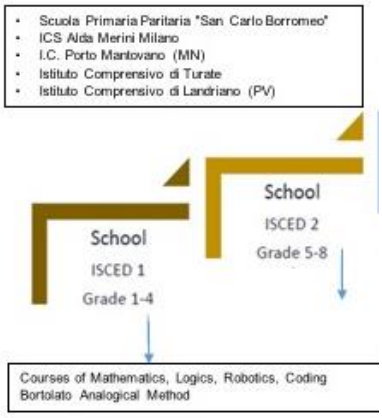
[24]More details about the services are available at: https://www.unimib.it/jobplacement

## Model creation



# The digital skills pipeline

## Mapping the educational and training offer at school level grades 1-8




The mapping activities referred to school grades from 1-4 and 5-8 involved teachers and educators from schools settled in the Lombardy region with attention to the city of Milan. Data collection via questionnaire involved teachers of Robotics, Mathematics and Logics courses. Based on our analysis we detect a lack of an institutional educational plan dedicated to courses or laboratories at primary school level dedicated to the acquisition of skills and knowledge similar to those required for the Data Scientist profile. The educators and teachers interviewed explained to us that they follow the ministerial plans for teaching mathematics and basic knowledge of science. Interesting results emerge in two cases that we analyzed in depth because of their specificity: (a) the laboratory of Robotics taught for primary school, and (b) the adoption of a teaching model based on an analogical method to teach mathematics, namely: Bortolato Analogical Method (MAB). Both the above-mentioned cases of innovation in teaching were possible thanks to the initiative of individual teachers. In the case of the Robotics course for primary school, the course is aimed at stimulating and developing problem solving, coding, design and assembly of robotic components (e.g. motors, sensors, mechanical parts ...), as well as at promoting teamwork and peer learning, through group discussions at the beginning and at the end of each lesson. The tasks are deployed using the LEGO MINDSTORM EV3 kit. In the case of the adoption of the MAB, the teaching of Mathematics through this method includes the introduction to the first concepts of logics, statistics, probability, geometry; initiation of problem solving; introduction to proportions; preparatory activities for coding. The activities are carried out individually or through work in small and large groups (class group). The method involves the use of various tools that pupils use at their discretion, freely deciding when to abandon them. Some of the tools available for pupils are the so-called: “the lines of 20, 100, 1000” tools that are commonly used to deliver the method, as well as multiplication tables and tool to approach calculation such as the “cassaforte dell’euro” (in English: “Euro Strongbox”). Are also available specific books dedicated to problem solving. Almost all the material and tools are available both on paper and in a digital format available for consultation via computer, this is because the method proposed the use of many useful software designed to teach online and remotely to assist pupils. Digital tools are particularly useful in the periods of DAD required during the emergency from COVID-19. Pupils learn to independently search for calculation or problem solving strategies and are encouraged to compare and discuss the different strategies identified. The analogical approach applied to the teaching of Mathematics provides a disciplinary flow that follow the natural learning path of children. Intuition, mental calculation, personal and effective solution strategies are privileged by the MAB. The approach to problems starts from images and fosters intuitive solutions. The pupils are invited to formulate logical solutions (formulating hypotheses). The cornerstone of the method is to think about learning as a process of comparison between peers, in an atmosphere of trust and mutual help. The role of teachers is to guide and assist their pupils in their personal learning process.

**Critical factors and opportunity of innovation**. In mapping the educational offer for primary school, we found a lack of offers related to topics from the STEM group apart from basic knowledge of Mathematics and Science. The initiatives of teaching additional topics such as coding, programming, or to teach Mathematics and Science since the primary school with an innovative method (i.e. the

