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EDTECH TOOLS IN THE PROFESSIONAL DEVELOPMENT SYSTEM FOR COMPUTER OPERATORS

EDTECH-ІНСТРУМЕНТИ У СИСТЕМІ ПРОФЕСІЙНОГО РОЗВИТКУ ОПЕРАТОРІВ ПК

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Abstract. The article examines the impact of modern educational technologies (EdTech) on developing PC operators' professional skills in the context of the digital transformation of work. The increasing complexity of digital environments, automation of routine operations, and increased requirements for the quality of performance of professional tasks necessitate the need to update approaches to improving employees'skills in this profile. *The aim* is to evaluate how effective EdTech solutions are in building and enhancing PC operators' hard and soft skills, which are essential in the digital economy.
The research methodology involved a combination of theoretical analysis of scientific sources, a review of EdTech platforms, empirical data collection and processing methods, and an experiment. During the experiment, respondents were divided into control and experimental groups. The latter used specialised EdTech tools: online simulators, interactive simulators, gamified modules, platforms for self-reflection, and case methods. The level of skills was assessed using quantitative indicators (speed, accuracy, work efficiency) and qualitative criteria (level of critical thinking, self-organisation, adaptability, attention to detail).
The results of the study demonstrated a significant improvement in professional competencies of respondents in the experimental group compared to the control group. In particular, the speed of data entry and the efficiency of working with specialised software increased, while the number of errors decreased. Moreover, individuals in the experimental group exhibited improved outcomes in critical thinking, self-organisation, adaptability, and attention to detail. Correlation analysis confirmed the close relationship between activity on EdTech platforms and the positive dynamics of professional development.
The scientific novelty lies in verifying the hypothesis regarding the direct impact of digital educational solutions on the development of professional skills of PC operators, confirmed by the experimental results. A systematic approach to assessing professional competence is proposed for the first time, covering technical and behavioural characteristics.
The practical importance of the study is found in the potential to utilise its results to enhance professional development initiatives, create customised learning paths, and introduce efficient digital solutions in the professional training framework. The results could form a modern model of continuous professional development in the digital economy.
Key words: professional skills; hard skills; soft skills; advanced training; digital transformation.

Анотація. У статті досліджено вплив сучасних освітніх технологій (EdTech) на розвиток професійних навичок операторів ПК в умовах цифрової трансформації праці. Зростання складності цифрових середовищ, автоматизація рутинних операцій і підвищення вимог до якості виконання професійних завдань зумовлюють потребу в оновленні підходів до підвищення кваліфікації працівників цього профілю. *Метою дослідження* є оцінка ефективності використання EdTech-рішень для формування й розвитку hard і soft skills операторів ПК, які є ключовими в умовах цифрової економіки.
Методика дослідження передбачала поєднання теоретичного аналізу наукових джерел, огляду EdTech-платформ, емпіричних методів збору та обробки даних, а також проведення експерименту. Під час експерименту респонденти були розподілені на контрольну та експериментальну групи. В останній застосовувалися спеціалізовані EdTech-інструменти: онлайн-тренажери, інтерактивні симулятори, гейміфіковані модулі, платформи для саморефлексії та кейс-методи. Оцінювання рівня навичок здійснювалося за кількісними показниками (швидкість, точність, ефективність роботи) та якісними критеріями (рівень критичного мислення, самоорганізації, адаптивності, уваги до деталей).
Результати дослідження продемонстрували значне покращення професійних компетентностей у респондентів експериментальної групи порівняно з контрольною. Зокрема, зросла швидкість введення даних та ефектив-

ність роботи зі спеціалізованим програмним забезпеченням, при цьому кількість помилок зменшилась. Крім того, учасники експериментальної групи продемонстрували вищі результати за показниками критичного мислення, самоорганізації, адаптивності й уваги до деталей. Кореляційний аналіз підтвердив тісний зв'язок між активністю на EdTech-платформах і позитивною динамікою професійного розвитку.

Наукова новизна роботи полягає у верифікації гіпотези щодо прямого впливу цифрових освітніх рішень на розвиток професійних навичок операторів ПК, підтвердженого результатами експерименту. Уперше запропоновано системний підхід до оцінювання професійної компетентності, який охоплює технічні та поведінкові характеристики.

