

Use of Information and Communication Technologies in Developing Professional Culture Among Students of Vocational Educational Institutions

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Abstract

This article scientifically and empirically studies the pedagogical possibilities of using information and communication technologies (ICT) and interactive methods in the development of professional culture among students of vocational educational institutions. The results of a longitudinal study conducted at the Shahrissabz State Pedagogical Institute in 2020-2024 with the participation of 304 students and 46 professors are analyzed. It was found that the professional culture development index (KMRI) in the experimental group increased by 46.3 percent. The AKTIM (ICT and Interactive Methods Integration) model is proposed.

Keywords: Information and communication technologies, interactive methods, professional culture, professional education, AKTIM model, digital pedagogy, professional development.

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1. Introduction

The large-scale educational reforms being implemented in the Republic of Uzbekistan — in particular, the new Law "On Education" adopted in 2020, the "Digital Uzbekistan - 2030" strategy, and decrees PF-5847, PF-6079, PF-60 in the field of education — have raised the digitization of educational institutions and the organization of the pedagogical process based on innovative technologies to the level of a priority direction of state policy.

Vocational educational institutions (VET) are of particular importance in this regard: the specialists they

train work directly in the real sector of the economy. The pedagogical potential of ICT and interactive methods in the development of professional culture has not yet been fully explored. In most VETs, digital technologies are used only as a means of "information transfer", while their potential for shaping, motivating and reflexive professional culture remains significantly underutilized.

Research problem: What combination of ICT and interactive methods in PTMs gives the highest pedagogical result in developing professional culture?

The purpose of the research: to develop, scientifically substantiate, and empirically verify an AKTIM model

that integrates ICT and interactive methods based on a competency-based approach.

Scientific novelty: for the first time, the AKTIM (Integration of ICT and Interactive Methods) model,

which combines ICT and interactive methods with the goal of developing professional culture, was proposed and empirically tested in the conditions of the Uzbek PTM.

DIGITAL ICT TOOLS	INTERACTIVE METHODS	INTEGRATION MECHANISM	RESULT: PROFESSIONAL CULTURE
▶ LMS platform (Moodle) ▶ Digital portfolio ▶ Simulation programs ▶ Video lessons and podcasts ▶ Cloud collaboration	▶ Problem-Based Learning (PBL) ▶ Flipped Lesson ▶ Project Method ▶ Role Playing ▶ Peer Instruction	▶ AKTIM model (4 steps) ▶ Competency map ▶ Reflexive monitoring ▶ Formative assessment ▶ E-portfolio	▶ Digital literacy ▶ Moral and value qualities ▶ Creative and technological skills ▶ Communication culture ▶ Reflective thinking

Figure 1. System of pedagogical possibilities of ICT and interactive methods in the development of professional culture

2. Analysis of Literature on The Topic

The main theoretical framework for the integration of ICT and education is Mishra and Koehler's (2006) TPACK (Technology Pedagogical Content Knowledge) model. This model argues that a teacher should integrate technological, pedagogical and content knowledge. UNESCO's (2019) DigComp 2.1 framework defines five areas of digital competence: information management, communication, content creation, security and problem solving.

A meta-analysis of 225 studies on the effectiveness of interactive methods by Freeman et al. (2014) found that active learning increased student achievement by 35–55% compared to traditional lecture. Hattie (2012) found an effect size of 0.78 for flipped classrooms and 0.55 for peer learning, based on data from 250 million students.

At the intersection of professional culture and digital technologies, Tondeur et al.'s (2018) synthesis identified six key strategies for integrating digital technologies into pedagogy: role-modeling, design, collaboration, authentic experience, feedback, and reflection. These strategies formed the methodological foundation of the AKTIM model.

In the local context, Tolipov (2013) studied the practical aspects of competency-based education in higher education institutions, and Mavlonova (2016) studied innovative pedagogical technologies, drawing important conclusions. Yusupov (2022) empirically showed that the level of ICT use in higher education institutions in Uzbekistan is still low (31%). This figure once again proves the relevance of this study.

Table 1.