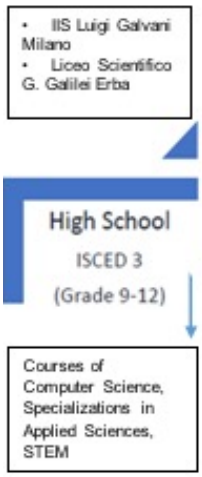
Bortolato Analogical Method) turned out to be the result of the initiative of individual teachers whom aim at raising children awareness in problem comprehension and solving. The data collected through the questionnaire indicate that according to the respondents, the Italian education system is not ready to accept the new needs of the school population as well as to review teaching plans and teaching methods that today are outdated and distant from the current needs of the students. The educational offer that we have mapped at primary school level, although it is not directly linked towards a specific scientific profile, shows two different and sometimes opposite ways of teaching. One way is limited to follow ministerial guidelines; another way of teaching at school level, even following the ministerial guidelines includes specific topics and material to ignite pupils with curiosity towards the scientific area of knowledge. The interviews with teachers and professors aroused several for innovation of the Italian educational offer. Specifically, since primary school level, to privilege the adoption of methods, such as the MAB, which foments thinking by analogies, learning and comparison between peers. Results from our study, in particular those derived from interviews, questionnaires, didactic materials, comparison with other methods, highlighted that a wider adoption of the MAB teaching approach would provide children with a mind-set to easily approach Science and STEM. The list below reports a sample of skills provided by the MAB and that have touching points with scientific professional profiles including the Data Scientist:

- Students' intuitiveness;
- Students' ability to easily catch a holistic comprehension of the phenomena;
- To think by analogies;
- To be able to learn complex and several topics thanks to a "raining teaching";
- The ability to perform a mental calculation even without numbers;
- To be able to discern between Mathematics and the language of Mathematics;

The MAB method is in line with the teaching approach already used in Nord Europe countries. It aims to innovate the education offered not only in the approach to Mathematics and Science, but also reading and writing.

Based on the present study we conclude that a proposal of innovation also at high school level can be address in terms of the following actions: (a) to foster a multi-classes approach with the aim to promote the learning from peers between students of different classes; (b) the adoption of a teaching approach that fosters an interdisciplinary perspective, which consists in being able to create connections between topics and subjects such as History and Physics, Science and Philosophy, Art and Mathematics, etc. The aim of an interdisciplinary approach is to identify connections and synergies which help students' in their knowledge management.

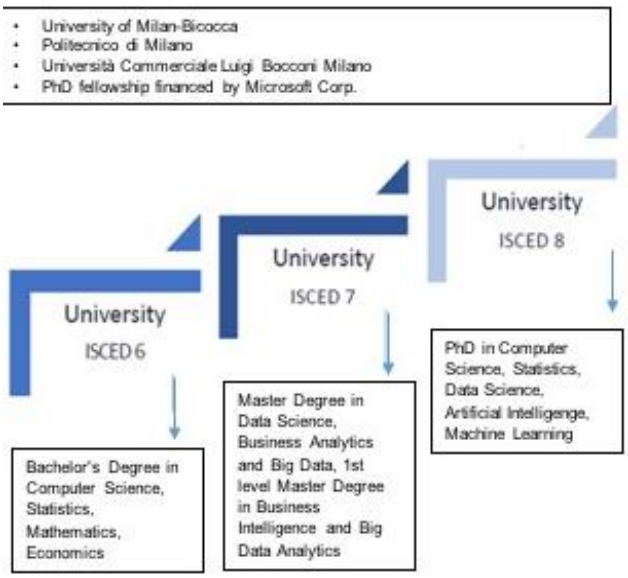
## Mapping the educational and training offer at high school level




The mapping activities referred to high school involved school teachers and university professors. At high school levels, the courses mostly provided are Computer Science and Applied Sciences. The courses aim at delivering knowledge useful for entering the job market. However, based on our results, high school teachers detected a gap in students' knowledge of basic Statistics concepts that are necessary to approach those courses. By the contrary about students' knowledge and skills, professors were surprised by their high level of digital knowledge and skill of usage of tools for digital design used also during laboratories and class at university. Teachers complain that they have only a limited number of lessons to deploy those courses weekly. The courses are structured following the ministerial guidelines. In some cases, thanks to teachers' initiatives and acknowledgement of a gap within ministry guidelines and students' needs, their lessons in Computer Science also provided basic concept of programming (e.g. Python) and machine learning.