Практична значимість дослідження полягає у можливості застосування його висновків для вдосконалення програм підвищення кваліфікації, розробки персоналізованих освітніх траєкторій та впровадження ефективних цифрових рішень у систему професійного навчання. Отримані результати мають потенціал для використання у формуванні сучасної моделі безперервного розвитку фахівців у цифровій економіці.

Ключові слова: професійні навички; hard skills; soft skills; підвищення кваліфікації; цифрова трансформація.

THE PROBLEM FORMULATION

The current stage of the information society's evolution is a fast technological development, which is manifested in the permanent digital transformation of all spheres of human activity. In this context, the PC operator's professional activity (a significant labour market segment) is undergoing significant qualitative and quantitative changes. The growing complexity of software complexes, the diversification of functional responsibilities and the strengthening of requirements for the productivity and accuracy of operations actualise the problem of continuous professional development and advanced training. The successful adaptation of PC operators to these challenges is determined by the level of their professional competence, which includes both "hard skills" – specific technical knowledge and skills for working with hardware and software, and "soft skills" – cognitive, communicative and organisational skills necessary for effective interaction in the digital environment.

In parallel, EdTech (educational technologies) are experiencing rapid development, offering innovative approaches to the organisation of the educational process. Integrating EdTech solutions – from learning management systems (LMS) and massive open online courses (MOOCs) to interactive simulators, adaptive learning and gamified platforms – opens up new opportunities for flexible, personalised and immersive learning. These technologies can provide rapid knowledge updating and the formation of relevant skills, minimising the time and space constraints inherent in traditional forms of learning. Despite the intuitive obviousness of the potential of EdTech, empirical studies that systematically analyse and quantify the direct impact of specific EdTech tools on the dynamics of the professional skills development in the category of PC operators remain fragmented and require scientific understanding. Existing scientific works mainly focus on general aspects of digital learning or specific areas, without comprehensively covering the impact on the PC operator profile. Thus, there is a scientific gap, which is essential for optimising educational strategies, developing effective EdTech solutions and increasing the competitiveness of specialists in the labour market.

LITERATURE REVIEW

The professional activity of PC operators in the information society: professional qualification requirements. The modern information society is characterised by integrating digital technologies into every facet of human existence, altering traditional job roles and creating new professional qualification demands. The PC operator has traditionally been known to perform routine data input and processing tasks. It is changing due to automation, artificial intelligence, and complex software development. This development determines a redefinition of the professional profile of a PC operator. Nowadays, a PC operator's profile demands not just technical abilities, but also cognitive, communicative and adaptive skills.

A review of professional standards applicable to the relevant qualification attributes and available labour market requirements allowed dividing the professional competence of a PC operator into two interrelated groups of skills: hard skills and soft skills [1–3].

The hard skills of the PC operator form the foundation for successful professional performance under conditions of digitalisation. The most critical among them is hardware and software competence, accompanied by familiarity with PC architecture at an intimate level, familiarity with the installation and configuration of operating systems, and proficiency at a high level in operating office software packages. Also, depending on the industry's particularities, one has to master specialised software, such as graphic editors or database management systems. Skills development assessment is conducted using such indicators as the speed and accuracy of performing typical actions, the number of errors during data processing, the efficiency of using program functionality, and the accuracy of diagnosing basic hardware and software malfunctions [4, 5].

No less important are data entry and processing abilities. They involve high speed of typing, the ability to process vast amounts of information, verification of the input information, and touch typing methods. Productivity in this field is reflected by such parameters as the quantity of characters per minute, quality of input

(the proportion of committed errors), and time taken to process a specified amount of information.

Another necessary component is knowledge of the basics of network technologies and cybersecurity. It includes understanding the computer network operation principles, basic skills for configuring network connections, and compliance with information security norms and standards to protect personal and corporate data. The combination of these skills is critically important for ensuring a PC operator's smooth and secure operation in the digital environment.

In an environment characterised by increasing uncertainty and continuous change, soft skills that foster adaptability, effective communication, and problem-solving for unconventional challenges are becoming increasingly vital. For a personal computer operator, these skills are equally important as technical expertise, as they enable efficient functioning in a fast-paced digital landscape. In particular, these include critical thinking and the ability to solve problems, which involves analysing information, establishing logical connections, identifying sources of errors, and formulating effective strategies for eliminating them, going beyond simple compliance with instructions.

