

EDUCATION TECHNOLOGIES AND INSTITUTIONAL BOUNDARIES: EDUCATION–BUSINESS INTERACTION IN THE CONTEXT OF INDUSTRY 5.0

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This study examines how education technologies influence institutional boundaries in the interaction between formal education systems and business organizations under Industry 5.0. While existing research has largely focused on the pedagogical role of digital learning, less attention has been given to how education technologies reshape the interaction between education and business as an integrated institutional process. Moving beyond their pedagogical function, education technologies are conceptualized here as institutional mediators that redistribute responsibilities for knowledge and skill formation across sectors. Using an institutional–analytical approach complemented by an illustrative case of Georgia, the paper shows that adaptive learning ecosystems expand more actively in contexts where foundational competencies are already present. This suggests that education technologies operate as capability-enhancing mechanisms rather than substitutes for formal education. The findings point to a reconfiguration of education–business interaction characterized by differentiated and context-dependent role distribution. At the same time, they highlight a potential tension between the inclusive aspirations of Industry 5.0 and the selective dynamics of market-driven training systems.

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1 Introduction

The transition from Industry 4.0 to Industry 5.0 reflects not only technological change but a broader reconfiguration of institutional arrangements that shape how knowledge and skills are produced and distributed across sectors. While earlier phases of industrial transformation emphasized efficiency and automation, Industry 5.0 introduces a governance-oriented perspective that places human-centricity, resilience, and societal alignment at the center of economic organization (European Commission, 2021).

This shift highlights the importance of coordination between education systems and business organizations in preparing the workforce for evolving labor market conditions (ILO, 2023). Rather than assuming that education simply responds to technological change, contemporary policy frameworks increasingly stress the need for institutional interaction in shaping workforce readiness (OECD, 2021).

Within this evolving landscape, education technologies have gained prominence as mechanisms that enable more flexible and responsive learning arrangements. Initiatives such as micro-credentials and modular training programs signal an emerging redistribution of responsibility for skill formation across higher education institutions, employers, and private providers (Council of the European Union, 2022).

At the same time, global monitoring efforts caution that the expansion of digital learning does not automatically produce inclusive outcomes. UNESCO highlights the importance of governance and accessibility in shaping how technological integration affects workforce development (UNESCO, 2023).

These developments suggest that the relationship between education and business is increasingly structured through hybrid learning ecosystems rather than through linear knowledge transfer.

Education technologies appear to play a central role in this transformation by enabling adaptive learning pathways that align workforce preparation with changing demands (OECD, 2023). However, emerging evidence indicates that such adaptive

mechanisms operate most effectively when supported by prior competencies and foundational learning structures (World Economic Forum, 2023).

Despite the growing attention to education technologies and Industry 5.0 in policy and academic discussions, the interaction between education systems and business organizations remains insufficiently explored as an integrated institutional process. Existing research tends to examine technological innovation, education systems, and labor market dynamics in relative isolation, while the mechanisms through which education technologies reshape institutional boundaries between these domains receive comparatively limited analytical attention.

This raises an important institutional question: do education technologies generate new capabilities, or do they primarily reshape how existing capabilities are mobilized?

Against this backdrop, this study examines how education technologies influence institutional boundaries in the interaction between higher education systems and business organizations under Industry 5.0.

Research Question

How do education technologies influence institutional boundaries in the interaction between education systems and business organizations under Industry 5.0?

2 Methodology

This study adopts an institutional–analytical approach to examine how education technologies influence the evolving interaction between higher education institutions and business organizations in the context of Industry 5.0.

The analysis is grounded in the premise that contemporary technological transitions are accompanied by shifts in institutional roles related to knowledge production and skill formation. Within this framework, education technologies are treated as the primary analytical focus due to their capacity to support adaptive learning mechanisms that respond rapidly to changing workforce demands.

Rather than viewing education technologies as neutral tools, the study conceptualizes them as institutional mechanisms that shape how responsibilities for skill development are distributed across sectors.

To capture these dynamics, the research combines conceptual analysis with an illustrative case study. Institutional theory is used to interpret how Industry 5.0 influences the interaction between education and business systems, particularly in relation to emerging forms of learning provision such as modular training and micro-credentials.