During the analysis of the education offered at high school level we had the opportunity to engage the research team of the SVELAMI – B project. The team included women university professors who have carried out activities to bring students closer to scientific subjects (i.e. Mathematics, Computer Science, Physics). The SVELAMI- B project coordinated by Prof. Silvia Penati of the Physics Department of University of Milan Bicocca, with the collaboration of Prof. Laura D'Alfonso and Dr. Daniela Di Martino, provides in-depth courses in the STEM field for primary school children and secondary school children (in the period January-June 2021). The project focused on a gender inclusive perspective to engage, in particular girls students in the STEM field, in line with European projects dedicated to women in science.

## Mapping the educational and training offer at University level




From some surveys on the web[25] Data Scientists in the USA are highly educated – 88% have at least a Master's degree and 46% have PhDs – and while there are notable exceptions, a very strong educational background is usually required to develop the depth of knowledge necessary to be a Data Scientist. To become a Data Scientist, it should be necessary to get a Bachelor's degree in Computer Science, Social sciences, Physical sciences, and Statistics. The most common fields of study are Mathematics and Statistics (32%), followed by Computer Science (19%) and Engineering (16%). A degree in any of these courses will give students the skills they need to process and analyse big data.

The Education Offer in Data Science in Italy highlighted that 3 Master degree courses are concentrated in Milan. But now we would like to show which other courses are present in Milan that deliver subjects related to Data Science, starting with the Bachelor's Degrees. If we limit the analysis to the subjects of Mathematics, Statistics and Computer Science, the main ones at the basis of Data Science, the Universities of Milan offer the following:

University of Milan-Bicocca: 1 Bachelor's Degree and 1 Master's Degree in Computer Science, 1 Bachelor's Degree and 1 Master's Degree in Mathematics, 2 Bachelor's Degree and 2 Master's Degree in Statistics. To these we must add 1 PhD in Computer Science, 1 in Statistics and 1 in Mathematics.

Politecnico di Milano: 1 Bachelor's Degree in Engineering of Computer Systems, 1 in Mathematical Engineering, 1 Master's Degree in Computer Science and Engineering, 1 Master's Degree in Mathematical Engineering, 1 PhD in Data Analytics and Decision Sciences, 1 PhD in Information Technology, 1 PhD in Mathematical Models and Methods in Engineering. Furthermore, Politecnico of Milan offers several MOOCs[26] in Computer Science, for example 4 courses on topics related to Artificial Intelligence.

University of Milan La Statale: 1 Bachelor's Degree in Artificial Intelligence, 1 Bachelor's Degree in Computer Science, 1 Bachelor's Degree in Computer Science for New Media Communications, 1 Bachelor's Degree in Computer Systems and Networks Security, 1 Bachelor's Degree in Mathematics, 1 Master's Degree in Computer Science, 1 Master's Degree in Informatics Security, 1 Master's Degree in Mathematics, 1 PhD in Computer Science, 1 PhD in Mathematical sciences.

Università Commerciale Luigi Bocconi Milan**:** This university mainly offers Economics Courses, but recently added 1 Bachelor's Degree in Mathematical and Computing Sciences for Artificial Intelligence, the above mentioned Master's Degree in Data Science and Business Analytics, 1 PhD in Statistics and Computer Science and 1 other PhD in Statistics.

[25] https://www.kdnuggets.com/2018/05/simplilearn-9-must-have-skills-data-scientist.html
[26] www.pok.polimi.it

There is a close relationship between these four universities, we also see it from the behaviour of students when enrolling in a Master's. In fact, we can see from the data in table 1 that most of the students (66%) who enroll in the Bicocca Master's Degree in Data Science come from one of these 4 universities, with a prevalence for students who have already graduated from Bicocca.

