

Paolo Bertuletti, Johannes K. Schmees, Fabienne-Agnes Baumann,
Dietmar Frommberger & Francesco Magni (Eds.)



Vocational Education in European Regions

Lower Saxony and Lombardy in Comparison

DAAD

Deutscher Akademischer Austauschdienst
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How Lombardy's short cycle tertiary education promotes innovation

PAOLO BERTULETTI, ANDREA POTESIO¹

Abstract: The contribution investigates and highlights the extent to which Lombardy's short cycle tertiary education fosters and supports innovation. This explorative research, which is grounded in semi-structured interviews conducted with nine higher technical education institutions across the region, sheds light on the nuanced role that this segment of regional vocational education and training plays. Contrary to the assumption that such education is necessarily and entirely market-driven, the findings suggest that, despite maintaining strong and substantial ties with the world of work, it is not fully aligned with market demands. Nonetheless, this branch of education could be considered a significant and crucial element within the broader skills ecosystem and play an essential role in promoting the development of new professional profiles, albeit within certain limits. Through this function, it contributes to shaping and enhancing the regional labour market, thus holding potential for long-term impact on innovation and economic growth.

Keywords: Innovation; Short Cycle Tertiary Education; Skills' Ecosystems; Vocational Education and Training; Lombardy.

1 Introduction

Higher technical education (*Istruzione tecnologica superiore*, ITS) is traditionally marginal within Italy's educational system: established only in 2008, in 2022 just 25,842 students had opted for this route (INDIRE – National Institute for Documentation, Innovation and Educational Research). Recently, the Italian Recovery and Resilience Plan of 2021 has made it one of its main targets: the ITS will receive EUR 1.5 billion in funding in the next two years with the explicit aim of doubling the number of enrolments until 2025. The government hopes to facilitate the development of the skills required to promote innovation and boost the economy, which has been suffering from low productivity rates for decades and more recently facing a lack of highly qualified technicians.

Lombardy is at the forefront of this process, since it is the Italian region with the largest number of ITS providers, covering all technological areas provided for by the

¹ Although this contribution is the result of a joint work of the two authors, paragraphs n. 1,2,4,5,6 and 7 can be attributed to Paolo Bertuletti; paragraph n. 3 to Andrea Potesio.

ministerial regulations (Decree No. 8327, 7th September 2011). In 2022, there were 20 ITS academies, 173 courses and 4,423 students enrolled in this region, while in the whole country there were 120 academies, 800 courses and 21,253 students (Zuccaro, 2022). However, considering the size of the current public investment, it is legitimate to ask: (1) If and to which extent ITS academies have supported innovation so far and (2) whether they are market-driven institutions, i. e. whose curriculum choices are influenced by businesses skill's needs and powerful interest groups, or actors that active and independently contribute to the definition of novel professional profiles.

Many authors claim that higher education in the neo-liberal context is increasingly focusing on the instrumental task of creating a skilled workforce for the global market (Zajda, 2020). This shift would produce a commodification of higher education and its marketisation, since its governance is influenced by indicators and standards-driven policies (Moscati et al., 2015). This risk is real, as Italian (and Lombardy's) ITS academies are run as foundations in which companies participate, with representation on the academy board, and the employment rate of their graduates partially determines their annual public funding². Nevertheless, when studying these institutions more closely, they seem to be able, at least in some cases, to act quite independently of partner companies as far as the choice of learning outcomes and the design of their curricula are concerned. Through an empirical inquiry, we clarify this point by considering the way ITS academies develop the skills that should enable future technicians to foster innovation. Our sample includes nine academies eight based in Lombardy and one in the neighbouring region Emilia-Romagna. The focus of our research is not on policy issues, but on curriculum design since we aim to shed light on the actual or potential role in promoting innovation played within skills ecosystems by Lombardy's ITS.

2 ITS academies in comparative perspective

Italian ITS may be categorised as 'short-cycle tertiary education' corresponding to level 5 of the ISCED 2011 taxonomy elaborated by the United Nations Educational, Scientific and Cultural Organization (UNESCO): Tertiary non-academic education programmes "designed to provide participants with professional knowledge, skills and competencies. [...] [T]hey are practically based, occupationally-specific and prepare students to enter the labour market", also providing, at least in some cases, "a pathway to other tertiary education programmes" (UNESCO, 2012, p. 48). Normally, short-cycle tertiary education trains specialised technicians, i. e. workers who solve practical problems in production, maintenance and management, applying upper or intermediate skills in science, technology, engineering, and mathematics (STEM).

ITS academies are managed by foundations, thus, private law bodies with a public purpose, endowed with statutory, teaching, research, organisational, administrative

² In comparison with other Italian tertiary education institutions ITS academies have a much higher employment rate of their graduates: 80% 12 months after graduation; among those who have found a job 91% work in a sector related to their studies (Zuccaro, 2022).

and financial autonomy. According to the minimum organisational standards set by the national law, foundations are composed of one technical upper secondary school based in the province where the academy is located, a vocational education and training (VET) provider, one or more companies active in the same economic sector of the course provided by the ITS academy and a university or a research centre (cf. art. 4 Law No. 99 15 July 2022). The enrolment requirement is an upper secondary general education leaving certificate or a post-secondary VET diploma. ITS courses are structured over 4 or 6 semesters, with a minimum annual number of hours ranging from 900 up to 1,000 (cf. art. 5 Law no. 99 15 July 2022). Higher technical diplomas delivered by Italian ITS rank at level 5 of the European Qualifications Framework (EQF), six-semester courses at EQF level 6.