The Georgian context serves as an analytical case based on selective observation of private training platforms, corporate learning initiatives, and sectoral patterns of skill demand. This approach allows the study to illustrate how education technologies expand within existing labor market structures, particularly in relation to differences in technological intensity and human capital readiness across sectors.

At the same time, the rapid expansion of business-driven training systems creates a growing need for more systematic statistical monitoring of skill formation processes. Comprehensive data on the distribution of training provision across sectors, the frequency of reskilling cycles, and the scale of non-degree-based employment remain limited, both in Georgia and in comparable contexts.

Accordingly, the Georgian case is approached as exploratory and interpretative analysis of observed sectoral patterns based on available data and mapping of existing training providers. The objective is not to establish causal relationships but to identify emerging patterns in the interaction between education systems and business-driven training ecosystems. The patterns identified in the analysis should therefore be interpreted as indicative rather than definitive, while more robust empirical validation remains an important direction for future research.

Through this combined approach, the study provides an analytical perspective on how education technologies influence the redistribution of roles between foundational knowledge production and adaptive skill formation.

3 Institutional Boundaries in Education-Business Interaction under Industry 5.0

3.1 Institutional Context of Education-Business Interaction Methodology

Recent academic and policy discussions increasingly interpret the relationship between education systems and labor markets as an institutional matter rather than a purely pedagogical or technological issue.

The transition toward Industry 5.0 has accelerated this shift by foregrounding the governance dimension of workforce preparation. The European Commission conceptualizes Industry 5.0 as a framework that integrates technological change with broader societal objectives such as resilience and human well-being (European Commission, 2021). This perspective implies that workforce readiness is shaped not only by technological adoption but also by institutional coordination between education providers and economic actors.

International organizations have emphasized this systemic view. UNESCO’s work on the future of education underscores the need to preserve education’s public function while adapting to changing labor market conditions (UNESCO, 2021). Rather than promoting technological substitution, UNESCO highlights the importance of maintaining institutional stability alongside flexibility.

OECD analyses similarly stress that adaptation to evolving employment structures depends on the interaction between formal education systems and lifelong learning mechanisms (OECD, 2021). More recent OECD work on micro-credentials suggests that emerging certification models are reshaping how competencies are recognized and validated across institutional settings (OECD, 2023).

The European Union’s recommendation on micro-credentials further illustrates this trend by encouraging flexible learning pathways delivered across higher education institutions, employers, and private providers (Council of the European Union, 2022). These developments signal an increasing redistribution of responsibility for skill formation.

At the same time, global monitoring efforts highlight potential governance challenges associated with technological expansion in education. UNESCO's Global Education Monitoring Report (2023) emphasizes the need for inclusive and accountable integration of digital learning systems.

Research on education governance also supports this institutional perspective. Studies examining digital platforms and data infrastructures indicate that emerging learning ecosystems increasingly rely on intermediaries that influence decision-making and legitimacy (Nichols & Dixon-Román, 2024; Williamson & Piattoeva, 2021).

Complementary research on EdTech intermediaries suggests that actors operating between public education systems and private market providers play a growing role in shaping how digital learning solutions are adopted and evaluated (Ortegón, 2024).

These insights are reinforced by broader labor market analyses. The World Economic Forum highlights the increasing importance of reskilling mechanisms driven by employers (World Economic Forum, 2023). Similarly, the International Labour Organization underscores the need for inclusive lifelong learning systems capable of responding to structural shifts in employment (ILO, 2023).

Taken together, this literature suggests that the interaction between education and business is evolving from a sequential relationship toward a more integrated arrangement.

3.2 Industry 5.0 and Boundary Reconfiguration

Within this evolving context, Industry 5.0 can be understood as a reconfiguration of institutional arrangements that shape how knowledge and skills are produced and coordinated across sectors (European Commission, 2021).

Historically, universities have functioned as key institutional actors responsible for the production of foundational knowledge and the conferral of epistemic legitimacy through formal qualifications (Marginson, 2019). Firms, in turn, have primarily specialized in firm-specific training aligned with operational needs, while the

provision of broader cognitive foundations has been implicitly treated as a function of the education system (Williamson, 1985).

This division of roles contributed to relatively stable institutional boundaries between education and business.

Institutional theory offers a useful lens for interpreting how these boundaries evolve. Institutions structure authority and responsibility across social domains (North, 1990). Under Industry 5.0, these arrangements become more dynamic as education and business increasingly share roles in workforce preparation.

