Advances in Science and Education

Advances in Science and Education, 2025, 18–23

doi: 10.70728/edu.v01.i10.005
Volume 01, Issue 10
ISSN: 3060-5415
Paper

PAPER

DETERMINANTS OF PERSONAL AND PROFESSIONAL COMPETENCY FORMATION FOR TECHNOLOGY EDUCATORS AMIDST SYSTEMIC EDUCATIONAL TRANSFORMATION

Yunusov Laziz Erkinovich[1,*]

[1]Chief Specialist of the Avloniy National Research Institute of Pedagogical Skills

* yunusov@gmail.com

Abstract

The worldwide progression towards a knowledge-based and digitally driven economy mandates fundamental shifts in educational frameworks. This transition places the Technology educator at its core, requiring their professional skillset to transcend basic technical expertise and incorporate advanced pedagogical, ethical, and adaptive proficiencies. This paper presents a focused analysis of the interconnected variables — classified as systemic/policy, institutional/contextual, and individual/subjective — that either foster the development or impose limitations on the professional maturation of these teachers. The study advances the argument that successful competency enhancement hinges upon three critical areas: the alignment and clarity of national digital education strategies, the cultivation of a supportive, well-resourced institutional environment, and the active reinforcement of teacher self-efficacy alongside routine reflective practice. The strategic identification and management of these dynamics are indispensable for upholding the rigorous standards of technology education and ensuring the complete fulfillment of the educational transformation agenda.

Key words: educational transformation, personal and professional competencies of technology educators, Technological Pedagogical Content Knowledge (TPACK) framework, digital pedagogy/didactics, systemic educational policy, institutional readiness/capacity, teacher self-efficacy, Professional Learning Communities (PLCs), digital infrastructure.

INTRODUCTION

The advent of the Fourth Industrial Revolution (Industry 4.0), catalyzed by the technological

Compiled on: December 4, 2025.

transformations spanning the late 20th and early 21st centuries, has fundamentally reshaped global economic and social landscapes. This shift presents unprecedented strategic imperatives for all societal structures, with the education system facing particularly intense pressure to adapt. In the Republic of Uzbekistan, a central strategic objective involves the wholesale modernization of the educational framework, specifically by reorienting its curriculum toward cultivating essential digital competencies and ensuring national educational standards meet evolving international requirements.

The implementation of the "Digital Uzbekistan"national program, coupled with the rapid, nationwide digitization of education, underscores the critical role of technology teachers in preparing the next generation for an innovative, knowledge-driven economy. This pervasive technological acceleration fundamentally alters the professional demands placed upon the educator of the "Technology"subject. A pressing need exists to transition from traditional vocational methods toward the adoption of digital pedagogy, which necessitates teaching cutting-edge disciplines such as computational thinking, robotics, data analysis, and the ethics of artificial intelligence. Crucially, the process of advancing teacher competencies extends far beyond mere episodic training courses; it is a complex, multi-layered undertaking governed by an intricate ecology of internal and external variables.

This article is therefore dedicated to conducting a rigorous scientific analysis of the core factors that directly shape the professional competency development of "Technology"teachers within the current paradigm of educational system transformation. By examining these influences across systemic (policy), institutional (school context), and individual (teacher-specific) levels, this research aims to provide education policymakers and school administrators with the evidence-base necessary to formulate effective, scientifically grounded interventions designed to maximize the professional potential of the teaching workforce.

MAIN CONTENT: DETAILED INVESTIGATION OF CONTRIBUTING FACTORS AND MECHANISMS

The construct of knowledge, historically a core domain of philosophical inquiry, has achieved substantial prominence within the technical sciences over recent decades. This intellectual and disciplinary convergence is evidenced by the widespread adoption of the term "knowledge"in the nomenclature of specialized computational fields and components. Specifically, it has become integral to the conceptualization and development of sophisticated systems, including knowledge-based systems, dedicated knowledge bases and repositories (knowledge banks), and the specialized processes of knowledge representation, acquisition, and utilization. This development underscores the formal establishment of a distinct discipline referred to as knowledge engineering.