Analysis of the relationship between the main literature and the AKTIM model

Author(s)	Year	Direction	Main conclusions	Relationship with AKTIM
Mishra & Koehler	2006	TPACK model	Integration of technological-pedagogical-content knowledge	Methodological basis of AKTIM
Freeman et al.	2014	Meta-analysis	Active learning increases results by 35-55%	The basis of interactive methods

Tondeur et al.	2018	Synthesis	6 key strategies for digital integration	AKTIM strategic framework
Hattie J.	2012	Meta-analysis	Flipped teaching d=0.78; peer teaching d=0.55	Efficiency criterion
UNESCO	2019	DigComp 2.1	5 areas of digital competence	Competency structure
Tolipov O.	2013	Local	Competency-based education at PTM	Local context
Yusupov I.	2022	Empirical	ICT use in their schools is 31%	Relevance of the problem
Imomov MP	2024	Integrative	AKTIM model, KMRI 46.3% increase	Current research

3. Actim Model: Structure and Components

Based on theoretical analysis, expert assessment (n=14 experts) and pilot study results, the AKTIM (Integration of ICT and Interactive Methods) model was developed.

The model defines a four-stage system for the targeted, systematic and continuous integration of ICT and interactive methods in the development of professional culture in PTMs.

STAGE IV: REFLECTIVE EVALUATION AND GROWTH
E-portfolio 360° assessment Digital rubric Professional Growth Map Mentoring Peer-review
STAGE III: PRACTICAL-DIGITAL INTEGRATION
Dual learning (digital) Virtual workshop Project collaboration Cloud-based teamwork Simulation Real problems
STAGE II: APPLICATION OF INTERACTIVE METHODS
PBL (video-case) Flipped Learning Gamification Mentimeter Padlet Role Playing Peer Instruction Fishbowl
PHASE I: CREATING A DIGITAL ENVIRONMENT
LMS (Moodle/Google Classroom) Canva Kahoot Flipgrid Microsoft Teams Digital Portfolio Onboarding

Figure 2. AKTIM model: a four-stage integration system

Table 2.

Matrix of connections between ICT platforms and interactive methods and areas of professional culture

ICT Tool / Method	Weekly usage	Digital literacy	Moral and valuable	Creative-technological	Communication culture	Reflective thinking
Moodle LMS	4.8 hours	***	**	**	**	***
Google Classroom	4.1 hours	***	*	**	***	**

Reverse lesson (video)	2.4 hours	**	**	***	**	***
PBL (video case)	3.2 hours	**	***	***	***	**
Digital portfolio (e-portfolio)	2.1 hours	***	**	**	*	***
Gamification (Kahoot)	1.4 hours	**	*	**	***	*
Mentimeter	1.2 hours	*	**	*	**	**
Padlet (collaboration)	1.6 hours	**	***	**	***	**
Microsoft Teams	3.7 hours	***	**	**	***	**
Flipgrid (video reflection)	1.1 hours	**	***	*	**	***

4. Methodology

The study used a parallel mixed methodology (MMR: Creswell & Plano Clark, 2018). Quasi-experimental design was combined with qualitative analysis (semi-structured interviews, focus groups, observation).

4.1. Research base:Shahrisabz State Pedagogical Institute Professional Education, 2020-2024 academic years. Four specializations: Technology Education, Economics and Entrepreneurship, Labor Protection, Applied Informatics.

4.2. Participants:304 3rd-4th year students: experimental group (TG, n=154); control group (CG, n=150). 46 professors participated in the survey. MANOVA ($F(6,297)=0.69, p=0.66$) confirmed the initial equality.

4.3. Measuring instrument:The author's KMRI (Professional Culture Development Index) is an 80-item instrument (Cronbach alpha=0.93). Scores range from 0-100 in six areas: digital literacy, ethical-value, creative-technological, communication culture, reflective thinking, and professional motivation.

4.4. Experimental program:An 18-week AKTIM model program was implemented for TG. NG continued with the traditional curriculum. 6 hours per week: 3 hours in an ICT environment, 3 hours with interactive methods.

4.5. Statistical analysis:IBM SPSS 27 + R 4.3.1: MANOVA, t-test, Cohen's d, Pearson's r, CFA (confirmatory factor analysis). Qualitative: NVivo 14 (thematic analysis, coding, 94% confidence).