Every ITS academy belongs to one of the six ‘technological areas’ provided for by national law, these areas are split in 17 sub-fields that can be also divided into 29 technical profiles (cf. Table 1). Each course must refer to one profile, linked to a legally established set of core and technical skills, but the academies may customise their offer adding or shaping autonomously learning units and renaming the course³.

Table 1: Technological areas, sub-fields and technical figures (Inter-ministerial Decree No. 8327, 7th Sept. 2011)

Areas	Sub-fields	Technical profiles
Green energy	Power supply and generation	Higher technician for energy supply and plant construction
	High efficient and energy-saving processes and plants	Higher technician for the management and verification of high-performing energy systems
		Higher technician for energy saving in sustainable building
Smart mobility	Mobility of people and goods	Higher technician for the mobility of people and goods
	Production and maintenance of means of transport and infrastructure	Higher technician for the production and maintenance of means of transport and infrastructure
	Infomobility and logistics infrastructure management	Higher technician for infomobility and logistics infrastructure management
Biotechnology	Industrial and environmental biotechnology	Higher technician for the research and development of biotechnological products and processes
		Higher technician for the quality system of biotechnological products and processes
	Manufacturing of diagnostic and biomedical devices	Higher technician for the production of diagnostic, therapeutic and rehabilitation equipment and devices

³ According to art. 3 Law No. 99 15th July 2022 technological areas and the corresponding core and technical skills will be reformed.

(Continuing table 1)

Areas	Sub-fields	Technical profiles
Made in Italy	Food industry	Higher technician for agricultural, agro-food and agro-industrial production and transformation
		Higher technician for the control, enhancement and marketing of agricultural, agro-food and agro-industrial productions
		Higher technician for environmental management in the agro-food system
	Construction	Higher technician for innovation and quality of housing
		Higher technician for process, product, communication and marketing for the furniture sector
	Mechanical industry	Higher technician for the innovation of mechanical processes and products
		Higher technician for automation and mechatronic systems
	Fashion	Higher technician for the coordination of design, communication and marketing processes of the fashion product
		Higher technician of process, product, communication and marketing for the textile, clothing and fashion sector
		Higher technician of process and product for the ennobling of the textile, clothing and fashion products
		Higher technician for the process, production, communication and marketing in the footwear-fashion sector
	Business services	Higher technician for marketing and internationalisation
		Higher technician for product sustainability (design and packaging)
Cultural Heritage and Tourism	Tourism and cultural activities	Higher technician for communication and marketing of tourism and cultural activities
		Higher technician for the management of hospitality facilities
	Cultural and artistic heritage	Higher technician for the management of restoration architectural sites
		Higher technician for the production/reproduction of artistic artifacts
ICT	Methods and technologies for software systems development	Higher technician for software systems development
	Organisation and use of information and knowledge	Higher technician for the organisation and the use of information and knowledge
	Architectures and infrastructures for communication systems	Higher technicians for communication systems' architectures and infrastructures

At least 60 % of teaching must be provided by staff recruited among professionals and the mandatory internship cannot take less than 35 % of the total amount of learning hours (art. 5 Law no. 99 15 July 2022). Courses can also be carried out as apprenticeships, in accordance with the provisions of art. 45 of Leg. Decree no. 81, 15 June 2015, and in compliance with the training standards set by the inter-ministerial Decree 12 October 2015 and regional regulations.

Italian commentators often compare ITS academies to the German Fachhochschule, but this is an undue comparison, since the latter offer academic courses leading to bachelor's and master's degrees and meet the criteria of the Bologna process, even if they do not award doctoral degrees. However, in our opinion not the German Fachhochschule but the German Fachschule/Fachakademie have much in common with Italian ITS academies, even if entrance requirements to ITS is not a completed vocational training but an upper-secondary general education leaving certificate. Moreover, it must be considered that academies originate not from initiatives held by the central or regional government, but through a bottom-up process involving local aggregations of stakeholders such as companies, VET schools, upper secondary schools, Universities, research centres, and local authorities).

3 Theoretical framework

The Italian Recovery and Resilience Plan states that ITS academies should promote innovation. However, nobody expects these institutes to make scientific discoveries, create technologies in their laboratories or develop new work process standards. Rather, they are supposed to train technicians who will be able to foster innovation in their own work contexts.

To understand how Lombardy's ITS academies may achieve this goal it might be useful to explore literature on innovation, with regard to the role of specialised technicians in the processes of acquiring and disseminating new knowledge.

3.1 Innovation as circular, iterative and distributed process

While extant literature describes the creation of new knowledge as an iterative and circular process which cannot be conceived without a specific application context (Gibbons, 1994; Etzkowitz & Leydesdorff, 2000; Chesbrough, 2006), studies on Marshallian industrial districts underline the fact that another type of innovation occurs through informal sharing of tacit knowledge normally embedded in companies and workers (Amin & Thrift, 1992; Lundvall & Johnson, 1994). Both well-known lines of research suggest that innovation may happen only within "systems" (Edquist & Johnson, 1997) or "ecosystems" (Finegold, 1999) of interdependent actors, including firms and educational institutions.