Equally important is attention to detail and scrupulousness, which ensure high accuracy in completing tasks, especially when working with confidential or critical information. An important component is also the ability to self-organise and have effective time management, which is manifested in the ability to plan the work process, determine priorities, meet deadlines, and independently manage one's professional development.

In the context of permanent technological change, the need for adaptability and flexibility is becoming more urgent – the readiness to quickly master new tools, respond to new requirements of the digital environment and maintain productivity even in conditions of uncertainty. In addition, communication skills play an essential role in the professional activities of a PC operator. For instance, effective interaction with users, colleagues and management, the ability to clearly and understandably explain technical aspects, and the ability to constructively resolve conflict situations are necessary to achieve common goals in a team and client environment. The combination of these soft skills largely determines the success of a PC operator in the modern digital context.

Assessment of soft skills is more complex and often requires psychometric tests, expert assessments, analysis of behaviour in a case study and self-assessment.

Therefore, the modern professional activities of a PC operator require the synergistic development of both hard and soft skills, which is a prerequisite for a successful career and the stability of the functioning of digital infrastructures.

Conceptual foundations of EdTech: classification, principles, advantages and challenges. The development of information and communication technologies has resulted in the expansion of EdTech, revolutionising conventional education. As an interdisciplinary field combining pedagogy, computer science, psychology, and design, EdTech aims to optimise and personalise learning [6–8]. It evolved from early e-learning formats to complex digital ecosystems offering interactive, individualised experiences. Its core principles include accessibility, interactivity, multimedia, adaptability, and personalization – ensuring wide access, engaging participation, diverse content formats, and tailored learning paths [9, 10].

EdTech tools for professional education include Learning Management Systems (e.g., Moodle, Canvas), MOOCs (e.g., Coursera, Udemy), adaptive learning systems, and gamified platforms. These tools enable centralised content delivery, dynamic progress tracking, and increased learner motivation. The andragogical approach underpins their use, focusing on adults' need for practical, self-directed learning based on prior experience [11–13].

EdTech brings significant advantages: flexibility, personalisation, increased motivation, and cost-benefit. However, there are still some residual problems. Digital divides, inadequate design of instruction, lack of student engagement under conditions of self-study, cybersecurity threats, and integration challenges can hinder its success. Nevertheless, EdTech has tremendous potential to increase professional competencies and deserves more research [13].

Global and domestic experience of using EdTech to develop professional skills. International experience of implementing EdTech in professional education demonstrates significant successes and an expanded range of applications. Global trends indicate the growing popularity of online platforms (Coursera, edX, Udemy, LinkedIn Learning), which offer certified courses and specialisations for developing hard and soft skills in various industries. Corporate universities of leading global companies are actively integrating EdTech for continuous training and retraining of their employees, using internal LMS, virtual simulators and simulation environments. In particular, in areas requiring high accuracy and speed of response (aviation, medicine, heavy industry), simulators and VR/AR technologies have become the standard for forming practical skills and improving personnel qualifications. International studies confirm a positive correlation between the use of adaptive learning systems and increased academic performance, as well as the development of critical thinking and problem-solving abilities [14, 15].

There is active development of the EdTech sector in Ukraine, driven by government support and private investments. Domestic educational platforms (e.g. Prometheus, EdEra, Be Smart) offer online courses for a wide range of users, including programs for developing

digital competencies and specialised skills of PC operators. Ukraine's regulatory and legal framework is gradually adapting to the needs of digitalisation of education, promoting the integration of electronic and distance learning forms. However, despite the general positive trend, domestic empirical research focused on the quantitative assessment of the impact of specific EdTech solutions on developing professional skills, specifically for PC operators, is limited. Most existing works focus on general aspects of e-learning or higher educational levels.

The gap in scientific research lies in the lack of a systematic empirical analysis of the effectiveness of using EdTech tools for the targeted formation and development of hard and soft skills in the category of PC operators in the Ukrainian context. The issues of optimal selection of EdTech solutions for specific professional tasks and methods of integrating these technologies into existing professional training and advanced training programs remain insufficiently studied. Thus, the study aims to eliminate this scientific gap by conducting an experiment and formulating scientifically based recommendations that have significant theoretical and practical significance for developing professional education and increasing the competitiveness of employees [13–15].