Serious changes are occurring in the education system of Uzbekistan within the framework of the "Digital Uzbekistan"(2030) national strategy aimed at integrating information and communication technologies (ICT) into the educational process. The subject "Technology,"which includes elements of engineering, design, and innovation, is key to developing STEM skills in students. However, teachers of this subject must continuously update their competencies to effectively use digital tools. Professional competencies include: technical knowledge (working with CAD programs, 3D printing), pedagogical skills (adaptation to hybrid learning), and the ability to integrate interdisciplinary approaches.

In the context of educational reforms implemented through the "Digital Uzbekistan"program, the impact of digital technologies on the professional competencies of "Technology"subject teachers can be substantiated using a number of pedagogical, psychological, and technological theories. Teachers' professional competencies involve cognitive (knowledge), affective (motivation), and behavioral (practical skills) aspects, and they are amplified under the influence of ICT. Theoretically, this technology facilitates the transition from traditional pedagogy to interactive pedagogy, increasing the effectiveness of teaching and the adaptability of teachers to modern demands.

It should be specifically noted that the development and perfection of the personal-professional competencies of ”Technology”teachers is not a linear process, but rather occurs through the complex influence of internal and external forces. In the context of systemic transformation (often caused by technological disruptions and the revision of national educational standards, such as the introduction of computational thinking (CT)), these factors become the decisive levers of change.

I. Systemic and Policy Factors: The Macro-Level Environment

Systemic factors relate to national, regional, or governmental policies that establish the overall framework, funding, and coherence for technology education.

1.Coherence of National Digital Education Policy

The theoretical substantiation of the influence of digital technologies on the professional competencies of ”Technology”subject teachers can be carried out based on the following approaches:

Competency-Based Approach and the TPACK Model. This approach defines competencies as an integration of knowledge, skills, and values necessary for effective work.

When digital technologies are applied to teachers, this spectrum is expanded by adding ”digital competence,”which includes skills in using ICT for pedagogical purposes. The TPACK model is the most important in substantiating this. It describes the interaction of three types of knowledge (technological, pedagogical, and content knowledge) (1) In the context of the ”Technology”subject (which includes engineering design, robotics, and innovation), digital tools (such as CAD programs like AutoCAD or local analogues in Uzbekistan) enhance TPACK by enabling teachers to integrate technology into teaching. Empirical studies show that developing TPACK significantly increases the teaching effectiveness of technology teachers.

In local practice, where teachers often face resource shortages, technology reduces barriers: online platforms (integrated into the Moodle, UzEdu system) enable personalized learning, developing teachers’ adaptability and creativity. Theoretically, this aligns with constructivist learning theory, where technology acts as a ”zone of proximal development,”stimulating teachers’ cognitive growth through active interaction.

A clear, long-term national strategy for digital education is the bedrock of teacher competency development. This strategy must go beyond simply providing computers; it must specify pedagogical goals (e.g., student-centered learning, project-based assessment) tied to technology use.

Policy Clarity: Ambiguous or frequently changing policy leads to teacher confusion and reluctance to invest time in new skills. Effective policies provide clear competency frameworks (such as the UNESCO ICT-CFT or DigCompEdu), offering teachers a roadmap for their professional journey. Funding Commitment: Systemic funding ensures equitable distribution of digital resources and sustained financing for high-quality, long-term Professional Development (PD) programs. Without dedicated, secure funding, institutional efforts remain sporadic and ineffective. (3)

2.Curriculum Integration and Alignment

The curriculum must explicitly require the application of advanced technologies and pedagogies. The transformation demands a shift in the teacher’s role from delivering prescribed content to facilitating student discovery and construction of knowledge using digital tools.

Horizontal and Vertical Integration: Competencies must be developed with the goal of integrating technology not just within the technology class but across the curriculum (horizontal integration), and ensuring a logical progression of skills from primary to secondary levels (vertical integration). This requires the Technology teacher to become a cross-curricular mentor.