*Tab. 1: Students enrolled in the Unimib Master's in Data Science 2019-20**[27]

| Origin of students enrolled in the Master's in Data Science | num | % |
|---|---|---|
| Università Degli Studi Di Milano-Bicocca | 69 | 51% |
| Università Degli Studi Di Milano | 8 | 6% |
| Politecnico Di Milano | 7 | 5% |
| Università Commerciale "Luigi Bocconi" Milano | 5 | 4% |

Another confirmation of the interdisciplinary nature of Data Science is the origin of the students who enroll in the Masters in Data Science. If we look for example at the course of the University of Milan Bicocca, we can see how the students come from courses of study of different disciplines. In table 2, we can see from which Bachelor degrees within Bicocca the students enrolled in the master's degree of Data Science in Bicocca come from, for the three academic years 2017-18, 2018-19 and 2019-20. Most of them come from Statistics and Computer Science courses, but also an important part come from Economics courses.

*Tab. 2: Courses of origin of students of Data Science 2017-20**

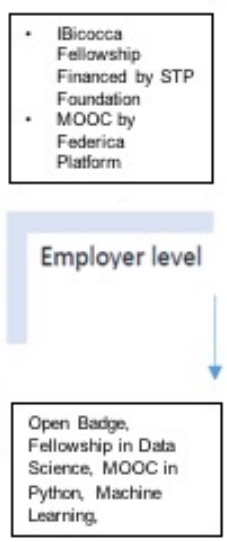
| University of Milano Bicocca | Accademic year | | |
|---|---|---|---|
| Courses of origin of students enrolled in the Master's in Data Science | 2019-20 | 2018-19 | 2017-18 |
| Statistical and Economic Sciences | 20 | 7 | 7 |
| Computer Science | 10 | 11 | 12 |
| Statistics and Information Management | 9 | 2 | 7 |
| Business Economics | 6 | 4 | 6 |
| Economics of Banks, Insurance and Financial Intermediaries | 6 | 5 | 7 |
| Marketing, Corporate Communication and Global Markets | 6 | 6 | 5 |
| Phisics | 5 | 5 | 3 |
| Economics and Business Administration | 4 | 1 | 4 |
| Mathematics | 3 | 1 | 0 |
| Biological Sciences | 0 | 1 | 0 |
| Environmental Sciences and Technologies | 0 | 1 | 0 |
| Communication and Psychology | 0 | 0 | 1 |
| ***Total students enrolled in the first year UniMIB Data Science Master's Degree*** | **69** | **44** | **52** |

This demonstrates, as mentioned, the richness and multidisciplinary nature also of the skills provided by the Data Science courses. IT skills, such as machine learning, database management, programming languages, are combined with statistical, economic but also mathematical and other hard science skills. We have already seen from a theoretical point of view what are the main skills of the Data Scientist, and the mapping of the courses offered by the Universities confirm this list, later we will see what the job market requires. But the skills mapped by Milan's Universities partially confirm the data

[27] Source: our elaboration from AlmaLurea Database (2021)

provided at the beginning of this paragraph, except for the importance of economic skills which seems to be a local characteristic.

## Mapping the educational and training offer at Employer level




Mapping the educational offer at CPD level we found several opportunities for those who are interested in a Data Science career. We found particularly interesting the online courses delivered by platforms dedicated to providing open badge and courses in MOOC modality.

iBicocca[28] is a project of the University of Milan-Bicocca which organizes activities and events dedicated to students enrolled in all bachelor's, master's and doctoral courses. Its goal is to spread the culture of innovation by sensitizing students to acquire certified transversal skills that can be used in the job market. iBicocca provides to students Open Badges in three different paths: Silver, Gold and Platinum. Launched in 2015, the project has so far issued 2237 Open Badges, involved 7754 students and started more than 100 internships.


CPD Educational offer via OPEN BADGE. An Open Badge is a digital photo of student' skills. Like a photo which not only has a picture, but also provides information on the place and time it was shot, the Badge too contains extra information – metadata – which can be read by all the applications which can read Open Badges. On Bestr[29] (the digital platform to enhance the Open Badge) there is a page describing the contents for each Badge, and anyone who obtains a Badge has a dedicated page, with his name, the date on which he obtained the Badge and a description of the Badge.

CPD Educational offer via MOOC. Federica is an eLearning platform managed by the University Federico II of Naples which operates in partnership with the most prestigious public Italian Universities to deliver university education in MOOC modality (Massive Open Online Courses) which are free online courses available for anyone to enroll. MOOCs provide an affordable and flexible way to learn new skills, advance career and deliver quality educational experiences at scale.