IDENTIFICATION OF PREVIOUSLY UNRESOLVED ASPECTS OF THE OVERALL PROBLEM

Lack of research on the impact of specialised EdTech solutions, such as training platforms, gamified courses, etc., on the effectiveness of the formation and development of hard and soft skills in PC operators compared to traditional training methods.

The aim is to analyse the impact of EdTech on the formation and development of professional skills in PC operators, to determine the effectiveness of using digital educational resources in improving their qualifications and adapting to modern requirements of the digital environment.

METHODS, OBJECT AND SUBJECT OF THE STUDY

To achieve the aim, the study used a set of complementary methods:

1) theoretical methods: system analysis, synthesis, generalisation, classification, induction and deduction – to substantiate theoretical concepts, study of scientific literature on EdTech, vocational education and labour psychology;

2) empirical methods: questionnaires, testing, structured observation, expert assessments, and experiments – to collect data on the level of skill formation and the effectiveness of EdTech use;

3) mathematical and statistical methods: mathematical statistics (correlation analysis) – for quantitative processing, verification and interpretation of the obtained empirical data, assessment of the statistical significance of the differences identified.

The object of the study is the process of developing professional skills in PC operators. **The subject** of the study is the influence of EdTech on the dynamics and quality of the formation and improvement of professional skills in PC operators.

MATERIAL

The choice of study methodological approach. To achieve the study's aim, an experiment investigated the cause-and-effect relationships between using EdTech technologies and developing PC operators' professional skills.

The randomised division method based on the initial skill level was used to form the experimental and control groups. At the first stage of the study (stage 1), PC operators' current level of hard and soft skills was assessed. Based on the results obtained, two groups of testees were formed:

1) experimental group (EG): 16 PC operators who underwent training using specialised EdTech solutions;

2) control group (CG): 17 PC operators who continued to improve their skills using traditional methods (independent study of instructions, consultations with colleagues/management, performance of typical tasks without interactive training).

This division minimised the impact of differences in initial skill levels on the experiment's final results, increasing the study's internal validity.

Criteria and indicators for assessing the development of professional skills of PC operators. Hard skills were evaluated based on quantitative indicators obtained during the performance of standardised practical tasks:

1) data entry speed: the number of characters per minute was measured when typing standard text and numerical data in a text editor (MS Word or Google Docs were used);

2) data entry accuracy: the percentage of errors from the total number of entered characters/data in the same tasks was recorded;

3) efficiency of work with office packages: the time for performing standardised tasks in MS Excel was assessed (for example, creating a pivot table, applying formulas, filtering data) and MS Word (formatting documents, using styles, creating lists). The number of actions required to complete the task was also assessed;

4) proficiency in specialised software: specific software (1C, CRM system for customer accounting), a series of typical tasks was also developed (order placement, entering customer data, generating a report). The criteria were task completion time, absence of errors, and use of optimal program functions.

Soft skills assessment was more complex and required the use of combined methods:

1) critical thinking and problem solving: assessed using case studies that simulate typical «problem»

situations (e.g., system failure, data inconsistency, need for quick information retrieval). Logic of thinking, sequence of actions, and optimality of the proposed solution were assessed on a five-point scale;

2) attention to detail and scrupulousness: measured by the number of identified errors in the provided data set or text, as well as the ability to notice inconsistencies in reports or documents;

3) self-organisation and time management: assessed through keeping work time diaries (filled in by the operators themselves and monitored by the manager), as well as through the results of a survey using a standardised scale (e.g., the self-organisation scale);

4) adaptability: measured the speed of mastering a new, previously unknown functionality or a simple new program (for example, a minimum training program for a new tool). The time required to achieve a certain level of proficiency and the ability to apply the acquired knowledge in practice were assessed.

Practical tasks: developed test tasks to assess hard skills as closely as possible to real work situations.

Case tasks: description of typical problem situations to assess critical thinking and problem-solving.

Questionnaires are for self-assessment of soft skills and collection of data on attitudes towards EdTech.