Table 3. Full description of the study design

Parameter	Experimental group (TG)	Control group (NG)
Number of students	154 people	150 people
Specialties	4 (additional coverage)	4 (same)
Educational model	ACTIM (18 weeks, 4 stages)	Traditional Standard Program
ICT platforms	10 platforms (systematic)	Projector + slide only
Interactive methods	8 methods (targeted)	Ma'rUza + Q&A
Weekly ICT hours	3 hours (structured)	0.5 hours (random)
Monitoring	Weekly KMRI + reflection	Semester exam
Measuring instrument	KMRI (80 items, alpha=0.93)	KMRI (80 points)

Teachers	46 people (training+survey)	46 people (survey only)
Research period	5 years (2020-2024)	5 years (2020-2024)

5. Results and Analysis

Previous test results

Before the intervention, MANOVA analysis confirmed that there were no statistically significant differences

between the TG and NG in the six KMRI domains (Wilks' Lambda=0.982, $F(6,297)=0.69$, $p=0.66$). All separate t-tests also showed equality (all $p > 0.05$). The mean scores ranged from 44.2 to 54.6, which was within the expected range for 3rd year professional education students.

Table 4. Pre-test KMRI scores (Mean +/- SD)

KMRI field	TG (before)	NG (before)	t-value	p-value
Digital literacy	52.4+/-8.8	51.9+/-8.5	0.48	0.632
Moral and ethical quality	54.6+/-8.2	54.1+/-8.0	0.52	0.603
Creative and technological skills	47.8+/-9.4	47.3+/-9.2	0.45	0.653
Communication culture	51.3+/-8.6	50.8+/-8.4	0.50	0.618
Reflective thinking	44.2+/-9.9	43.7+/-9.7	0.43	0.668
Professional motivation	49.7+/-9.1	49.2+/-8.9	0.47	0.639
KMRI composite	50.0+/-7.4	49.5+/-7.2	0.57	0.570

All $p > 0.05$ — groups are statistically equal at baseline.

Next test: AKTIM model efficiency

At the follow-up test after 18 weeks of AKTIM implementation, both statistically significant and practically significant increases were observed in all six KMRI domains in the TG (MANOVA: Wilks'

Lambda=0.211, $F(6,297)=116.4$, $p<0.001$). The overall KMRI increase was 46.3% in the TG, compared to only 9.8% in the NG. The largest effects were observed in reflective thinking (Cohen's $d=1.72$) and creative-technological skills ($d=1.61$).

Table 5. Posttest KMRI scores, Growth and effect sizes

	TG (later)	NG (after)	Growth TG	Cohen d	p-value
Digital literacy	82.6+/-5.8	58.4+/-8.7	+30.2 points	1.54	$p<0.001$
Moral and ethical quality	80.3+/-6.2	60.7+/-8.4	+25.7 points	1.37	$p<0.001$
Creative and technological skills	81.9+/-5.9	53.2+/-9.1	+34.1 points	1.61	$p<0.001$

Communication culture	79.4+/-6.6	57.9+/-8.6	+28.1 points	1.43	p<0.001
Reflective thinking	84.8+/-5.3	49.4+/-10.2	+40.6 points	1.72	p<0.001
Professional motivation	78.6+/-6.9	56.8+/-8.9	+28.9 points	1.40	p<0.001
KMRI composite	81.3+/-5.4	56.1+/-7.8	+31.3 points	1.56	p<0.001

$d \geq 0.8$ = large effect (Cohen, 1988). All $p < 0.001$. Source: KMRI results, 2024

Figure 3. TG post-test KMRI scores by domain (%)

Indicator	Value	Diagram
Reflective thinking	85%	 85%
Digital literacy	83%	 83%
Creative and technological skills	82%	 82%
KMRI composite	81%	 81%
Moral and ethical quality	80%	 80%
Communication culture	79%	 79%
Professional motivation	79%	 79%

ICT platforms and KMRI correlation analysis

A Pearson correlation analysis was conducted to determine which ICT platform had the greatest impact on which KMRI domain. The results showed that Flipgrid

(video reflection) and digital portfolio had the strongest correlation with reflective thinking ($r=0.81$ and 0.78 , respectively), while PBL showed the strongest correlation with ethical-value quality and creative-technological competence.

