Human Development in the Algorithmic Era: A Quantitative Analysis of the Impact of Adult Education and Training on Soft Skills

Sviluppo umano nell'era algoritmica: un'analisi quantitativa sull'impatto dell'educazione e formazione degli adulti sulle soft skills

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Abstract

The accelerating diffusion of Artificial Intelligence (AI) and automation critically highlights the strategic importance of soft skills, interpersonal, cognitive, and self-management capacities that distinguish human agency and foster holistic individual development in digitalized workplaces. This paper examines whether adult education and training (AET) stimulates soft skill development in Italy, a context where policy and employer-driven programs have historically prioritized technical competences (hard skills). Using nationally representative data from the INDACO-Adults 2022 survey (N = 40,477), we construct a soft skills index via a Graded Response Model (GRM) and estimate OLS regressions to assess the association between AET participation and self-perceived skills. Results indicate a positive and significant relationship, robust to multiple controls. Heterogeneous effects emerge: surprisingly, retired adults and individuals unable to work show particularly strong associations, suggesting a profound impact on personal well-being and re-engagement, while employed and unemployed adults display more modest gains. Importantly, individuals who already value training report substantially higher soft skill levels, underscoring the relevant role of intrinsic motivation and a supportive learning culture. By linking pedagogical theory with large-scale quantitative evidence, the study highlights the need for policies that embed transversal skills into AET curricula and promote lifelong learning culture as a human and civic priority, as well as an economic one.

Keywords: soft skills, adult education and training, lifelong learning, artificial intelligence, work.

L'accelerazione della diffusione dell'Intelligenza Artificiale (AI) e dell'automazione evidenzia in modo critico l'importanza strategica delle soft skills, ovvero le capacità interpersonali, cognitive e di autogestione che distinguono l'agire umano e promuovono lo sviluppo integrale della persona nei luoghi di lavoro digitalizzati. Questo studio esamina se l'educazione e la formazione degli adulti (AET) possano stimolare lo sviluppo delle soft skills in Italia, un contesto in cui le politiche e i programmi promossi dai datori di lavoro hanno storicamente privilegiato le competenze tecniche (hard skills). Utilizzando dati rappresentativi a livello nazionale dall'indagine INDACO-Adulti 2022 (N = 40.477), abbiamo costruito un indice di soft skills tramite un modello di risposta graduata (GRM) e stimato regressioni OLS per valutare l'associazione tra la partecipazione all'AET e le competenze auto-percepite. I risultati indicano una relazione positiva e significativa, robusta a controlli multipli. Emergono effetti eterogenei: sorprendentemente, gli adulti in pensione e gli individui inabili al lavoro mostrano associazioni particolarmente forti, suggerendo un profondo impatto sul benessere personale e sul re-coinvolgimento, mentre gli adulti occupati e disoccupati mostrano guadagni più modesti. È importante sottolineare che gli individui che già apprezzano la formazione riportano livelli di soft skills sostanzialmente più elevati, evidenziando il ruolo rilevante della motivazione intrinseca e di una cultura di apprendimento favorevole. Collegando la teoria pedagogica con prove quantitative su larga scala, lo studio sottolinea la necessità di politiche che integrino le competenze trasversali nei curricula AET e promuovano una cultura dell'apprendimento permanente come priorità umana e civica oltreché economica

Parole chiave: soft skills, educazione e formazione degli adulti, lifelong learning, intelligenza artificiale, lavoro.

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DOUBLE BLIND PEER REVIEW

1. Introduction

The current socio-economic landscape is undergoing a profound transformation, driven by the rapid advancements in Artificial Intelligence (AI) and automation. This era, often dubbed the Fourth Industrial Revolution (Schwab, 2016), is fundamentally reshaping the nature of work, redefining professional architectures, and generating a significant polarization of the labor market. As AI systems increasingly automate not only manual but also complex cognitive tasks, the very essence of human involvement in work – particularly in symbolic elaboration and meaning-making – is being challenged (Arntz et al., 2017; Brynjolfsson et al., 2018; Green et al, 2023; Cazzaniga et al., 2024).

This shift presents not merely a technological or economic problem, but a profound anthropological and cultural challenge. It calls into question the very essence of human agency and thriving when traditional cognitive labour is increasingly automated. This forces a societal introspection into how individuals derive purpose, connect with others, and develop their full potential within evolving professional and community landscapes Crucially, it demands a critical re-evaluation of the fundamental aims and pedagogical approaches of education and training, urging us to consider how learning can cultivate genuinely human capacities in an increasingly automated world.

In this evolving paradigm, the emphasis often falls on technical upskilling and reskilling, framing education as a reactive mechanism to adapt the "human resource" to new technological demands. In fact, a recent OECD report (2025) highlights that much adult training remains short, compliance-oriented, and reactive rather than proactive or strategic. However, this purely economic lens risks overlooking the deeper existential, identitarian, and political dimensions of work. As Nussbaum (2011) powerfully argues, a truly flourishing human life, encompassing a meaningful professional trajectory, requires the cultivation of fundamental "human capabilities" that extend far beyond mere technical proficiency. From a pedagogical standpoint, this implies a shift from a transactional view of learning to one that fosters holistic individual development and societal well-being.