3.2 The skills ecosystem model applied to vocational education

The authors cited above focus on the relationship between the world of work and universities or research centres, whereas the impact on innovation of VET providers has not been granted as much attention in the literature. However, the skills ecosystem model, elaborated by Finegold studying high-tech companies (see Chapter 1 in this volume), has been adopted in some Australian and British studies to provide a new way of thinking about and reforming intermediate i. e. vocational skills (Dalziel, 2015; Hodgson & Spours, 2016; Buchanan *et al.*, 2020). The fundamental idea behind the use of the skills ecosystem model in VET policies and research is the following: Education should not provide firms with the skills they ask for but make firms search for the right skills.

“The nature of labour demand is far from self-evident. The challenge is not so much to predict specific skill sets which will be needed but rather what capacities and capabilities are best developed now to ensure the country has the capacity to adapt rapidly as circumstances change and, where possible, shape the way jobs are defined.” (Buchanan *et al.*, 2017, p. 450).

3.3 The role of educational institutions

Some promising insights to better understand how higher VET may accomplish this task are given by Vona and Consoli's reflections on innovation and skill dynamics. As these authors have pointed out, at early stages of technological development knowledge transfer is reliant on the mobility of a few talented individuals. New knowledge is still tacit. Only the purposeful and explicit absorption of practical know-how in formal education enhances a process of 'knowledge systematisation' which helps firms to improve contents and assignments of work tasks and smoothes the adoption of technological and organisational innovations. Since novel and mostly tacit knowledge is not well known, educational institutions must take a proactive role in identifying innovations, incorporating them into their curricula and design innovative job profiles to “open up new opportunities by facilitating the translation of that technology to unforeseen contexts of use” (Vona & Consoli, 2014, p. 1408).

In this sense the 'fine-tuning' of existing educational programmes not only would facilitate the diffusion of skills already identified on the labour market, but also create the demand itself for new skills, which otherwise would remain the subjective property of individual talented workers. According to this perspective, a key role in the innovation process within skills ecosystems might be played by short-cycle education institutions, such as ITS academies, whose aim should be the training of skilled technicians who will lead the transition towards the application of new knowledge and solutions in their working context.

3.4 Technicians as contributors to innovation

The role of technicians in industrial innovation processes is well known. Using cross-industry and cross-country data from eight western nations, Mason *et al.* argue that “upper intermediate-skilled workers may contribute to spillovers that increase productivity” (Mason *et al.*, 2017, p. 27). In other words, they would enhance firms' “absorptive

capacity”, i. e. the ability to transform and exploit acquired external knowledge (Zahra & George, 2002, p. 191).

Inside their company technicians contribute to so-called ‘incremental innovation’, i. e. the gradual improvement of existing work processes and technologies through knowledge creation in the workplace⁴.

“The ideas behind such incremental gains are typically born out of intimate familiarity with technology of the kind technicians acquire through their experience of operating, maintaining and solving problems with the relevant machines and processes. In performing their duties, therefore, technicians learn how technology can be improved, enabling them to contribute to the creation of the knowledge required for incremental innovation” (Lewis, 2020, p. 622).

The point is to identify more precisely, which competence ‘innovative’ technicians must have to perform in this way. In other words, assuming that ITS academies ‘systematise’ and provide their students the basic knowledge to use cutting-edge technologies, as Vona and Consoli recommended, what are the personal characteristics that the future technicians must cultivate in order to make the most of them, once employed in a company?

The international appreciation of the German dual apprenticeship system of VET, characterised by a ‘holistic’ rather than a ‘functional’ approach (Bertuletti, 2021; Deißinger, Heine, & Ott, 2011, p. 398), suggests that an adaptive workforce with a broader professional mindset and a wide range of skills is the key for competitive and dynamic production (Tether *et al.*, 2005, p. 7). In this sense, the *forma mentis* of the typical German skilled worker, based on the systematic alternation between theory and practice (Potestio, 2020), seems to be suitable to support problem solving and incremental innovation (Toner, 2011, p. 48).

Following the Italian sociologist Butera, it can be said that future technicians must be ‘broadband’ professionals, in the sense that they will be asked to do a large number of activities “very different in terms of content, level, educational background” without losing their professional identity, because this identity will not be reduced to a list of tasks summarised in a rigid job description, but built around a ‘script’ to be interpreted in a singular and unique way within a specific organisational and working environment. That means that technical knowledge and skills can be made effective only by a clever, creative and sensitive ‘interpreter’ (Butera, 2017, pp. 294–296).

Then, it is not surprising that in the existing literature, alongside hard skills, soft skills are considered essential for fostering incremental innovation among technicians. The latter include communication skills, teamwork, leadership, initiative and accepting responsibility, constant vigilance regarding quality, flexibility, analytical skills and creative problem solving, capacity to learn and to teach (Toner, 2011, pp. 56–57). Moreover, the importance of non-cognitive skills for every career success has been now recog-

4 This has to be distinguished from “radical innovation”, which corresponds to the introduction of completely new knowledge and is usually connected to purposeful R&D. The conceptual distinction between “radical” and “incremental innovation” is due to the historian of technology Nathan Rosenberg (1994).

nised (Heckmann *et al.*, 2006), as well as personal value orientation and social behaviour as a major part of professional competence (Weigel, Mulder & Collins, 2007).