Already in the early twenty-first century, it was noted that workforce preparation was shifting from a linear model toward a more integrated configuration, in which education and business interact through overlapping institutional roles (Etzkowitz & Leydesdorff, 2000). Firms have gained greater capacity to respond to short-cycle skill demands, while education systems continue to sustain foundational knowledge that supports long-term adaptability (Barnett, 2018).

Importantly, this transformation has generated considerable scholarly and societal interest. Reflecting the reconfiguration of institutional boundaries, it appears at times as complementary, at times as overlapping, and in some cases is interpreted as implying a partial substitution of traditional educational functions by education technologies.

3.3 Education Technologies as Mediating Infrastructures

Within this emerging configuration, education technologies play a central role in shaping how institutional boundaries are negotiated.

By enabling modular learning formats, micro-credentials, and short-cycle training programs, education technologies facilitate more flexible engagement of firms in workforce preparation.

Historically, universities focused on providing foundational knowledge and general competencies, while firms concentrated on role-specific training. Education technologies now enable firms to participate more directly in learning processes

traditionally associated with formal education systems. However, this shift does not imply that education technologies replace the role of higher education.

Research indicates that adaptive training mechanisms are most effective when supported by prior competencies and foundational learning structures developed within formal education (Barnett, 2018).

In this sense, education technologies function not as substitutes but as mediating mechanisms that structure interaction between foundational knowledge production and adaptive skill provision. They allow firms to respond more rapidly to emerging workforce needs while maintaining reliance on the broader cognitive foundations cultivated by higher education institutions.

Consequently, education technologies contribute to a redistribution of responsibilities rather than a displacement of institutional roles. Their significance lies in enabling coordination between stability and flexibility within workforce preparation systems.

Within the context of Industry 5.0, this mediating role becomes particularly important as education and business systems increasingly operate through hybrid arrangements. Education technologies thus shape how institutional boundaries are reconfigured while preserving the continued relevance of foundational education.

4 Education-Business Interaction in Practice: The Georgian Case

In Georgia, the expansion of education beyond universities is most visible within IT and digitally intensive professions, where rapid technological change and persistent skill mismatches generate strong demand for continuous reskilling. However, rather than beginning with institutional actors, it is analytically more appropriate to first examine how reskilling demand is distributed across sectors of the economy. This approach allows for a clearer understanding of why certain sectors become focal points of post-university training ecosystems, while others remain comparatively less integrated into adaptive learning structures.

The Georgian case demonstrates that the emergence of adaptive learning systems is closely associated with sectoral differences in human capital readiness and technological exposure. To capture these dynamics, the analysis draws on sectoral employment data from the National Statistics Office of Georgia (GeoStat), which provides insight into how reskilling demand is distributed across the economy.

Instead of focusing on workforce size as the primary determinant of training provision, the analysis examines how differences in sectoral characteristics, particularly technological intensity and baseline competencies - shape the conditions under which reskilling demand emerges. Table 1 provides an analytical approximation of sectoral patterns of reskilling demand and human capital readiness in Georgia, based on available GeoStat data and observed training dynamics across sectors. The classification reflects relative differences across sectors rather than precise quantitative measurement.

Table 1: Sectoral Patterns of Reskilling Demand and Human Capital Readiness in Georgia

Sector	Relative Employment Significance	Evidence of Reskilling Demand
IT & Digital Services	Low	Very High
Finance & Banking	Medium	Medium-High
Healthcare	Low	Low
Construction	High	Low
Agriculture	Medium	Very Low

Table 1 shows that demand for reskilling does not necessarily follow employment mass. Sectors such as IT and finance exhibit relatively higher levels of reskilling activity despite their smaller workforce shares, while sectors with larger employment bases display comparatively lower levels of adaptive skill upgrading.

These differences are associated with variations in technological intensity and the presence of baseline competencies across sectors. Adaptive learning systems tend to emerge more actively in environments where existing skills facilitate further training, whereas in sectors with lower initial capacity, the expansion of such systems appears more limited.

It is also important to note that, although the IT sector accounts for a relatively small share of total employment, digital competencies are increasingly relevant across multiple sectors. This broader relevance contributes to sustained demand for IT-related training, beyond the boundaries of the sector itself.