While often implicitly valued, their relevance is not a novelty of the AI era. Over the past decades, the decline of manufacturing and the parallel expansion of service economies have progressively elevated the importance of transversal and relational competencies across labour markets (Kyllonen, 2013; Heckman & Kautz, 2012). What is new today, however, is that in an algorithmically augmented workplace their strategic importance becomes undeniable (WEF, 2023). Indeed, contemporary pedagogical thought increasingly emphasises that in a period where AI can mimic and even surpass human cognitive processing in many domains, the uniquely human capacities – often categorized as soft skills – emerge

as the true differentiators and sources of sustainable value (Deming, 2017; Succi & Canovi, 2020).

These skills are crucial not only for employability but for promoting individual and collective well-being in a rapidly changing world (European Commission, 2020). Moreover, a recent work in adult education and training (AET) highlights soft skills as foundational for adult agency, enabling individuals to actively make sense of their lives and shape their futures rather than passively adapt to external dictates (Merriam & Baumgartner, 2020). They are the competencies that empower individuals to engage meaningfully with technology, to collaborate effectively with diverse teams, and to exercise informed judgment in morally complex scenarios that AI alone cannot resolve (Davenport & Kirby, 2016). Moreover, they form the bedrock of what Aristotle termed *phronesis*, or practical wisdom (Bertagna, 2011), which is essential for exercising ethical and reflective judgment in an increasingly automated work environment. For this study, we focus on six widely recognised soft skills critical for diverse professional and personal contexts: collaboration, problem-solving, teamwork, discipline, leadership, and communication (Cinque, 2016).

This global imperative finds particular resonance in the Italian context. While national policies and employer-driven training programs continue to emphasize technical and professional competencies (Inapp-Anpal, 2025; INDACO-Imprese, 2022), recent surveys also point to a systemic underdevelopment of transversal and soft skills. For instance, a 2024 study by the Politecnico di Milano's HR Innovation Practice Observatory found that 36% of workers lack necessary soft skills. Similarly, the Cegos International Barometer (2024) reports significant demand for training in organizational effectiveness (45%), creativity (33%), and agility (30%). Hence, integrating soft skills into AET pathways represents not only a global challenge but a strategic priority for the Italian educational and occupational system.

Therefore, understanding the actual impact of AET initiatives on the development of soft skills becomes paramount. By examining a representative sample of the Italian adult population through microdata from the *Survey on Adult Training Behaviours* (INDACO-Adulti, 2022), we aim to uncover statistically significant relationships between engagement in AET and self-perceived levels of soft skills. Our study, grounded in educational theory, seeks to illuminate how adult learning environments can proactively foster human capabilities in a rapidly evolving world.

Based on this pedagogical horizon, this paper seeks to address the following research questions:

– *Research Question 1*: Is there a statistically significant relationship between self-perceived levels of soft skills (such as collaboration, problem-solving, team-

work, discipline, leadership, and communication) and participation in AET programs?
– *Research Question 2:* Which socio-demographic and training-related factors (e.g., age, gender, education level, occupational standing) moderate the association between AET participation and soft skills, and are there significant heterogeneous effects across different employment conditions?

While our quantitative analysis cannot directly observe pedagogical processes, understanding the association between AET participation and soft skills provides essential groundwork for future inquiry into the 'pedagogical how' of effective adult learning.

The paper proceeds as follows. Section 2 reviews the existing literature on the relationship between AET and soft skill. Section 3 describes the dataset and the variables used in the analysis. The empirical methodology is presented in section 4. Section 5 presents the results, followed by a discussion and conclusions in Section 6. Finally, section 7 presents briefly some policy implications.

2. Literature Review: The Effect of AET Programs on Soft Skills

Understanding how AET influences soft skill development requires examining both theoretical frameworks and empirical evidence. The escalating demand for soft skills in the contemporary labour market and society, intensified by the Fourth Industrial Revolution and the pervasive integration of AI, has spurred significant interest in understanding how AET programs contribute to their development. While theoretical frameworks extensively highlight the pedagogical potential of AET for fostering transferable competencies (e.g., Jarvis, 2010; UNESCO, 2022), empirical evidence, particularly large-scale quantitative studies, remains a crucial area of investigation. This section reviews key strands of the literature: (1) definitional and measurement issues of soft skills; (2) empirical evidence of training or interventions; (3) pedagogical research on soft skills development; (4) national and comparative studies, especially in Italy.

Soft skills, often referred to as non cognitive, transversal, or socio emotional competencies, lack a universally agreed definition. Some works emphasize interpersonal and affective components (e.g., communication, teamwork, adaptability), while others include intrapersonal traits such as self-regulation and resilience. This diversity creates challenges for stable and shared assessment. For instance, a study of van den Beuken et al. (2025) emphasizes that even within academic settings, instructors find it difficult to define and assess soft skills consistently. Similarly, studies validating soft skills measurement instruments show evolving frameworks. For example, Crespí et al. (2025) conducted a quasi-experimental study across two universities in Spain and Mexico using the *Basic Generic Com-*

petencies Questionnaire (BGCQ). Their findings suggest that curricular subjects dedicated to transversal competencies can significantly improve students' intrapersonal skills, though the absence of a control group and the reliance on self-perceptions limit causal inference

Empirical studies provide mixed evidence of the impact of training on soft skills or related outcomes such as self efficacy and adaptive behavior. For example, Joie-La Marle et al. (2023) evaluated a metacognition-based soft skills training program with 180 employees in a pre/post experimental design including a control group. The intervention significantly enhanced participants' soft skills metacognition, self-efficacy, and adaptive performance, with evidence that self-efficacy partially mediated the training's impact. In contrast, Groh et al. (2016) conducted a RCT with over 1,300 female community college graduates in Jordan. While the 45-hour soft skills training improved participants' optimism, mobility, and self-perceptions, it did not translate into sustained employment gains.