4 Empirical inquiry

Our inquiry focuses on how and to what extent Lombardy's ITS academies support innovation within the ecosystem of upper technical skills. According to our theoretical premises three main matters related to the design of technicians' curricula have been investigated: (1) the provision of a broad professional mindset, (2) the presence of learning activities aimed at soft skills development and (3) the involvement of ITS institutions in the process of 'knowledge systematisation and spreading'.

Semi-structured interviews (Kvale & Brinkmann, 2014) were conducted with key collaborators (teachers, managers, directors or consultants) of nine academies, covering almost every technological area currently provided for by the Italian legislation on higher technical education⁵. Below is a table with the role held by the interviewees, the type of contract they have with the academy as well as their educational and professional background (Table 2).

Table 2: Role, work contract, educational and professional background of the people interviewed (n. of respondents)

Role	Work contract	Education	Professional Background
Teacher (1)	Full-time (5)	In the same field of his/her Institution (4)	Experience in the same economic sector where students will be probably employed (4)
Manager of placement services (1)	Secondment (1)	In another field (5) *two of them in Educational sciences	Experience in another economic sector (1)
Institute's technical consultant (1)	Collaborator (3)		Previous experience in Education (4)
Course director (4)			
Foundation's director or vice-director (2)			

All interviews were audio-recorded, fully transcribed and thematic analysis (Bryman *et al.*, 2021, pp. 537–541) using MAXQDA. In the text, we will refer to the transcriptions as follows: '[interviewee's role], [ITS academy's sector], [date]'. Before the interviews, study plans were checked. Normally, academies offer several courses within the same technological area. It is important to note that for each institution, we considered one course only.

⁵ Biotechnology, Construction, Cultural Heritage and Tourism, Fashion, Food industry, Green energy, ICT, Mechanical industry, Smart mobility. One of the academies considered (Food industry) is based in the neighbouring region Emilia-Romagna. We did not manage to interview any academy active in the Business services area.

5 Results

5.1 Broad or narrow professional mindset?

Through the analysis of the study plans of the nine courses offered by the ITS academies considered, it is clear that the selection of subjects in their curricula is based on the main professional functions of the corresponding technical profile. However, all courses also include various learning units that focus on fundamental general subjects, which are necessary prerequisites for technical (and job-specific) ones, such as mathematics or physics, or on transversal subjects that are applicable to different job profiles and sectors, such as English or communication skills. The general and transversal subjects constitute a relevant portion of the total learning hours attended at school, ranging from 20 % (at the academies active in the food industry and tourism sector) to 50 % (at green energy ITS academy)⁶. In fact, as one interviewee notes, “approximately a good 30 % of the number of hours is aimed at creating a professional identity that is independent of the type of job or sector in which our students will be employed.” (Teacher, ICT, 18.11.2022).

All interviewees maintain that the job profile trained in their courses, while preparing students for direct job placement, at the same time provide a sufficiently wide education, which will allow them to also work in various sub-sectors in the same technological area (e.g. technicians for the design and development of food production who come from the ITS academy active in food industry may be employed either in the cereal or dairy or meat or wine or even in the fish industry) as well in different roles (laboratory analysis, production, quality control, health and hygiene, marketing and distribution). The same is true for the other institutions in the sample. For instance, graduates from the academy active in the mechanical industry (mechatronic manufacturing) may be employed as programming, quality and control or maintenance technicians: “they have a specific preparation, of course, but not too much, otherwise we stick them in fixed roles preventing them from professional development” (Course director, Mechanical industry, 16.01.2023). Industrial chemistry technicians from a biotechnology ITS academy may be hired as laboratory or quality and control technicians, but also as project managers or even in marketing; e-commerce marketing managers trained by the ITS academy active in fashion could work in digital marketing as well in the logistic or warehouse management.

The only exception is represented by the ITS academy active in smart mobility which trains highly specialised technicians: aircraft maintainers certified by the European Aviation Safety Agency (EASA). In this case, however, the complexity of the machinery that technicians must deal with, the rapid technological evolution and the need to operate in different countries (aircraft workshops are scattered all over the world), require young people with an open mind and who are ready to learn continuously: “for sure these technicians do not carry out routinary tasks” (Foundation’s director, Smart mobility, 11.02.2023).

6 See example table 3.

Nevertheless, it must be underlined that a considerable part of the overall training at ITS courses is covered by internships which are compulsory by law for at least 30 % of the total amount of hours⁷. Among the institutions considered in this research internship ratios range from 33 % (construction) up to 48 % (cultural heritage and tourism) (see Table 3). More oriented to specific job positions, internships represent the vocational moment of higher technical education: “we can say that ours is a funnel-shaped training path where the specialisation is given by the internship” (Course director, Mechanical industry, 16.01.2023).