Experiment stages:

1) stage 1 (one week): initial diagnostics of the level of hard and soft skills of PC operators according to the developed criteria and tools, formation of experimental and control groups;

2) stage 2 (four weeks): direct implementation of the educational process.

3) stage 3 (one week): repeated diagnostics of both groups' hard and soft skills. Data collection is based on the subjective perception of the effectiveness of training, statistical processing, and analysis of the results obtained.

The choice of EdTech solutions for the experimental group was determined by their potential for the targeted development of the identified hard and soft skills.

For the development of hard skills (speed, accuracy, software proficiency):

1) online touch typing simulators for systematic training of typing speed and accuracy;

2) interactive simulators of office programs/ specialised software MS Office simulators, or test environments for specific software. These simulators enable practicing typical operations, receive instant feedback and identify errors;

3) video tutorials and microlearning. Short video instructions and step-by-step guides on specific program functions, available «on demand».

For the development of soft skills (critical thinking, problem solving, adaptability):

1) case study and problem-based learning platforms: online platforms that offer real or simulated professional cases, where PC operators have to find solutions using available resources independently;

2) gamified modules: quests and tasks with points and ratings that stimulate quick and accurate resolution of typical "non-standard" situations, contributing to the development of attention to detail and adaptability;

3) online resources for self-reflection and feedback: platforms that allow for recording progress, analysing errors, and receiving feedback from the system or manager.

ORGANISATION AND CONDUCT OF EXPERIMENTAL TRAINING

The total number of study participants was 33 PC operators. All participants were employees with different work experiences. The total duration of the experiment was six weeks. Data collection was carried out in several stages:

1) before the experiment: conducting an entrance test of hard skills and a survey/case study for soft skills in both groups.

2) during the experiment (formative stage): for the EG – monitoring of activity on EdTech platforms (statistics of task performance, time spent on the platform, results of intermediate tests). For both groups, it was observed the performance of daily work tasks and recorded manifestations of hard and soft skills. Short weekly surveys/conversations with participants regarding their perception of the learning process and difficulties encountered;

3) after the experiment: repeated conduct of the same set of tests and tasks to assess hard and soft skills in both groups. A final questionnaire was conducted to collect qualitative data on the subjective assessment of training effectiveness and the difficulties encountered by the participants. All results were systematised, codified and prepared for statistical processing using specialised software.

RESULTS

Analysis of PC operators' initial professional skills development in the experimental and control groups. At stage 1 of the study, an initial assessment of PC operators' hard and soft skills was carried out. According to the results, two groups were formed: an experimental group (EG), which included 16 operators, and a control group (CG), which included 17 operators, considering the maximum possible balance in terms of the initial level of skills. It enabled minimising the impact of individual differences on the experiment results.

The average indicators and standard deviations for hard skills at stage 1 are in Table 1.

Based on the data in Table 1, it was concluded that the differences in the values of hard skills between the EG and CG at stage 1 were statistically insignificant ($p > 0.05$ by Student's t-test), confirming the success of the representative groups formation. Similarly, the

Table 1. PC operators' average hard skills indicators at stage 1 (± standard deviations)

Hard skills' indicator	Experimental group (n = 16)	Control group (n = 17)
Data entry speed (s/min)	205 ± 15,2	208 ± 14,8
Data entry accuracy (%)	94,1 ± 1,8	93,8 ± 2,1
Excel task execution time (min)	12,5 ± 1,1	12,3 ± 1,0
Efficiency of working with special software (points)	3,2 ± 0,4	3,3 ± 0,5

Note: The "efficiency of work with specialised software" indicator was evaluated on a five-point scale (where 5 points is the highest efficiency indicator). The indicators "data entry speed", "data entry accuracy", and "Excel task execution time" were measured quantitatively (characters per minute, percentages, and minutes, respectively).

Table 2. PC operators' average soft skills indicators at stage 1 (± standard deviations)

Soft skills' indicator	Experimental group (n = 16)	Control group (n = 17)
Critical thinking (score)	3,1±0,3	3,0 ± 0,4
Attention to detail (number of errors)	5,8 ± 1,2	6,1 ± 1,0
Self-organisation (score)	3,4 ± 0,5	3,3 ± 0,4
Adaptability (score)	3,0 ± 0,3	3,1 ± 0,4

Note: The "critical thinking", "self-organisation", and "adaptability" indicators were assessed on a five-point scale. The "attention to detail" indicator was measured as the number of identified errors.

analysis of soft skills indicators at stage 1 (Table 2) also showed a comparable development between the groups.