Moving towards more robust empirical designs, several studies have leveraged larger datasets, though often with varying definitions and measurements of soft skills. For example, a study by Cedefop (2018) analyzing European survey data indicated that participation in continuous vocational training was positively linked with a higher self-reported ability to adapt to new tasks and work methods, which aligns with key aspects of flexibility and problem-solving. Furthermore, large-scale surveys, such as the OECD Survey of Adult Skills – PIAAC (OECD, 2019) frequently show correlations between participation in adult learning activities and self-reported higher levels of critical competencies, including self-efficacy, initiative, and problem-solving, all of which are critical components of soft skill. Crucially, while these studies identify important correlations, much of this research relies on cross-sectional data and, in some cases, self-reported outcomes, thereby limiting strong causal inference and the ability to capture the full, multidimensional nature of soft skills.

Beyond outcomes, pedagogical scholarship sheds light on *how* soft skills are cultivated. Kolb's (1984) experiential learning cycle emphasises that competencies develop through concrete experience, reflective observation, abstract conceptualization, and active experimentation. Schön's (1983) "reflective practitioner" model similarly highlights how professionals develop judgment and adaptive capacity through structured reflection on practice. For soft skills, this implies that effective AET must go beyond knowledge transmission to create spaces for authentic practice and critical reflection. Soft skills like communication and teamwork are inherently relational and develop through interaction. Vygotsky's (1978) sociocultural theory and subsequent work on communities of practice (Wenger, 1998) demonstrate that learning is fundamentally social. Problem-based and project-based learning approaches (Hung, 2011; Savin-Baden & Fraser, 2023) create authentic contexts where learners must negotiate meaning, manage conflicts, and co-construct solutions, precisely the conditions that foster interpersonal com-

petencies. Mezirow's (1991) transformative learning theory posits that adults develop new perspectives through critical reflection on assumptions and beliefs. This process is particularly relevant for intrapersonal soft skills like self-regulation, discipline, and leadership, which require metacognitive awareness and intentional self-development. Finally, a persistent challenge in soft skills education is transfer across contexts. Adult learning research suggests that skills are more transferable when learned in authentic, varied contexts and when learners explicitly reflect on how competencies apply across situations (Barnett & Ceci, 2002). However, a critical gap exists: while these pedagogical frameworks are theoretically robust and supported by small-scale qualitative studies, large-scale quantitative evidence linking specific pedagogical approaches to soft skill outcomes in adult populations remains scarce. Our study cannot directly observe pedagogical practices within AET programs, but by establishing the association between AET participation and soft skills, we create a foundation for future research examining which pedagogical characteristics drive these effects.

While the international literature provides important theoretical and methodological grounding, understanding the Italian case requires examining its specific policy context and existing empirical evidence. Several studies position the debate on soft skills and training within the Italian and broader comparative contexts. Caggiano et al. (2020) compared 80 Italian and 80 Finnish higher education students' self evaluations of soft skills, finding both shared competencies and significant differences in attributes such as sensitivity, assertiveness, and social desirability, which the authors link to differences in cultural expectations and curriculum design. Meanwhile, the OECD's Survey of Adult Skills in Italy (2025) reports that older adults (aged 55-65) significantly lag behind younger cohorts in literacy, numeracy, and adaptive problem solving, and that gaps by educational attainment remain large. In a cross national analysis using the first cycle PIAAC data for Italy, France, the UK, and Sweden, Cegolon (2017) finds that AET participation is positively associated with literacy and numeracy skills among older adults, although the strength of association varies markedly among countries. While valuable, these studies predominantly focus on basic skills (literacy and numeracy). Thus, they provide less direct insight into the impact of AET on the broader spectrum of transversal soft skills (e.g., communication, collaboration, leadership, etc.) across the general adult working-age population. This underscores a critical gap in the existing literature for Italy.

These findings suggest that while Italy shares global trends in skill gaps, the emphasis in policy and employer-driven training has remained predominantly technical, with less systemic attention to transversal and soft skills.

From these strands, several gaps emerge that our study aims to address:

– much empirical evidence focuses on youth and students, with less attention to adults outside formal education. We specifically examines a nationally rep-

resentative sample of Italian adults (18-64), providing crucial insights into this demographic;
– the full spectrum of soft skills - interpersonal, intrapersonal, adaptability, metacognition - is measured inconsistently, often relying on self-reports. Few studies use latent variable models to capture complexity with rigor. We address this by constructing a psychometrically robust soft skills index using a Graded Response Model (GRM), providing a more nuanced and reliable measure;
– Italian and cross-national studies tend to emphasise basic skills (e.g. literacy and numeracy) rather than transversal soft skills, or focus narrowly on educational rather than workplace/adult contexts. Our research explicitly targets a broad index of six critical transversal soft skills – collaboration, problem-solving, teamwork, discipline, leadership, and communication – within the adult learning landscape;
– there is limited evidence on heterogeneous effects and on the practical magnitude of soft skill gains from training. This study investigates these heterogeneous effects across different employment conditions, offering a more granular understanding of AET's impact.