Federica Platforms delivers up to 300 MOOCs which include 2000 lessons provided with different digital tools (6000 videos, 50.0000 slides). It is the leading platform in Europe for open access multimedia education, and in the world's top ten to produce MOOCs. The University of Milano-Bicocca joins the partnership with Federica to offer MOOCs on Big Data. Learners can discover the multidisciplinary nature of Big Data and learn about basic languages like Python and R. This course provides the skills for new jobs like Data Analyst, Data Scientist, Data Journalist, Data Driven Marketer and Data Engineer.

Information derived by the collaboration of the Job Placement office (University of Milano Bicocca) highlighted the increasing number of students interested in choosing the career of Data Scientist after

[28] http://ibicocca.it/

[29] https://bestr.it/

attending specific graduate or postgraduate courses and their easy and quickly inclusion in the Italian labour market due to the high demand for this professional profile.

# Resultant Skills Priorities and Recommendations

## Resultant digital skills and the role of Universities

Universities play a key role in monitoring both the educational offer proposed in the digital field, and the evolving scenario of digital skills requested at a labour market level by companies. Based on the data collected on courses and teachings proposed by the universities, it is possible to highlight some relevant aspects of current training in the digital environment offered to the new generations.

By considering the common traits among the universities, observed in terms of course structure and teaching content, the study allows us to understand at least some characteristics of the national university system, giving us the opportunity to offer useful recommendations for its renewal.

1. Supply of digital skills overall poor in compulsory courses.

Beyond the Polytechnic Universities, which by definition offer a consistent number of basic and advanced digital courses, the majority of universities offer a basically low number of digital courses, in line with the relative courses of study. If we look at the basic digital skills, which our research requires by many professionals, we note that the offer is rather scarce. Typically, basic digital courses are offered in preparation for subsequent years or, in the case of humanities or health professions courses, are offered without an educational long-term program. The supply of basic digital skills does not exceed 1% of the total mandatory supply of the universities analysed.

2. Many digital courses are free to choose, among these the courses in Digital Transformation Culture emerge.

There is a tendency on the part of institutions to leave a large part of the course teachings, in some cases all, to be chosen by the student. Among these, the presence of courses that offer education in the digital field is frequent. It is also noted that study courses close to areas typically "touched" by technology and digital technology are introducing Digital Transformation Culture courses aimed at providing digital skills useful for the student's future career. An example is the "Organization and digitization of multimedia showcases" teaching in the Cultural Heritage course of the University of Milan or the "Digital Strategy" teaching in the Communication Design course of the Politecnico di Milano. These courses are typically not compulsory, but are part of the elective teaching groups.

3. Polytechnics hold the largest number of advanced digital courses, but they do not neglect the Digital Transformation Culture.

It is not difficult to imagine that the most varied offer of basic skills and advanced digital courses belong to the courses provided for in the courses of the Polytechnic Universities. What is interesting to note is that even in the Polytechnics there is a growing predisposition towards teaching skills in Digital Transformation Culture. The latter are designed to train students in compliance with multidisciplinary subjects that intersect transversal skills with potential opportunities for growth and social impact.

## Resultant skills priorities from school to university

Table 3 reports a synthesis of the skills required to Data scientist profile and the skills delivered at school and university levels. As shown in the table, only a few cases at school are delivered courses propaedeutic also for this professional profile such as: machine and deep learning, analysis of problems for opportunities.