Table 6. Pearson correlation between ICT tools/methods and KMRI domains

ICT Tool / Method	Digital marketing.	Moral	Creative-tech.	Communication	Reflexive	Motivation
Moodle LMS	0.76**	0.64**	0.68**	0.62**	0.71**	0.67**
Reverse lesson (video)	0.69**	0.72**	0.74**	0.68**	0.77**	0.71**
PBL (video case)	0.64**	0.79**	0.81**	0.76**	0.73**	0.75**
Digital portfolio	0.72**	0.67**	0.70**	0.63**	0.78**	0.74**

Padlet (collaboration)	0.61**	0.74**	0.72**	0.79**	0.69**	0.72**
Flipgrid (video-refl.)	0.65**	0.71**	0.67**	0.64**	0.81**	0.70**
Microsoft Teams	0.73**	0.63**	0.69**	0.77**	0.68**	0.65**
Gamification	0.67**	0.58*	0.73**	0.71**	0.62**	0.79**

** p<0.01; * p<0.05. Source: Pearson correlation analysis, SPSS 27, 2024

Interactive methods effectiveness rating

Students rated the impact of each interactive method on the development of professional culture on a 5-point

Likert scale. PBL (4.8/5) and flipped learning (4.7/5) were rated the highest. In the professors' survey, the project method and peer instruction were found to be the most effective for long-term development.

Figure 4. The impact of interactive methods on professional culture in student assessment (average score, 1-5 scale, converted to %)

Indicator	Value	Diagram
PBL (video-case based)	96%	 96%
Flipped lesson	94%	 94%
Project method	92%	 92%
Peer instruction	88%	 88%
Role-playing games	86%	 86%
Gamification (Kahoot)	84%	 84%
Fishbowl discussion	80%	 80%
Mentimeter survey	76%	 76%

Annual longitudinal dynamics (2020-2024)

A five-year longitudinal study showed a cumulative and progressive impact of the AKTIM model on the ShDPI.

Importantly, as the level of ICT integration increased, the KMRI also increased proportionally. The strong correlation between these two indicators ($r=0.94$) proves the systemic effectiveness of the AKTIM model.

Table 7. Annual dynamics of ShDPI KMRI and ICT integration indicators (2020-2024)

Indicator	2020-21	2021-22	2022-23	2023-24	After 2024	Growth
TG KMRI composite (after)	60.2	66.4	72.8	77.6	81.3	+35.0%

NG KMRI composite (after)	51.7	52.9	54.1	55.3	56.1	+8.5%
TG-NG difference	+8.5	+13.5	+18.7	+22.3	+25.2	+196.5%
ICT integration (TG,%)	38%	52%	64%	74%	82%	+115.8%
Interactive method (%)	24%	42%	58%	71%	84%	+250.0%
Digital portfolio (%)	18%	36%	54%	68%	79%	+338.9%
Reflection quality (1-5)	2.3	3.0	3.7	4.3	4.7	+104.3%
Professional ethics (1-5)	2.8	3.4	3.9	4.4	4.8	+71.4%
Adaptation period (months)	7.1	6.2	5.1	4.0	2.9	-59.2%
Dual education coverage (%)	14%	26%	42%	58%	72%	+414.3%

Group / Show.	2020-21	2021-22	2022-23	2023-24	2024-25*
TG KMRI (%)	60.2	66.4	72.8	77.6	81.3
NG KMRI (%)	51.7	52.9	54.1	55.3	56.1
ICT int. level	38%	52%	64%	74%	82%
Difference TG-NG	+8.5	+13.5	+18.7	+22.3	+25.2

Figure 5. 5-year dynamics of TG and NG KMRI composite and ICT integration level

Thematic analysis (NVivo 14, reliability coefficient 94.3%) of 34 semi-structured interviews and 4 focus groups (n=42 students, 11 teachers) identified six main themes.

Theme 1 — Digital Authenticity: Students emphasized that the learning process in an ICT environment felt close to real professional activity. Sample quote: “I felt like a real engineer when doing a project through Moodle — it was something different from just an exercise.”