By bridging pedagogical theory with rigorous quantitative evidence, and by specifically addressing these gaps using a nationally representative Italian adult sample, this study contributes significantly to understanding how adult learning can foster crucial human capabilities in the algorithmic era.

3. Data and variables

We use data from the *Survey on Adults' Educational Behaviours* (INDACO-Adults 2022), carried out in Italy by the National Institute for Public Policy Analysis (INAPP), in collaboration with the National Institute for Statistics (ISTAT). Included among the surveys of public interest, its implementation is foreseen by the National Statistical Plan (PSN) of SISTAN 2020-2022 (IAP-00003) and by the National Operational Programme - Active Employment Policy Systems (PON SPAO) co-financed by the European Social Fund (ESF), 2014-2020 programming, for which INAPP acts as an Intermediate Body.

The survey explores a range of areas, including participation in formal and non-formal education and training activities; sociodemographic, cultural, and occupational gaps in access and perceived benefits; skills; barriers to learning; intergenerational learning dynamics; and the impact of the COVID-19 on work and educational behaviours, smart working.

Our analysis is based on a nationally representative sample of 40,477 individuals, stratified by gender, age (18-64), education attainment, and geographic region (Italian region).

Dependent variable

As part of the INDACO-Adults 2022 questionnaire, respondents were asked the following question in reference to skills:

"We now present you with a set of skills. For each one, we ask you to indicate how much you believe you possess and how much you would be interested in strengthening it":

a. Collaboration
b. Problem solving
c. Team-working
d. Discipline
e. Leadership
f. Communication

Each statement required a response using a four-point scale: "*No, I do not own this skill and do not intend to strengthen it*"; "*No, I don't own it, but I would like to strengthen it*"; "*Yes, I own it, but I would like to strengthen it*"; "*Yes, I own it, and I don't feel I need to strengthen it*". Using responses to the six items that were asked, a continuous 'soft skills' scale is constructed. This has been done via estimation of a Graded Response Model (GRM) for ordered categories. We then standardised the scale to mean zero and standard deviation one, allowing us to interpret the estimates in terms of effect sizes. A higher score on this standardized index thus indicates a stronger self-perceived proficiency across these six soft skills.

Explanatory variable

The main independent variable of interest is AET participation. This is a dummy variable that takes a value of 1 if the individual attended workshops, seminars, and labs, of short duration, practical or theoretical, for professional or personal reasons in the 12 months preceding the interview. It takes a value of 0 otherwise. Examples include training days, informative seminars on work, and workshops on company results. This broad definition encompasses various forms of non-formal adult education and training courses, including both employer-provided and self-initiated training activities.

Control variables

INDACO-Adults 2022 questionnaire also captured a range of other information, which are used as statistical controls within parts of our analysis. This includes:

- Female: a dummy variable equal to 1 if the respondent is female and 0 if male;
- Age: a categorical variable divided into 5 groups: 18-24; 25-34; 35-44; 45-54 and 55-64;
- Education: an ordinal variable with three levels: low (from primary education to lower secondary education), medium (upper secondary education and post-secondary non-tertiary education) and high (from bachelor's degree to PhD);
- Country of birth: a binary variable taking the value 1 if the respondent was born in Italy, and 0 if born abroad;
- Citizenship: a nominal variable indicating whether the respondent holds an Italian, EU or extra-EU citizenship;
- Regional Area: a five-categories variable: North-West, North-East, Centre, South, and the Islands;
- Employment Status: a categorical variable comprising seven levels including employed, unemployed, retired, unable to work, student, and engaged in household activities
- Training importance: a dummy indicating whether the respondent perceives training for their professional and personal development.

Table 1 reports descriptive statistics for all variables used in the analysis.

The Soft Skills Index, by construction, has mean zero and standard deviation one, ranging from - 3.08 to 1.24, indicating substantial heterogeneity across workers.

Participation in adult education and training (AET) is relatively limited: only 26% of respondents reported attending some workshops, seminars, and labs in the 12 months prior to the survey. By contrast, perceptions of AET are much stronger: nearly 88% of workers consider AET important for their professional and personal development.

The distribution of employment status indicates that the majority of respondents are employed (61.4%), while about one in five are unemployed (20.6%). A smaller share of the sample consists of retired individuals (5.8%), students (4.7%), and those engaged in domestic activities (6.7%). Only a very limited proportion (0.9%) report being unable to work.

Sociodemographic characteristics show that the sample is evenly split by gender (49% female). The age distribution is well spread across working-age categories: 11.4% are aged 18–24, 17.5% are 25–34, 20.8% are 35–44, 26.4% are 45–54, and 24.0% are 55–64. Regarding educational attainment, 42.2% of workers hold a low level of education (compulsory schooling), 39.1% have a medium level (upper secondary), and only 18.7% hold a high level (tertiary). Citizenship is overwhelmingly Italian (96.3% of the sample), while EU citizens account for 1.7% and non-EU citizens for 2.0%.