Emphasis on 21st-Century Skills: Policies must prioritize skills like Computational Thinking (CT), data literacy, cybersecurity, and Artificial Intelligence (AI) ethics, requiring teachers to master these concepts and the pedagogical techniques to teach them effectively. (4)

3.Pre-Service and In-Service Continuum

A persistent factor hindering professional development is the disjunction between Initial Teacher Education (ITE) and Continuing

Professional Development (CPD).

Bridging the Gap: Systemic reform must ensure that ITE programs provide a strong foundational understanding of the Technological Pedagogical Content Knowledge (TPACK) framework. If ITE lags, CPD is forced into remedial training, which consumes time and resources that should be dedicated to advanced competency development.

Accreditation and Standards: Policies regarding accreditation and professional standards must be updated regularly to reflect the current demands of the digital classroom, linking certification and advancement to demonstrated mastery of new digital and ethical competencies.

II. Institutional and Contextual Factors: The School Ecosystem

These factors pertain to the school's immediate environment, resources, and culture, which either support or inhibit the practical application of new competencies.

1.Digital Infrastructure and Technical Support

The physical and logistical environment is a primary barrier (often referred to as First-Order Barriers). The most advanced teacher training fails if the tools are inaccessible or unreliable.

Reliability and Access: Teachers require guaranteed access to working hardware, robust network connectivity, and specialized software. The development of competencies in areas like educational robotics or data visualization is impossible without the corresponding physical and digital infrastructure.

Human Technical Support: The availability of on-site technical support staff reduces the burden on teachers, freeing them from troubleshooting issues and allowing them to focus on pedagogical application. Lack of support generates stress, reducing the perceived ease of using technology.

2.School Leadership and Visionary Management

The leadership team creates institutional conditions and provides support for change.

Modeling and Advocacy: School leaders must not only advocate for technology integration but also participate in professional learning themselves to understand the challenges and possibilities. Their vision must align technology use with the school's overall educational goals, clearly articulating why the changes are necessary.

Resource Allocation: Leaders must strategically allocate budget for specialized technology resources, dedicated PD time (e.g., half-days for planning), and relief from teaching loads to allow for the development of new curriculum materials.

3.Collaborative Culture and Professional Learning Communities (PLCs)

Professional growth is profoundly social. Isolated practice prevents the diffusion of innovation.

Job-Embedded Collaboration: Effective competency development is maximized when it occurs within Professional Learning Communities. These communities allow technology teachers to share resources, co-plan lessons, observe peers, and receive immediate, context-specific feedback.

Inter-Departmental Collaboration: The Technology teacher's role is enhanced when they collaborate with teachers of other subjects (Science, Art, Humanities) to design cross-curricular projects, embodying the philosophy of technology integration rather than isolation.

4.Quality of Professional Development Program

Institutional PD programs must adhere to adult learning principles to ensure high transferability to the classroom.

Sustained and Long-Term: Short, one-off training events have minimal impact. Effective development must be sustained over weeks or months, including follow-up coaching, mentoring, and opportunities for reflective practice.

Active and Practice-Oriented: The courses must be active, requiring teachers to design lessons, practice new techniques with student-relevant content, and reflect on the outcomes, rather than passively receiving information (The 30-hour minimum threshold for behavioral change is often cited in research).

III. Individual and Subjective Factors:

The Teacher's Role These factors are internal to the teacher and represent the Second-Order Barriers—psychological states, beliefs, and motivation—that are often more difficult to overcome than resource constraints.

1.Teacher Self-Efficacy and Beliefs about Technology. (2) A teacher's belief in their capability to successfully execute a course of action is perhaps the single most potent predictor of their adoption of new methods.

Self-Efficacy: Low digital self-efficacy results in avoidance of challenging technological tasks, regardless of external resources. PD programs must be designed to promote successful early experiences, using modeling, mastery experiences, and verbal persuasion to boost confidence.