Tab.3 Skill taught at school and university levels

| Skills required to Data Scientist | knowledge or tools to skill development provided at school level (Yes/No) | University level |
|---|---|---|
| Machine learning | YES (few cases) | YES |
| Deep learning | YES (few cases) | YES |
| Algorithms | YES | YES |
| Execute analytical mathematical calculations | YES | YES |
| Unstructured data | NO | YES |
| Working in teams | YES (few cases) | YES |
| Teamwork principles | NO | NO |
| Business ICT systems | NO | YES |
| Cloud computing | YES (basic) | YES |
| Database | YES (basic) | YES |
| Think creatively | YES (few cases) | NO |
| Analyse problems for opportunities | YES (few cases) | YES |
| Manage data collection systems | NO | YES |
| Manage ICT data architecture | NO | YES |

As we describe in the previous section the delivery of these courses depend on the personal initiative of the professors. The few cases of courses that are able to provide students with skills such as: creative thinking, analysis of problems for opportunities, also at primary school level, refers to courses delivered adopting the Bortolato Analogic Method. It is interesting to notice that despite at university level are delivered a wide range of courses that cover most of the skills required to be a Data Scientist, there is a lack of courses that focus on: teamwork principles and creative thinking. Based on our report it is urgent both to foster implementation of courses that are available only in a few schools, and to design an educational and training program to get students closer to stem subjects from the primary school level. Another priority is to foster a teaching methodology that promotes students' capability to think creatively, be able to analyse problems for opportunities, team working and learning by peers.

## Resultant Skills based on Italian job market

Thanks to the contribution of the CRISP Department, directed by prof Mario Mezzanzanica, we had the opportunity to analyse data from a recent research report that extracted the most relevant skills of the Data Scientist profession from the online job vacancies in 2019 in Italy. In the tables 4-6[30] we can see the skills divided in Hard Digital (HD), Hard Not Digital (HND) and Soft (S) skills. The skills are sorted by the Skill Rate and nominated according to the ESCO classification level 3. In particular, table 4 shows the main Hard Digital skills of Data Scientist. The most relevant is "unstructured data", it means that Italian job market searches people able to manage big data in the form of texts, images and video. Along with this, companies require skills of Information Systems Management, know how to use different software and analytical tools, and everything that revolves around databases. Among these skills, we can see also some specific tool or languages, like SQL, NoSQL, Oracle etc.
There is no shortage of requests for skills related to the Web and Internet. These skills confirm what we have outlined as fundamental theoretical knowledge of the Data Scientist: Computer Science and analytical skills are fundamental for this profile. Instead, some skills such as machine learning or artificial intelligence seem to be missing, this however could be due to a different terminology or different way of classification of the skills. To resolve this doubt, a mapping should be made between the theoretical skills and those extracted from the job advertisements that are named with the ESCO taxonomy.

*Table 4: Hard Digital Skills of Data Scientist**

| Type | ESCO skill level 3 | Skill Rate |
|---|---|---|
| HD | unstructured data | 1,0 |
| HD | use content management system software | 0,2 |
| HD | document management | 0,2 |
| HD | use analytics for commercial purposes | 0,2 |
| HD | software anomalies | 0,1 |
| HD | tools for software configuration management | 0,1 |
| HD | Agile project management | 0,1 |
| HD | business intelligence | 0,1 |
| HD | SQL Server Integration Services | 0,1 |
| HD | NoSQL | 0,1 |
| HD | maintain database performance | 0,1 |
| HD | unified modelling language | 0,1 |
| HD | use digital device operating systems | 0,1 |
| HD | ICT project management methodologies | 0,1 |
| HD | develop ICT workflow | 0,1 |
| HD | Oracle Relational Database | 0,1 |
| HD | use online communication tools | 0,1 |
| HD | World Wide Web Consortium standards | 0,1 |
| HD | ICT security legislation | 0,1 |
| HD | ICT security standards | 0,1 |
| HD | ICT system programming | 0,1 |

[30] *Source: our elaboration from Crisp's report (2021).*

Table 5 shows the Hard Not Digital skills. Here we have some economics skills, and some skills related to project management issues, planning tasks and specific production processes. There is also a strong evidence of security and quality issues and customer management skills. These evidences underline that the importance of the Data Scientist in environments and jobs not only of data analysis, but also of interpretation of economic phenomena, and the ability to understand some specific aspects of work in the company, for example the ability to relate to customers.