Finally, the geographic distribution of respondents reflects the Italian population structure: 26.5% live in the North-West, 19.5% in the North-East, 19.7% in the Centre, 23.4% in the South, and 10.9% in the Islands.

	Mean	Sd	Min	Max	N
Soft skills index (std.)	0.00	1.00	-3.08	1.24	40,477
AET participation	0.26	0.44	0.00	1.00	40,477
Female	0.49	0.50	0.00	1.00	40,477
Age group:	3.26	1.28	1.00	5.00	40,477
Education level	2.00	0.69	1.00	3.00	40,477
Born in Italy	0.95	0.22	0.00	1.00	40,477
Citizenship	1.04	0.25	1.00	3.00	40,477
Geographic area	2.65	1.35	1.00	5.00	40,477
Employment status	1.87	1.48	1.00	6.00	40,477
Importance of training	0.88	0.33	0.00	1.00	40,477

Tab. 1: Summary statistics

4. Methodology

To estimate the strength of the relationship between training participation and adult soft skills, we use OLS regression. This model is specified as:

$$Soft\ Skills_i = \alpha + \beta.AET_i + \gamma.D_i + \delta.B_i + \theta.W_i + \varepsilon_i \quad (1)$$

Where:

$Soft\ Skills_i$ = represents the soft skills score of individual *i*, derived from the GRM model and standardized (mean = 0, SD = 1);

AET_i = the explanatory binary variable equals to 1 if the individual reported participating in some AET activities in the 12 months prior to the survey, and 0 otherwise;

D_i = A vector of controls capturing the demographic characteristics of the respondent, including gender, age and education;

B_i = other aspects related to the individual's background, such as country of birth, citizenship and geographic area of residence;

W_i = refers to work-related characteristics, such as employment status and the perceived importance of training;

i = individual i;

ε_i= the error term.

The parameter of interest is , which captures the conditional association between participation in AET and adults' soft skills. Given the continuous and approximately normal distribution of the standardized soft skills index derived from the Graded Response Model (GRM), OLS regression is employed to provide a clear and interpretable estimate of the average linear association between AET and soft skills, controlling for covariates. While acknowledging the self-reported nature of the soft skills measure, OLS provides a robust and widely accepted method for examining these associations within large-scale survey data.

All analyses apply the sampling weights provided by the INDACO-Adulti 2022 survey, ensuring representativeness of the Italian adult population.

Several limitations of this study should be acknowledged.

First, the cross-sectional design of the INDACO-Adulti 2022 survey prevents us from making strong causal claims. While the analysis identifies associations between AET participation and soft skills, it cannot establish whether training leads to skill improvement or whether individuals with higher soft skill levels are more inclined to engage in AET activities.

Second, the measure of AET is relatively coarse. It is captured through a binary indicator of whether the respondent participated in AET during the past 12 months. This measure does not account for heterogeneity in frequency, duration, intensity, content, or quality of training activities, all of which may influence soft skill development in different ways.

Third, despite controlling for a broad set of demographic, background, and work-related variables, there remains a risk of omitted variable bias. For instance, an individual's inherent curiosity or motivation, prior informal learning accumulated through diverse life experiences, or the strength of their personal and professional social networks—all of which cultivate soft skills—might also influence their propensity to engage in AET. Furthermore, the specific pedagogical design (e.g., highly interactive vs. passive formats) and quality of the training received could independently affect skill development. Comprehensive control for such variables, and their complex interactions, is a perpetual challenge in empirical research. Factors such as personality traits, motivation, cognitive ability, or social capital—which are not captured in the dataset—could simultaneously affect both the propensity to participate in AET and the development of soft skills, potentially confounding our estimates.

Finally, the study is based on self-reported survey data, which may be affected by measurement error and social desirability bias. Respondents may overstate their soft skills or underreport lack of AET. Moreover, the soft skills index, while psychometrically robust, remains an indirect proxy and cannot fully capture the multidimensional nature of non-cognitive skills.

Despite these limitations, our approach provides robust estimates of the association between AET and soft skills in a large, nationally representative sample,

establishing an important empirical foundation for understanding these relationships in the Italian context.

5. Results

Table 2 includes the results of OLS regressions conducted to examine the association between a series of individual characteristics and participation in training activities (AET) with the soft skills index. The results are presented in four sequential models that show how the effect of participating in AET is influenced by the inclusion of additional control variables.

In Model I, this initial model includes only the AET variable as a predictor. The coefficient is positive and highly significant ($\beta = 0.356$, $p < 0.01$), suggesting that participation in AET is strongly associated with a higher soft skills index. However, the model explains only 0.9% of the total variance in the dependent variable ($R^2 = 0.009$), indicating the need to include more variables.

In the second model, the introduction of key demographic variables (such as gender, education and age) increases the model's explanatory power ($R^2 = 0.076$). In this model, the association of AET with soft skills remains significant ($p < 0.01$), but its coefficient is reduced ($\beta = 0.205$). This indicates that individuals who participate in AET have, on average, a soft skills index that is 0.205 standard deviations higher than those who don't, all else being equal. Demographic variables show significant effects: being female is negatively associated with soft skills (coefficient -0.187, $p < 0.01$), while higher education levels (Medium education: 0.322, High education: 0.527, $p < 0.01$ for both) and older age groups (relative to 18-24) are positively associated with soft skills. This suggests that soft skills tend to accumulate with age and formal educational attainment.