For example, from a psychological perspective, digital technologies influence teachers' affective competencies through self-determination theory, where autonomy, competence, and relatedness are strengthened. The use of ICT in the "Technology"subject (for example, VR simulators to demonstrate engineering processes and online tools) increases motivation. In Uzbekistan, such technologies allow the "Technology"teacher to automate routine work, freeing up time for creativity. Cognitive Load Theory explains how technology optimizes learning: interactive platforms reduce other data load, allowing students to focus on subject-specific competencies. For teachers in Uzbekistan, especially in rural areas, this creates a "digital bridge,"ensuring equality of educational opportunities.

Pedagogical Beliefs: A teacher's fundamental belief in student-centered learning must align with the demands of digital pedagogy. Teachers who hold traditional, content-delivery beliefs are more likely to use technology merely to automate old practices (e.g., digital worksheets) rather than transform learning.

2.Adaptability, Flexibility, and Resilience (The Growth Mindset) Given the speed of technological obsolescence, the capacity for continuous adaptation is a core competency itself.

Embracing Change: Technology teachers must possess a Growth Mindset, viewing technical challenges and evolving tools not as threats, but as essential opportunities for professional mastery. They must be comfortable with the concept of "perpetual beta"in their practice.

Time and Effort Investment: Developing advanced competencies (like coding instruction or data analysis) requires significant personal time and mental effort. The teacher's intrinsic motivation to invest this effort is a defining factor in successful competency development.

3.Reflective Practice and Criticality

High-level professional competency development relies on the teacher's ability to critically analyze their own performance and the impact of the technology they use.

Technology Critique: The Technology teacher must develop competencies in critically evaluating digital tools for their pedagogical effectiveness, ethical implications, and suitability for diverse learners, moving beyond the vendor hype.

Metacognition: Engaging in reflective journaling, video analysis of lessons, and post-lesson discussions allows teachers to bridge the gap between theoretical knowledge acquired in PD and the complex reality of classroom practice, thus consolidating new professional competencies. Thus, these technologies significantly improve the professional competencies of "Technology"subject teachers in Uzbekistan, promoting innovation in education. Further use of them should appropriately include mandatory professional competency enhancement modules in professional development programs, the development of digital literacy modules, and the establishment of regional support centers focused on rural areas.

CONCLUSION

The professional maturation of the Technology educator within a dynamic, transforming educational paradigm is fundamentally characterized as a high-interdependency process. Optimal development is realized when three distinct factor categories achieve harmonious convergence: Systemic factors must furnish clear, coherent, and equitable policy direction; Institutional factors must consistently supply requisite material resources, dedicated time for practice, and a robust collaborative culture; and Individual factors must actively contribute core elements such as intrinsic motivation, strong digital self-efficacy, and an unwavering commitment to continuous, lifelong learning. For educational systems to effectively harness the transformative capabilities of technology, the focus of policymakers and school administrators must strategically transition from mere technological procurement to the comprehensive empowerment of the teaching force. By designing and implementing scientifically grounded interventions that deliberately address all three categories of influence—namely, guaranteeing the availability and functionality of technical infrastructure, prioritizing high-quality, job-embedded professional learning opportunities, and proactively nurturing the teacher's digital self-efficacy—the continuous cultivation of highly competent technology educators can be sustained, thereby ensuring the foundational preparedness of students for the complexities of the rapidly evolving digital future.

References

1. Mishra, P., and Koehler, M. J. (2006). Technological Pedagogical Content Knowledge (TPACK): A Framework for Teacher Knowledge. Teachers College Record, 108(6), 1017-1054.

2. Bandura, A. (1997). Self-efficacy: The exercise of control. New York: W.H. Freeman and Company.

3. Darling-Hammond, L., Hyler, M. E., and Gardner, M. (2017). Effective Teacher Professional Development. Palo Alto, CA: Learning Policy Institute.

4. OECD. (2021). The Future of Education and Skills 2030: Learning Compass. Paris: OECD Publishing.