Table 3: One example of study plan/Course: Mechatronic manufacturing – ITS Academy Mechanical industry

	N. of hours	%
<i>Transversal learning units</i>		
Communication, Marketing and Customer Management	20	
Corporate Organisation	35	
English	40	
Health & Safety and Quality System	35	
Job Market Orientation	30	
Machinery Legislation	20	
Maintenance Troubleshooting	30	
Metrology, Measurement and Testing	20	
Project Work	50	
Team Building, Project Management & Cost Accounting	35	
TOT	315	15,75 %
<i>General learning units</i>		
Fundamentals of Automation	30	
Mechatronic (Basic)	90	
Maths and Statistics (Basic)	30	
TOT	150	7,5 %
<i>Technical learning units</i>		
Computer Aided Manufacturing	30	
Computer Numerical Control	40	
Computing and Programming	30	

⁷ According to the previous legislation (art. 4 D. P. C.M. 25th January 2008) which the courses considered followed. Now this quota has risen to 35 % (art. 5 Law no. 99 15th July 2022).

(Continuing table 3)

	N. of hours	%
Design and 3D Simulation	60	
Industrial Design	30	
Industrial Drives	40	
Industrial Network and IoT	40	
Manufacturing Processes & 3D Printing	80	
Manufacturing Studies & Product Industrialisation	30	
Pneumatics & Oleodynamics	60	
Programmable Logic Controllers	105	
Robotics	60	
Smart Factory	30	
Switchboards Design	60	
Systems Supervision	40	
TOT	735	36,75 %
Internship	800	40 %

5.2 Learning activities for soft skills' development

All people interviewed are aware of the importance for their students to develop not only technical skills (i. e. hard skills related to a specific profession), but also cognitive and social soft skills, which go beyond specific occupations and are needed across various job contexts (Pellerey 2016). The main idea is not to enhance the propensity for innovation among students, but to teach those behaviours and attitudes that will help them to positively integrate into the company context.

For this purpose, different didactical strategies are deployed to simulate corporate work organisation within the school context. All ITS academies use case studies or project works or both; some of them are authentic tasks assigned directly by a real company, solved or carried out with the tutoring of teachers chosen for their professional expertise (fashion; ICT).

Projects may be assigned at the end of the school year (mechanical industry) or, more commonly, at the end of single learning units. Sometimes (mechanical industry; fashion; green energy) project works are developed within contests (e. g. the one held by the Italian Ministry of Education on Industry 4.0 or hackathons for students). They may involve the creation of a product, from design to its presentation to a panel of experts, e. g. a furniture component (construction) or an energy-saving shower (green energy), as well as the drafting of a plan for the manufacturing process (mechanical industry) or the delivery of a hospitality service (cultural heritage and tourism).

Case studies normally adopt what one interviewee called a 'reverse engineering' approach: considering a production defect or a mistake in the process "students must carry out a backward analysis of what was the genesis of the problem" (Teacher, ICT, 18.11.2022). Future aircraft maintainers may be asked to solve the case of a notorious aircraft accident (smart mobility). Future Food industry technicians had to solve the case of a famous snack which had to be withdrawn from the market after the discovery of bacterial infections in some batches. They may also be asked to explain how they would employ an innovative sanitation method in the dairy industry after the recent introduction of novel hygiene regulations by an importing country (food industry). All these activities are supposed to enhance problem solving skills. It is important to stress that their realistic character depends on the fact that "they are proposed or supported by teachers coming from the world of work" (Course director, Construction, 26.01.2023). Sometimes "the task (e.g. how to eliminate a carcinogenic molecule from the final product or set the line according to the principles of lean production) is given by engineers who will provide the solution adopted in reality during a company visit a few months later. There, the best solution found by the students is awarded" (Manager of placement services, Biotechnology, 12.10.2022).

According to all interviewees these activities are carried out in groups in order to enhance teamwork skills. Specific teaching strategies are used to make the learning process more effective. Every team may, for instance, reproduce the company's functions: "we did a project based on a brief given by a big fashion house: students had to come up with a new catalogue of accessories. We gathered students from different courses: one had to deal with design, the other with financial matters, the third with marketing, and they had five days to make it. The student from the Fashion designer course wanted to be creative, one from the marketing course had his own ideas, the other was concerned about budget constraints, and they argued furiously. This is simply what happens in the companies" (Foundation's vice-director, Fashion, 26.08.2022). Team members are often intentionally chosen with different skill levels and educational backgrounds to facilitate peer tutoring (ICT; food industry; biotechnology). At the end of each project, students are normally expected to give a presentation, in order to also exercise communication skills. A role rotation within the group should guarantee that everyone is involved (biotechnology). To facilitate remote collaborative work, one academy (ICT) provides all necessary technological equipment (PCs, internet connection, software) for free.

Furthermore, all courses provide specific learning units on soft skills, such as team work (cultural heritage and tourism; mechanical industry; food industry; green energy), effective communication (cultural heritage and tourism; fashion; mechanical industry; food industry; smart mobility; green energy) and design thinking (fashion; mechanical industry; biotechnology; ICT; green energy). In its courses, two foundations provide 60 hours for 'soft skills workshops' (construction; smart mobility). Lessons are normally held by professional coaches, corporate trainers and psychologists.