Moving to Model III, the addition of variables related to citizenship, birthplace, and geographic area, the R^2 slightly increases to 0.083. The association of AET with soft skills remains positive and significant ($\beta = 0.196$, $p < 0.01$). Citizenship and geographic area show significant effects: being a non-Italian citizen (EU: -0.144, Non-EU: -0.156, $p < 0.10$ for both) and residing in areas outside of the North-West (specifically in the Central, South and Islands regions) is negatively associated with soft skills, highlighting potential regional disparities in skill development or perception.

Finally, Model IV, the most comprehensive one, includes additional variables such as employment status and the importance attributed to training. In this model, the association between AET and soft skills, while remaining positive and highly significant, is further reduced (0.096, $p < 0.01$). This indicates that a notable portion of the effect of participating in AET is indeed explained by factors such as an individual's employment status and their prior perception of training's importance. Being employed shows a strong positive association ($\beta = 0.436$, $p <$

0.01), suggesting that active participation in the workforce correlates with higher soft skill levels. Most notably, the perceived importance of training has the highest significant coefficient in this model (0.400, $p < 0.01$). This finding is particularly insightful: it implies that individuals who already value training for their professional and personal development tend to report substantially higher soft skills. While our cross-sectional design limits causal claims, this strong correlation suggests either that proactive learners are more skilled, or that the act of valuing training itself fosters a mindset conducive to soft skill development. The final model explains 14% of the total variance in the dependent variable ($R^2 = 0.140$).

	(1)	(2)	(3)	(4)
	Model I	Model II	Model III	Model IV
AET	0.356***	0.205***	0.196***	0.096***
	(0.021)	(0.021)	(0.021)	(0.021)
Female		-0.187***	-0.184***	-0.086***
		(0.016)	(0.015)	(0.015)
Education (Ref.: Low education)		0.000	0.000	0.000
Medium education		0.322***	0.306***	0.220***
		(0.018)	(0.018)	(0.018)
High education		0.527***	0.507***	0.338***
		(0.021)	(0.021)	(0.020)
Age (Reference: 18-24)				
25-34		0.269***	0.277***	0.162***
		(0.026)	(0.026)	(0.030)
35-44		0.466***	0.469***	0.296***
		(0.026)	(0.026)	(0.031)
45-54		0.439***	0.432***	0.261***
		(0.023)	(0.023)	(0.030)
55-64		0.275***	0.262***	0.185***
		(0.024)	(0.024)	(0.032)
Citizenship (Ref.: Italian)				
EU			-0.144*	-0.138*
			(0.082)	(0.079)
Non-EU			-0.156*	-0.131
			(0.089)	(0.084)
Birthplace: Italy			0.103*	0.108**
			(0.056)	(0.051)
Area (Ref.: Norths-West)			0.000	0.000
			(.)	(.)
North-East			-0.039	-0.055**
			(0.026)	(0.025)
Central			-0.054***	-0.037**
			(0.019)	(0.018)
South			-0.180***	-0.084***
			(0.021)	(0.021)

Islands			-0.161***	-0.053**
			(0.026)	(0.025)
Employment Status (Ref.: Unemployed)				
Employed				0.436***
				(0.023)
Retired				-0.033
				(0.043)
Unable to work				-0.271**
				(0.112)
Student				0.044
				(0.035)
Engaged in domestic activities				-0.095**
				(0.039)
AET importance				0.400***
				(0.029)
Constant	-0.065***	-0.509***	-0.509***	-1.016***
	(0.009)	(0.023)	(0.061)	(0.066)
R^2	0.009	0.076	0.083	0.140
N	40,477	40,477	40,477	40.477

Standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.01*
Tab. 2: OLS regressions of AET activities on soft skills

To summarise, the regression results consistently show that participation AET is a robust and positively associated factor with the self-perceived soft skills index. This association remains significant across all four models, even after controlling for a wide range of demographic, geographic, and professional variables. The final model underscores that while AET participation has an independent positive association, this effect is partially mediated by an individual's employment context and their inherent valuation of lifelong learning.

Our analysis further explores whether the association between participating in AET and soft skills varies across different employment conditions. The results, presented in Table 3, show six separate regression models, each corresponding to a specific employment group: unemployed, employed, retired, unable to work, student, and engaged in domestic activities. Each model included the full set of control variables described in Section 3

	(1)	(2)	(3)	(4)	(5)	(6)
	Unemployed	Employed	Retired	Unable to Work	Student	Domestic activities
AET	0.069***	0.178**	0.639***	1.791***	0.149***	0.229
	(0.022)	(0.077)	(0.230)	(0.623)	(0.057)	(0.158)
Constant	-0.602***	-1.008***	-0.984*	-0.440	-0.912***	-0.618*
	(0.087)	(0.136)	(0.516)	(0.568)	(0.178)	(0.342)
	0.055	0.046	0.108	0.149	0.089	0.092
N	24855	8345	2333	350	1898	2696

Standard errors in parentheses
** p<0.10, ** p<0.05, *** p<0.01*
Tab. 3: Regression of AET activities on soft skills among different employment statuses

A key finding in Table 3 is that AET participation has a positive and significant association with soft skills for most employment statuses. This suggests that regardless of their primary employment situation, individuals who participate in AET activities tend to have higher self-perceived soft skills scores. However, the magnitude of the AET effect is not uniform across all groups.