Overall, the observed pattern helps explain why post-university learning activities are more visible in innovation-oriented domains, while remaining less developed in sectors with large employment shares.

Table 2 shows that private platforms and corporate academies in Georgia are primarily concentrated in digitally intensive and business-oriented domains. This distribution corresponds with the sectoral patterns observed in Table 1, where reskilling activity is more visible in areas characterized by higher technological exposure.

Table 2: Training Providers in Georgia and Their Sectoral Focus

Provider (Georgia)	Training type	Sectors / domains
Skillwill	Private training platform (courses + certificate)	IT/Tech, project management, short-cycle skills
IT Academy STEP Georgia	Private academy; certification-oriented tracks	Programming, cybersecurity, UI/UX, design
TBC IT Academy	Corporate-funded professional training	Software development, DevOps, Data, IT support
TBC Techschool	Short-cycle programs	Front-end, Back-end, Mobile dev, AI basics
TBC Campus	Business and digital skills training	Digital marketing, Data analysis, entrepreneurship
Bank of Georgia – TB Academy	Private training center	Finance, accounting, taxation
Bank of Georgia – 360 Education	Online platform	Business training and masterclasses
TBC Education	Multi-program ecosystem	Tech and AI learning

Taken together, the two tables indicate that training provision does not closely follow overall employment distribution. Instead, it appears more developed in sectors where existing skills and technological requirements create conditions for continuous upgrading.

At the same time, the presence of corporate academies suggests that some firms increasingly engage in structured training activities within organizational settings. These initiatives extend learning into the workplace, particularly in domains where rapid adaptation is required. In contrast, formal education continues to play a more stable role in providing broader foundational competencies that support long-term skill development.

In this context, the Georgian case points to a differentiated pattern of interaction between education and business. Training systems do not develop uniformly across sectors but are more active where prior capabilities support further skill development, resulting in a more uneven distribution of learning opportunities.

Overall, these patterns suggest that the expansion of adaptive learning systems is shaped not only by technological change but also by existing institutional and human capital conditions. This provides a more grounded understanding of how the relationship between education and business evolves through differentiated and context-dependent adjustments within the broader transformations associated with Industry 5.0.

5 Discussion: Institutional Complementarity under Industry 5.0

The analysis presented in this study suggests that the transition to Industry 5.0 does not dissolve the traditional distinction between education and business but reshapes their interaction into a more differentiated and complementary structure.

As demonstrated in the Georgian case, adaptive learning ecosystems expand selectively in sectors characterized by pre-existing human capital readiness. This indicates that education technologies function not as independent generators of capability but as mechanisms that support the further development of existing competencies. This selective expansion reflects differences in sectoral capacity to absorb and utilize new skills, rather than differences in technological availability alone.

Such dynamics reinforce the continued structural relevance of universities within evolving knowledge ecosystems. While firms gain flexibility in addressing short-cycle skill requirements through private platforms and corporate academies, universities

remain central to the formation of foundational competencies that enable adaptive learning.

From an institutional perspective, this reflects a reallocation of roles rather than their erosion. Businesses increasingly focus on rapid, role-specific skill formation, whereas education systems sustain broader knowledge structures that underpin long-term innovation capacity.

In this context, the distinction between university-based education and private or corporate training ecosystems can be understood in terms of their underlying institutional logics. University-based education remains oriented toward foundational, discipline-based knowledge and long-term learning trajectories, while private and corporate systems focus on applied, role-specific competencies and short-cycle training formats aligned with labor-market demand.

This differentiation becomes particularly relevant in the context of Industry 5.0, where adaptive capacity depends not on the dominance of a single model but on the interaction between them. The Georgian case illustrates how such interaction develops unevenly across sectors, highlighting the importance of institutional coordination.

At the same time, the expansion of adaptive learning systems is not uniform. Training activity tends to concentrate in innovation-intensive domains while remaining more limited in sectors with large employment shares but weaker foundational skill bases.

This uneven diffusion points to a potential tension within the Industry 5.0 paradigm. While the framework emphasizes inclusive and human-centered development (European Commission, 2021), the mechanisms that support rapid adaptation may operate more effectively in already advantaged environments. This tension underscores the importance of governance and coordination in shaping how technological transformation unfolds.

Without such coordination, the reconfiguration of institutional roles may reinforce existing capability differences across sectors and workforce groups. Ensuring that flexibility is balanced with inclusivity therefore becomes a key condition for the sustainable development of learning ecosystems.