Some ITS academies see soft skills development activities not only as opportunities to learn behaviours which are appropriate to the work context, but also to personal

growth. In these cases, interviewees consider self-improvement to be closely intertwined with professional development. In fact, “the soft skills required by service professions are linked to ethical values that hit all dimensions of life” (Course director, Cultural Heritage and Tourism, 03.02.2023). In the so-called soft skills workshop “students become aware of their personal attitudes, which soft skills they have developed or not, and together with their trainers understand that the harmonious personal growth contributes to the building of a broader professional profile” (Course director, Construction, 26.01.2023). “Thoroughness and accuracy is an essential behavioural characteristic for professionals [aircraft maintainers] whose mistakes can cost people lives” (Foundation’s director, Smart mobility, 11.02.2023). This is the reason why some academies are beginning to introduce a coach in their staff to support students’ careers. “Our effort to educate on punctuality requires individual mentoring” (Course director, Cultural Heritage and Tourism, 03.02.2023). One institution starts this tutoring right from the very beginning of the course with an assessment followed by individual talks: “An analysis of students’ learning style, their creativity and personal attitudes, as an opportunity that brings out strengths and weaknesses” (Foundation’s vice-director, Fashion, 26.08.2022).

5.3 ITS involvement in knowledge systematisation and spreading

Regarding systematisation and spreading of new knowledge our inquiry revealed, among the cases considered, three different patterns of interaction between academies and companies. Regarding the choice of technical learning outputs, some ITS academies seem to be rather reactive, simply responding to the needs of businesses. Others take a more proactive role. Some even suggest to companies how to innovate their business.

Close to the first pattern there are four institutions, whose courses are designed according to business needs, within the frame of a constant information exchange between companies and the school. In this case the academies rely on the information about innovation provided by some big partner companies. Although they play a marginal role in the knowledge systematisation, in this model educational institutions may also support the spreading of innovations, helping businesses, especially small ones, to be aware of cutting-edge technologies or work-processes. “Our course manager [...] is constantly in contact with the training managers of some leading company [...] this reciprocal exchange is practically what leads all the processes forward, if we find something new and interesting we communicate it to our partners and vice versa, if there is something new in the company environment, we are informed about it, we adapt and then use it from an educational point of view” (Foundation’s director, Smart mobility, 11.02.2023).

At the ITS academy active in the mechanical sector annual surveys and focus groups with partner companies are carried out to understand how to reshape courses. An expert (maybe an employee of a partner company or a freelancer) provides support in the curricula design. Typically, academies come to know of cutting-edge technologies through partner companies which are leaders in the automation industry. Corpo-

rate technicians show the applications of a new technology to the institute's teachers (e.g. a robotic cell). With the help of the same companies the academy may buy such technologies for its own laboratories and then update the corresponding learning unit (in this case: innovative machinery such as collaborative robots).

In the case of a biotechnology academy, too, companies which occupy a leading position in the chemical sector indicate evolving trends (lean production and management, industry 4.0 etc.) The academy takes these suggestions into consideration and eventually updates its courses. When training units on industry 4.0 were added, the institute asked a researcher from the National Research Center (CNR) to identify the essential knowledge and skills to integrate 4.0 technologies into chemical production. This work was carried out in synergy with corporate consultants and other teachers.

At least in three other cases, although course design is based on surveys and focus groups among partner enterprises, new skills trends have been identified and acknowledged first through consultation with experts (researchers or professionals) who are not employed by any companies. This is what we identify as the second pattern of interaction between academies and companies.

“The course was born after a conference organised by *Politecnico di Milano* on sustainable mobility trends, such as: charging stations, sharing mobility and new fuels. These are actually three main points of our course, whose design took place in close contact with companies and experts consulted by our staff to understand what companies in this sector need.” (Course director, Green energy, 21.12.2022).

It should be added that the aforementioned academy also provides learning units on biofuels and hydrogen, two technologies whose applicability is still controversial and not yet established on the market.

Finally, two ITSS appear to be active promoters of business innovation (third model), as conceptualised by Vona and Consoli (2014), i.e. redesigning their training programmes according to emerging knowledge and disseminating it among companies. One academy through the spread of fresh know-how, the other through what we can call a “systematisation” of new knowledge and skills linked to emerging job profiles. In the first case, one institution, which provides a course for marketing and internationalisation of wooden furniture, helps partner companies (usually SMEs) to renovate their business approach:

“To digitise the whole aspect of communication but also marketing through e-commerce platforms [...] How did we do that? We recruited experienced freelance professionals keen on social media, multichannel marketing, and communication to teach in our course [...] our students [...] bring to the companies the knowledge they really need but are not able to acquire alone.” (Course director, Construction, 26.01.2023).

Something similar occurs also for the course, provided by the same academy, on design and industrialisation of the furniture product. “Sometimes companies buy new machinery but don't know how to use its full potential. Our students who have studied to make these technologies work can help the company make the most of them”

(Course director, Construction, 26.01.2023). For the interviewee, the foundation's contribution to innovation is twofold: it trains young people who can lead innovation processes within SMEs and it urges partner companies to make investments on cutting-edge technologies.