A particularly noteworthy finding is the disproportionately large and highly significant positive associations observed among individuals who are unable to work ($\beta = 1.791$, $p < 0.01$) and those retired ($\beta = 0.639$, $p < 0.01$). For these specific subpopulations, engaging in AET activities is linked to a very substantial increase in self-perceived soft skills. This is a surprising insight, as it implies that AET may have a particularly meaningful impact on well-being and a sense of purpose for individuals outside workforce. For the unable to work group, this remarkably large association ($\beta = 1.791$) is especially striking. It is plausible that for individuals facing significant barriers to traditional employment, any engagement in AET, even through short workshops, provides a profound boost to self-efficacy, a renewed sense of capability, or valuable social connection. These benefits could translate into a much higher self-perception of soft skills, especially if they previously experienced a decline in these areas due to their employment situation. However, it is important to interpret this substantial effect with a small caveat, given the comparatively smaller sample size (N=350) for this specific group. While statistically significant, the smaller number of observations means the precise magnitude should be considered with a degree of caution. For retired individuals, AET can provide essential cognitive stimulation, opportunities for social engagement, and a continued sense of personal growth, which are crucial for maintaining mental well-being and a positive self-image of their capabilities after exiting the formal workforce.

The association is also positive and significant for the unemployed ($\beta = 0.069$, $p < 0.01$) and for the students ($\beta = 0.149$, $p < 0.01$). This finding is particularly

important for policy, as it demonstrates that AET could be a valuable tool for these groups in improving their future employability or enhancing their foundational skill sets.

Interestingly, the effect is smaller but still significant for the employed ($\beta = 0.178$, $p < 0.05$). This may imply that while AET benefits those actively working, the marginal gains in self-perceived soft skills might be less dramatic compared to groups that are not engaged in daily professional activities where these skills are constantly practiced. Finally, for those engaged in domestic activities, the coefficient is positive but not statistically significant ($\beta = 0.229$). This may be due to a smaller sample size for this group or other unobserved factors that might mediate the relationship.

The R-squared values vary across the models, with the highest values observed for the "unable to work" ($R^2 = 0.149$) and "retired" ($R^2 = 0.108$) groups, indicating that AET explains a greater proportion of the variance in soft skills for these specific populations.

These heterogeneous effects warrant pedagogical interpretation beyond statistical description. The modest overall effect ($\beta=0.096$) is pedagogically coherent: soft skills develop gradually through practice and reflection, not through brief didactic transmission. The dramatic effects for retired ($\beta=0.639$) and unable to work ($\beta=1.791$) individuals suggest AET functions differently across life contexts. For marginalized groups, AET may represent not merely skill acquisition but what Sen (1999) terms capability expansion, namely creating spaces where adults exercise agency and resist narratives of dependency.

6. Conclusion and Discussion

This study examined the relationship between AET participation and soft skill development in Italy using nationally representative data from the INDACO-Adulti 2022 survey. Our findings reveal three key patterns that merit careful interpretation.

First, by constructing a psychometrically robust soft skills index and estimating a series of regression models, we found that AET participation is positively and significantly associated with higher levels of self-perceived soft skills. This association remains robust across specifications and persists even after accounting for demographic, occupational, and contextual variables. The effect size, while not large, represents a meaningful improvement in self-perceived skills, suggesting that AET serves as a vital tool for personal and professional development in the context of increasing automation. From a pedagogical perspective, these insights are crucial. They demonstrate that soft skills are not innate or predetermined, but can be intentionally nurtured through lifelong education. AET thus emerges as a site of subjectification (Biesta, 2022), where adults can reframe their identities,

strengthen agency, and engage critically with the transformations of contemporary work and society.

Second, the analysis also revealed pronounced heterogeneous effects: the impact of AET is particularly strong among retired adults and individuals unable to work, showing that AET offers significant benefits for these often-overlooked segments of the population. The heterogeneity of effects also highlights the need for differentiated pedagogies: what benefits an employed professional may differ from what empowers a retired adult or an individual excluded from the labour market.

Furthermore, our findings highlight the strong correlation between an individual's prior perception of training's importance and their self-reported soft skills, suggesting that intrinsic motivation and value placed on learning play a significant role alongside formal participation. This finding points to the importance of pedagogies that cultivate learners' metacognitive awareness and intrinsic motivation - not merely delivering content but fostering dispositions toward lifelong learning (Knowles, 1984).

These findings make three key contributions. In the first place, they provide large-scale evidence for Italy, a context where empirical research on adult learning and soft skills remains limited. Then, they broaden the function of AET, demonstrating that its value extends beyond employability to encompass human development, democratic participation, and resilience in times of uncertainty. Finally, by highlighting strong associations among groups outside the labour force, the study foregrounds AET's role as a civic resource: combating isolation, enhancing confidence, and enabling adults to sustain meaningful lives across diverse trajectories. Retired adults and individuals unable to work, who may experience reduced social engagement or a loss of purpose after leaving the workforce or due to health conditions, appear to derive great benefit from AET in terms of self-perceived skills and potentially renewed confidence.