*Table 5: Hard Not Digital Skills of Data Scientist*

| Type | ESCO skill level 3 | Skill Rate |
|---|---|---|
| HND | financial forecasting | 1,0 |
| HND | documentation types | 0,7 |
| HND | provide documentation | 0,3 |
| HND | analyse business processes | 0,3 |
| HND | data protection | 0,2 |
| HND | information security strategy | 0,1 |
| HND | provide customer follow-up | 0,1 |
| HND | give advice to others | 0,1 |
| HND | measure customer feedback | 0,1 |
| HND | apply quality standards | 0,1 |
| HND | quality control systems | 0,1 |
| HND | define quality standards | 0,1 |

Finally, table 6 shows the main Soft skills. Lean project management means that Data Scientist should also be able to manage a project, or a company or a start-up, according to the Lean methodology. Moreover, the profile must have many communication skills, being able to speak in public, having leadership skills and knowing how to work in a team.

*Table 6: Soft Skills of Data Scientist*

| Type | ESCO skill level 3 | Skill Rate |
|---|---|---|
| S | Lean project management | 1,0 |
| S | be attentive | 0,7 |
| S | manage project metrics | 0,6 |
| S | present reports | 0,4 |
| S | speak about your work in public | 0,4 |
| S | adapt to different roles | 0,2 |
| S | use positive language | 0,2 |
| S | provide leadership | 0,2 |
| S | service-oriented modelling | 0,2 |
| S | Assertiveness | 0,1 |
| S | delegate activities | 0,1 |
| S | adjust priorities | 0,1 |
| S | make an effort | 0,1 |
| S | plan teamwork | 0,1 |
| S | prioritise tasks | 0,1 |
| S | communicate with customers | 0,1 |

We also find some of these skills in the theoretical framework presented previously, but it is interesting that from the job advertisements, from the market, there are other soft skills that have probably been emerged recently.

## Digital Skills Gaps in the City/Region needing to be addressed

Italy has very low levels of basic and advanced digital skills, the lateness in digital transition processes and in digital skills, diffusion is confirmed by the lateness that Italian companies are experiencing in the use of technologies such as the cloud and big data, as well as in the adoption of e-commerce. These limits at economic and industry sectors highlight the crucial role of ICT professions and the increasing demand for profiles such as Data Scientist, Software developer, Informatics engineer.

The Lombardy region likewise the national territory suffers from the gap in digital skills but despite the rest of the country is the region with high level of engagement to invest in ICT education with particular attention to the Data Scientist profile.

The graph in figure 8 shows the responses from questionnaire about the readiness of Italian educational system to innovate in terms of redesign the educational program at national level to include new teaching accordingly to new students' needs, and their personal and professional growth to face future the challenges of the job market