The second, and more relevant case, is represented by an ITS academy which provides a two-year course to become a fashion designer. A few years ago, some of its teachers, fashion industry professionals hired to teach some learning units, reported the launch of a new powerful 3D clothing modelling software (Clo 3D). No Italian fashion house used this software at that time. Nevertheless, the academy decided to include a module on this subject in its fashion designer course.

Over the years this technology had evolved and it was clear that it could become the 'core' of a new professional profile. The academy then decided to open a new course for digital fashion design. A special scanner (VIZU) was also purchased to transfer the characteristics of fabrics (shine, grain etc.) to digital models, and a software to create avatars of customers wearing the digital clothes. The new training course was structured around the use of these new technologies.

The digital fashion designer did not yet exist in the market. However, after the first edition of the course, some companies that turned to the academy seeking for 'traditional' fashion designers, decided to hire these new technicians to change their organisation towards digital modelling.

In this case, it was not the companies that asked the educational institution to modify its training offer based on a predetermined professional profile, but the opposite: the ITS academy anticipated them, having realised the opportunities offered by some cutting-edge technologies. Thanks to the advice of some teachers, hybrid profiles coming from the world of work (not necessarily employed by a single company, but freelancing), it was possible to design the curriculum of future technicians who will be able to use those technologies to innovate production processes and transform the companies themselves. The design of study plans was partially based on the results of a survey conducted among companies and partially on suggestions coming from the teaching staff. For example, the photography teacher, an established photographer in the fashion industry who has been working for major brands, suggested how to conceive the digital photography learning unit, because "using Photoshop to retouch photos for a traditional catalogue is one thing, but using it to create realistic 3D renderings is another" (IFoundation's vice-director, Fashion, 26.08.2022).

In general, it can be said that in all academies – whichever pattern they belong to – teachers recruited among professionals play a key role in the interplay between the world of work and educational institutions, especially when innovation is concerned. At the ITS academy active in the ICT sector the packaging course was created on the explicit mandate of the Milan trade associations, but the role of teaching staff with different backgrounds is still fundamental for the steady update of the curriculum. "High profile professionals know the things that will enter in the work of work in a few years. Companies will come later" (Teacher, ICT, 18.11.2022). One teacher, who is also involved in the course design, said:

“Yesterday I was in Bologna at the national flexography conference. New procedures for managing customer-supplier information exchange through packaging were presented. Currently, nobody applies these procedures, but ISO standards already exist, and they will spread in the coming years. I convey all this knowledge in advance to my students who are now attending the course to become a Packaging Specialist.” (Teacher, ICT, 18.11.2022).

The same thing emerged during the interview with a teacher and consultant of the academy active in the Food industry. Also here, teachers hired from the world of work can quickly adapt the teaching contents of their lessons as soon as they realise that new procedures or technologies are emerging. The person interviewed spoke about the process of ozonisation for the sanitation of dairy industry environments, introduced in her learning unit shortly after new import restrictions were imposed by the American health authority on Italian imports, such as parmesan cheese.

Furthermore, the collaboration between students and companies during the course could enhance innovation's spreading. At one ITS academy

“Teachers of a specific teaching unit may coordinate a project work assigned by a company to a whole class or a single student. Our foundation signs an agreement with the company that commissions a brief to one of our class groups. For example, the task is to design a three-dimensional model of slippers using new software. The company pays the teacher, who then becomes a sort of consultant, for coordinating the group and then for mentoring an intern (one of our students) that will try to carry out that project in the company – the experience represents also the chance to ‘test’ a possible future technician to be hired [...] This means that the company can try a new working method (in this case the digital design of its products) thanks to the work of an intern who knows the last release of one professional modelling software quite well, taking advantage at the same time of the support of an expert teacher.” (Foundation's vice-director, Fashion, 26.08.2022).

6 Discussion

6.1 Broad or narrow professional mindset?

The collected information suggest that the nine academies considered, while preparing specialised technicians ready to enter in the job market, provide a (relatively) wide range of skills, which allow them to adapt in different professional positions thanks to – so we may argue – a sufficiently broad professional mindset. This is due to legislative, scholastic, practical and also – at least in some cases – pedagogical reasons.

Firstly, ministerial regulation, while leaving ITS institutions great autonomy in the curricula's design and learning outputs' choice, still indicates a set of quite broad professional profiles to reach at the end of the Italian higher technical education (Interministerial decree No. 8327 of 7th September 2011). This prevents the education offer from being too narrow:

“the focus of the course is precisely green mobility. However, this does not mean that our 1100 hours of school-based teaching are exclusively on sustainable and electric mobility [...] our mandate is to prepare a technical figure recognised at a national level: the upper technician for the management and the verification of high-performing energy systems. For

this reason, we give our students an elementary background useful to be employed not only into mobility-related fields [...] Thanks to this general preparation, after an internship in the right place, someone could be employed also by companies which deal with energy efficiency, both with technical or even managerial functions.” (Course director, Green energy, 21.12.2022).