At a broader theoretical level, our consistent quantitative evidence of AET's positive association with self-perceived soft skills reinforces the critical importance of these capabilities. The results resonate with the capability approach (Nussbaum, 2011) and with pedagogical perspectives that emphasize subjectification (Biesta, 2022) as a core aim of education. In an algorithmic era where cognitive tasks are increasingly automated, soft skills emerge as critical markers of human distinctiveness, relationality, and ethical judgment. AET, when designed with this broader horizon, can help preserve what Sennett (2008) calls the "savor of the craft": the ability of individuals to find meaning, agency, and dignity in their professional and social lives. Specifically, the enhanced soft skills facilitated by AET, as evidenced in our study, can empower individuals to engage more effectively in democratic processes, fostering critical discourse and informed decision-making. Furthermore, these skills contribute to individual and collective resilience, enabling citizens to adapt to and critically navigate the complex social and economic shifts brought about by the algorithmic era. We envision these contexts not as

spaces of human substitution, but as arenas for human–technology co-evolution (Simondon, 2016), where human agency, enriched by soft skills, remains central to a just and humanly sustainable future of work.

Nonetheless, the study has limitations. Its cross-sectional design prevents us from making strong causal claims, and the reliance on self-reported measures introduces the risk of response biases. Moreover, while the strong effects for the unable to work and retired groups are significant and compelling, the relatively smaller sample sizes for these populations (especially unable to work) mean that these magnitudes should be interpreted with some circumspection, even if the statistical significance remains robust. Future research should build on longitudinal data and consider more nuanced measures of training content and intensity. Qualitative approaches could also complement these findings by exploring how adults subjectively experience the link between training and their personal or professional trajectories.

In conclusion, this paper shows that AET can play a pivotal role in promoting soft skills, with implications that extend beyond employability to human development and democratic participation. As societies navigate the challenges of the algorithmic era, the strategic integration of soft skills into lifelong learning policies and practices represents not just an economic necessity, but an anthropological and civic imperative.

7. Policy Implications

The evidence presented in this study calls for a rethinking of AET in Italy, shifting from a narrow focus on technical employability skills to a broader strategy that deliberately cultivates soft skills as essential components of human development. For such policies to be effective, recommendations must move beyond general principles to actionable strategies.

First, soft skills cannot be effectively developed through brief add-on modules but require systematic integration throughout learning pathways. Italy's sectoral training funds (Fondi Interprofessionali) could adopt quality criteria requiring demonstrable soft-skill components in funded programs, aligning funding with learner-centred outcomes (INAPP-ANPAL, 2025). The National Qualifications Framework can incorporate modular and stackable micro-credentials to make transversal competencies visible and portable across contexts (INAPP, 2025). European evidence shows that micro-credentials are emerging as flexible instruments for targeted upskilling outside formal pathways (CEDEFOP, 2023)

Second, evidence consistently shows that problem-based learning, collaborative projects with structured interaction, experiential learning cycles, and mentoring relationships foster soft skill development far more effectively than passive lectures (Lee & Lee, 2024; Jeske & Linehan, 2020). Regional training accreditation

should include explicit pedagogical criteria, requiring providers to demonstrate active learning methods. INAPP could develop practical implementation guides with concrete examples, while public procurement could incentivize pedagogically innovative proposals.

Third, many AET instructors possess technical expertise but limited pedagogical preparation. Sustained professional development - ideally university-level certificates in adult education - should cover learning theory, instructional design, and assessment methods. Regional authorities could facilitate communities of practice where educators share experiences and collectively improve teaching quality.

Fourth, given the heterogeneity observed in this study - by gender, education, age and employment status - specific efforts should be directed towards underrepresented groups. Flexible formats (blended learning, modular evening or weekend programs) should be promoted to reach older adults, women re-entering the labor market, migrants and those temporarily unable to work (Santini et al., 2019; Luka, 2023). Concrete measures such as childcare support, partnerships with community centers, unions, and third-sector organizations can further reduce barriers to participation and build trust (OECD, 2020).

Fifth, policymakers should cultivate a lifelong, learning culture leveraging the significant role of an individual's perceived importance of training. Policies should aim to foster a societal culture that values lifelong learning intrinsically, emphasizing the broader personal and civic benefits of skill development beyond immediate job market demands (Cegolon, 2023). This could involve public awareness campaigns or flexible learning pathways that cater to diverse motivations.

Finally, policy interventions should be systematically monitored and evaluated. A national observatory on transversal skills in adult learning could be established to integrate program-level data with large-scale surveys (e.g., INDACO, PIAAC), creating an evidence base for iterative policy improvement.

In sum, these recommendations suggest a shift from viewing AET merely as a mechanism for technical adaptation toward recognizing it as a strategic investment in transversal skills. By embedding soft skills in curricula, fostering partnerships, incentivizing participation, ensuring inclusivity, and strengthening evaluation, AET can function not only as an instrument of labor market adjustment, but also as a vehicle for inclusion, empowerment, and the development of human capabilities in the algorithmic era.

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