6 Conclusion

This study set out to examine how education technologies influence institutional boundaries in the interaction between higher education systems and business organizations under Industry 5.0.

The analysis suggests that technological transformation does not eliminate traditional institutional distinctions but reconfigures them through new patterns of coordination.

Education technologies emerge not as substitutes for formal education but as mediating infrastructures that enable firms to participate more directly in adaptive skill formation while maintaining reliance on foundational knowledge produced by universities.

The Georgian case illustrates how this transformation unfolds in practice. The expansion of private training platforms and corporate academies demonstrates the growing role of business actors in workforce preparation. At the same time, their effectiveness remains dependent on prior competencies rooted in formal education, and their development appears uneven across sectors.

This suggests that the impact of education technologies is conditional rather than autonomous, depending on existing institutional and human capital conditions.

Theoretically, the findings contribute to understanding Industry 5.0 as an institutional transformation that reshapes how responsibilities for knowledge production and skill formation are distributed across sectors.

Rather than dissolving boundaries between education and business, Industry 5.0 renders them more dynamic and context-dependent.

From a policy perspective, the study underscores the importance of maintaining strong foundational education systems alongside investments in adaptive learning mechanisms.

Without such balance, technological transitions may enhance responsiveness without supporting inclusive workforce development.

Ultimately, sustainable adaptation under Industry 5.0 depends on institutional complementarity between stable knowledge production and flexible skill formation. The findings suggest that the expansion of adaptive learning ecosystems appears to be shaped more by pre-existing institutional and human capital conditions than by technological availability alone. This highlights the risk that Industry 5.0-driven transformations may reinforce capability asymmetries unless governance mechanisms actively align flexibility with inclusivity.

7 Directions for Future Research and Policy Implications

The findings of this study suggest that while Industry 5.0 advances a vision of inclusive and human-centered development, adaptive learning ecosystems appear to expand more actively in contexts where foundational competencies are already established. This points to a potential tension between the inclusive aspirations of Industry 5.0 and the selective dynamics of market-driven skill formation.

At the same time, the analysis highlights an important limitation related to the availability and structure of statistical data on skill formation processes. Existing datasets, including those used in this study, provide only partial insight into the distribution of training provision, the frequency of reskilling cycles, and the scale of non-degree-based employment. This constrains the ability to fully capture the dynamics of adaptive learning ecosystems and underscores the need for more systematic and comparable statistical frameworks.

Future research could therefore explore how policy frameworks might ensure that the growth of education technologies contributes to broader workforce inclusion rather than reinforcing existing capability distributions. Comparative studies across national and sectoral contexts would provide valuable insight into how institutional arrangements shape the inclusivity of adaptive learning systems and what

governance mechanisms may be required to align flexibility with equitable access to skill formation.

While this study focuses on a single-country case, it contributes to advancing an institutional perspective on Industry 5.0 by highlighting the redistribution of roles between education systems and business actors. Further research could build on this framework by examining how different governance configurations mediate the balance between foundational education and adaptive training.

Such work is likely to be important for informing policy approaches that support technological responsiveness while maintaining long-term capability development and social cohesion.

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Summary

This study examines how education technologies influence institutional boundaries in the interaction between higher education and business under Industry 5.0. Moving beyond technology-centered interpretations, the analysis conceptualizes Industry 5.0 as an institutional transformation that redistributes responsibilities for knowledge production and skill formation across sectors.

The findings suggest that technological change does not dissolve the distinction between education and business but reconfigures their relationship into a system of complementary roles. Education technologies enable firms to participate more directly in adaptive skill formation while remaining reliant on foundational competencies sustained by formal education systems.

The Georgian case illustrates how this redistribution unfolds in practice, highlighting the expanding role of private and corporate training alongside universities, as well as the uneven development of adaptive learning across sectors. Theoretically, the study advances an institutional interpretation of Industry 5.0 by emphasizing the evolving and context-dependent allocation of responsibilities for knowledge production and skill formation.

From a policy perspective, the findings suggest that investments in adaptive learning need to be accompanied by sustained support for foundational education systems. Without such balance, technological responsiveness may deepen existing capability differences rather than support inclusive workforce development, making governance and institutional coordination central to effective transition strategies.