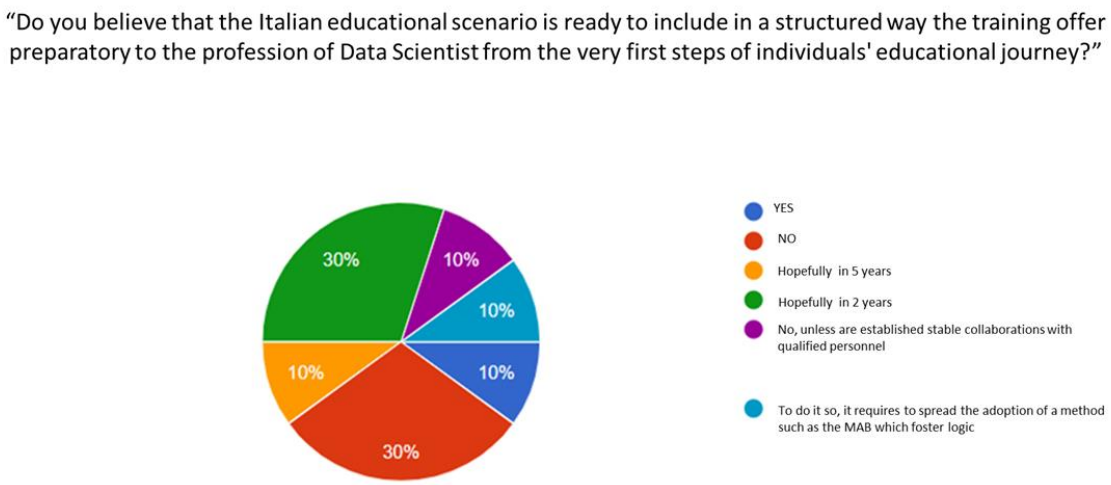



Fig. 8 Readiness of the Italian Education offer to innovate

## Recommendations to overcome Skills Gaps

During the identification of a skill pipeline, we acknowledge that especially at school but also at each level of the Escalator until the employer one, it is missing a unique identification of the Data Science profile. To date, although there is an awareness of the relevance of this professional profile, none of the educational offerings, excluding at the university level, is clearly connected with this specific profile. We detect that educational programs adopted by Italian educational ministry struggle to innovate or follow the digital transformation at socio cultural and economic levels and consequently the new professions required by the job market.

To overcome the gap, we confirm the urgency to open a dialogue with policy makers in order to support the Italian school reality, towards digital transition and the innovation of teaching methodology. For example, by including methods such as the MAB for primary school, and/or the adoption of inter-disciplinary connections, include the participation of professionals from the sector to deliver initial courses or laboratories at school to get students closer to science and STEM subjects.

Based on our research, up to date, any innovative process is fostered with a “Bottom up approach” which refers to the condition in which innovation is promoted by individuals, such as educators, teachers, professors, but no one of the applied innovative methods or approaches are supported at institutional level. The urgency to fulfil the identified gap is confirmed by the lack of a recent census by the MIUR (Italian Ministry of Instruction, University and Research) which the last release refers to data of 2016.

In terms of the proactive process of innovation of the educational offer, we considered it interesting to foster the ICT skills integration since primary school, as well to intervene both on infrastructures and on processes. In particular, to integrate tools material for laboratories, equipment and software and their integration into learning processes. Invest in finding the right mix of learning traditional and use of technology; as well in overcoming the learner-teacher gap to enhance digital skills of teachers. Design new educational offers to allow students to achieve curricula adhering to the job market and to develop "new" skills required by the rapid digital changes that characterize the current and incoming scenario.

With regard to the need to make curricula adhere to the demand of the labour market, it seems appropriate that the education and training systems orient their offer, not only and not so much towards specific disciplines (eg. STEM), as much as towards interdisciplinary integration, capable of passing training for technical skills (eg. intended as basic skills, part of a course of computer science or technology).

It is essential to develop integrated skills such as programming and the development of "logical thinking" to keep pace with evolving technologies. The development of these skills should form an integral part of most educational and training curricula, a kind of mainstream education of future digital citizens. This is because, mostly nowadays, it is crucial to develop education and training programs aimed at ensuring the employability of individuals (and, in so doing, the competitiveness of businesses). In particular, it becomes strategic to promote collaboration between government, education and training institutions and businesses, encouraging joint action between these actors.

## Recommendations for how the Escalator Model can be improved if used again

The Escalator framework can be a valid tool for promoting social dialogue and listening to the needs of the production system by linking skills (intended as learning objectives of education and training courses) to the real work activities of production processes. Its adoption can foster the dialogue between the wide range of non-governmental actors, businesses, professionals and trade associations.

Its adoption can play a relevant role in the engagement of different stakeholders, and engender synergies between the different sectors of public administration and research institutions (universities, research canters and Observatories). A crucial role in linking Universities and the job markets is played by the Job Placement and Career Services that have a full perspective of whether the offer and demand for a specific professional profile match. In particular, we report the experience of the Job Placement teams of the University Milano Bicocca that not only provides services that link graduate students with the demand of the labour market but also encourage placements and internships opportunities by providing training courses able to facilitate graduates' entrance in the job market.

To conclude, to extend the adoption of the Escalator to each region so as to be able to perform comparison and cross regional results in order to identify the different levels of gaps, similar needs and to design educational policy at a national level being able to intervene on each local reality depending on the different needs. In doing so, the ESCALATOR can deploy a key for measuring policy outcomes firmly anchored to the objectives set: adopt observation metrics to examine the relationship between innovation and dissemination of digital skills and policy outcomes.