Secondly, as explicitly stated by three interviewees (smart mobility; biotechnology; mechanical industry) and confirmed also by the annual national monitoring released by INDIRE (National Institute for Documentation, Innovation and Educational Research), the educational background of students enrolled in ITS is very different, even in the same course, and not always consistent with the specialisation. Born as natural prosecution of the secondary technical education – in 2020 most of the students enrolled in the Italian short cycle tertiary education still had a technical upper secondary leaving certificate (58,7%), but not always in the same technological field of the ITS course attended. In recent years, the number of enrolments coming from general upper secondary education has increased (up to 22.6 % in 2020). The number of those having an academic degree already has risen too (4%). Students with a VET qualification were only 13.6 % in 2020. There is also a considerable number of students over 30 years of age (almost 10 %) (Zuccaro, 2022). This forces the academies to provide a series of preparatory teaching units at the beginning of each course.

Furthermore, providing a broad set of skills is also necessary because ITS students’ employment destinations could be very differentiated: they are mostly SMEs in different sub-sectors.

“If one student ends up in a large, highly structured company, then he or she can become a specialist (perhaps in Amazon sales) [...] But if he or she ends up in a smaller company, then he or she needs to be able to handle logistics, shipping, returns, inventory, a product catalogue on the site, omnichannel marketing etc.” (Foundation’s vice-director, Fashion, 26.08.2022).

Alongside these practical reasons, in the choice of a broad educational offer at least during some interviews, pedagogical motivations were also cited: “we need to develop in our students the ability to study and learn continuously” (Course director, Cultural Heritage and Tourism, 03.02.2023); “it is essential that they acquire a method and a mindset to evolve quickly following the rapid technological transformation” (Foundation’s vice-director, Fashion, 26.08.2022); “we would also like to equip them with a personal method to progress on a path of professional growth” (Course director, Construction, 26.01.2023). This feature, though, does not seem to be explicitly related to the ability to innovate work processes.

6.2 Learning activities for soft skills’ development

The attention of the nine interviewees paid to the development of soft skills is high. More than university teaching – in Italy often characterised by outdated teaching environments, overcrowded and frontal lessons (Rostan, 2014, pp. 102–104) – higher technical institutions manage to offer learning activities where the focus is actively exercising personal soft skills in small groups. During the interviews, the link between soft skills

and the ability to find innovative solutions does not come out explicitly⁸, despite a strong insistence on the importance of promoting problem solving strategies.

In general, soft skills are seen as functional character components for the effective adaptation to the relational dynamics typical of work contexts. As we have seen, this 'utilitarian' approach does not prevent the emergence of an explicit attention to the pedagogical dimension of personal growth. In this sense, the interweaving of professional and personal development might be the way to prepare technicians who will be able to support innovation processes.

6.3 ITS involvement in knowledge systematisation and spreading

Regarding the contribution of ITS academies to the innovations' systematisation and spreading the inquiry offer a twofold scenario. In the production sectors (aeronautics, mechanics, chemistry), where the use of new technologies directly impacts work processes, ITS curricula's design appears heavily influenced by skills needs expressed by some leading companies. In the service sector (marketing, hospitality, fashion design), where the use of new technologies has a more indirect impact on work processes, ITS institutions play a more proactive role in defining new job profiles.

In any case, teachers recruited from the world of work are crucial. These 'hybrid' professionals act as a 'bridge' between the production or service sector and academies for the acquisition of new knowledge, its integration and sometimes its original re-elaboration into curricula, as well as its dissemination among companies which are often not able to use or do not even know of it.

7 Conclusions

The enquiry presented here is still exploratory in nature. Based on the analysis of the internal documents of the organisations considered (study plans) and the voice of those who work for them, it can only provide interesting insights to understand the *modus operandi* of the Lombardy's ITS academies and the way they see their own function within the skills ecosystem.

However, the information gathered seems sufficient to give an objective idea of the relationship between academies and the world of work, which is more complex than the supply-demand model. Academies do not always play a merely passive role in the VET of future technicians but participate, with different levels of intensity, to the definition of professional profiles and the development of the respective field. This is possible thanks to a valuable job of re-elaboration of the emerging knowledge which corresponds to what some scholars call 'systematisation of innovations'. In addition to fulfilling demands of the labour market, academies play an important role in the spreading of new information and know-how among partner companies. In other words, they are equipping future technicians to drive the so-called 'incremental innova-

8 With the only exception of the academy active in the biotechnology sector, which offers a 12 hours teaching unit called team building, mindfulness and creativity.

tion'. One might assume that this also happens because of the collaboration between ITS academies and universities, but this aspect does not emerge in the interviews, as the interaction with researchers seems to be rather marginal.

Important limitations to the research obviously remain. Firstly, to evaluate the role played by ITS academies in the dissemination and systematisation of innovative know-how, we rely only on interviewees' testimonies about successful practices. We do not know how much these positive examples count in the overall activity of short cycle education in Lombardy. Secondly, although respondents are confident that their courses give an adequate preparation for different professional roles and fields, neither have data been collected on the professional careers of ITS graduates, nor evidence that their alleged broad professional mindset allows them to promote innovation at the workplace. Finally, teaching activities aimed at developing soft skills are surely relevant within ITS curricula, but we do not have evidence to assess the educational results of those activities.

More research is needed to find out whether academies are only providing skills which are supposed to foster innovation or whether they are also promoting the professional and personal development of future technicians. This is a crucial question, since the human factor is the key to organisational and economic development (Bertagna, 2006) and only the personal agency is the basis of innovation processes (Costa, 2013; 2018).

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