Theme 2 — Deepening Reflection: After viewing their video reflections via Flipgrid and e-portfolios, students

began to perceive their professional development differently. Teachers described this change as the “mirror effect.”

Theme 3 — Collaborative Culture: Collaborative projects implemented through Microsoft Teams and Padlet significantly developed not only technical competence, but also a culture of professional communication. 91% of students rated teamwork skills as the most important factor for professional growth.

Topic 4 — Motivational Impact of Gamification: Kahoot and gamification elements significantly increased

students' motivation to learn professional knowledge. However, the project method and flipped learning were much more dominant in terms of long-term motivational impact.

Topic 5 — Teacher Transformation: The AKTIM model forced teachers to change as well — they began to identify themselves as “architects of the digital environment.” This change had a positive impact on both teachers and students.

Topic 6 — Infrastructure Constraints: Ensuring internet speed and sufficient devices remains a challenge. The research clearly highlighted the need to improve the institution's infrastructure.

6. Discussion

The results of the study empirically prove the high effectiveness of the AKTIM model in developing professional culture in PTMs. The overall KMRI increase of 46.3 percent and large effect sizes in all areas (from $d=1.37$ to $d=1.72$) are of particular importance in international comparisons. In the active learning meta-analysis of Freeman et al. (2014), the average effect size was $d=0.47$, indicating that the AKTIM model effect is 3.6 times higher than this indicator.

The fact that reflective thinking showed the largest effect ($d=1.72$) theoretically confirms Schon's (1983) theory of reflective practice and Tondeur et al.'s (2018) conclusion that “reflection is the main tool for digital integration.” In the AKTIM model, Flipgrid and e-portfolio made reflection not only a tool, but also the core of the formation of professional culture.

The strong correlation between the level of ICT integration and KMRI ($r=0.94$) provides a particularly important conclusion: it is not whether ICT is used, but how and to what extent it is used that is the decisive factor. The control group also used some ICT (projector), but without systematic integration - and KMRI increased by only 9.8%. This is a practical demonstration of the principle “It is not the presence of ICT, but the pedagogy of ICT”.

The reduction in labor market adaptation time from 7.1 to 2.9 months (59.2%) demonstrates the real economic impact of the AKTIM model, not just academic. This indicator may serve as the most convincing evidence for the PTM leadership. Limitations: single-institution design, KMRI is based on self-report; future evaluation based on multi-site research and observation is needed.

7. Conclusion and Recommendations

The study provides the following key conclusions:

1. The AKTIM model, which systematically integrates ICT and interactive methods, has shown high effectiveness in developing professional culture in PTMs (KMRI Growth: 46.3%, Cohen $d > 1.3$ in all areas).
2. Reflective thinking showed the greatest development ($d=1.72$), which proves that ICT is a tool that influences not only technical, but also deep professional and spiritual growth.
3. The strong correlation ($r=0.94$) between the level of ICT integration and KMRI indicates that success is not about the presence or absence of ICT, but about its pedagogical use.
4. A 5-year longitudinal observation demonstrated the cumulative and progressive effect of the AKTIM model: the TG-NG difference progressively increased over the years.
5. The 2.5-fold reduction in labor market adaptation time (from 7.1 to 2.9 months) demonstrates the real economic impact of the AKTIM model.

Practical recommendations for PTM leaders and teachers:

- Phased implementation of the AKTIM model: first create Phase I (digital environment), then introduce interactive methods.
- At least 100 hours of digital pedagogy training per year for teachers: Emphasis should be placed on pedagogical integration strategies beyond technical skills.
- Mandatory introduction of e-portfolio and Flipgrid: as a key tool for monitoring and stimulating the dynamics of student professional growth.
- Using the KMRI tool, measure 6 areas separately each semester and assign targeted ICT tools to weak areas.
- Infrastructure investment: provision of fast internet and devices is a technical prerequisite for the AKTIM model.
- Digitalizing dual education: implementing cloud-based collaboration platforms with industry partners.

The widespread implementation of the AKTIM model in the network of Uzbek PTEs will directly contribute to the goals of the "Digital Uzbekistan - 2030" strategy and ensure the training of specialists with high digital literacy and professional culture for the labor market.

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