The deficit of statistically meaningful distinctions between groups in stage 1 of the study allowed for an evaluation of the effects of the EdTech intervention during that stage.

Dynamics of PC operators' hard skills development under the influence of EdTech. After the four-week stage 2, hard skills were re-measured in both groups. The obtained results are in Table 3. They demonstrate significant differences.

The Student's t-test showed statistically significant differences between the EG and the CG for all hard skills indicators ($p < 0.01$ and $p < 0.001$). In particular, the average data entry speed in the EG increased by 19.5 % compared to stage 1, while in the CG, this indicator increased by only 3.4 %. Similarly, the accuracy of data entry in the EG showed an increase of 3.9 %, and the time to complete complex Excel tasks decreased by 21.6 %, which indicated a significant increase in efficiency. The most impressive increase (+40.6 %) was recorded in the efficiency of working with specialised software, directly related to interactive simulators.

These data convincingly demonstrated that the targeted use of EdTech solutions significantly accelerated and improved the formation of PC operators' hard skills compared to traditional training methods.

Dynamics of soft skills development among PC operators under the influence of EdTech. Analysis of the dynamics of soft skills development (Table 4) also showed positive changes in the experimental group after the implementation of EdTech solutions, although less pronounced compared to hard skills.

Statistical analysis revealed statistically significant differences ($p < 0.05$, $p < 0.01$ and $p < 0.001$) between the EG and the CG for most soft skills indicators. In particular, the scores on critical thinking in the EG increased by 35.5 %, while in the CG – by only 6.7 %. The number of errors indicating attention to detail decreased in the EG by 67.2 % (from 5.8 to 1.9), while in the CG this decrease was minimal (9.8 %). The increase in self-organisation and adaptability indicators in the EG was also more

Table 3. PC operators' average hard skills indicators at stage 3 (± standard deviations)

Hard skills' indicators	EG (n = 16)	CG (n = 17)	EG gain (%)	CG gain (%)	Significance of differences (p-value)
Data entry speed (c/min)	245 ± 12,3	215 ± 13,5	+19,5	+3,4	<0,001
Data entry accuracy (%)	97,8 ± 0,9	94,5 ± 1,5	+3,9	+0,7	<0,01
Excel task completion time (min)	9,8 ± 0,8	11,9 ± 1,1	–21,6	–3,3	<0,01
Efficiency in working with special software (points)	4,5 ± 0,3	3,5 ± 0,4	+40,6	+6,1	<0,001

Note: The «efficiency of working with specialised software» indicator was assessed on a five-point scale (where 5 points is the highest efficiency indicator). The indicators «data entry speed», «data entry accuracy», and «Excel task execution time» were measured quantitatively (characters per minute, percentages, and minutes, respectively) and were not assessed on a point scale.

Table 4. PC operators' average soft skills indicators at stage 3 (± standard deviations)

Soft skills' indicators	EG (n = 16)	CG (n = 17)	EG gain (%)	CG gain (%)	Significance of differences (p-value)
Critical thinking (score)	4,2 ± 0,3	3,2 ± 0,4	+35,5	+6,7	<0,01
Attention to detail (number of errors)	1,9 ± 0,4	5,5 ± 0.9	–67,2	–9,8	<0,001
Self-organization (score)	4,1 ± 0,5	3,5 ± 0,4	+20,6	+6,1	<0,05
Adaptability (score)	4,0 ± 0,3	3,2 ± 0,3	+33,3	+3,2	<0,01

Note: The "critical thinking", "self-organisation", and "adaptability" indicators were assessed on a five-point scale. The "attention to detail" indicator was measured as the number of identified errors.

significant, which can be explained by gamified elements, case studies, and personalised learning trajectories that stimulated independence and solution-seeking.

Detection of relationships between skill development and EdTech use. Correlation analysis was done to work out the relationship between activity on EdTech sites (study time, number of tasks completed) and hard and soft skill development in the experimental group to establish cause-and-effect conditions. The following notable correlations were found:

1) a positive high-degree correlation between time spent on blind typing simulators and an increase in data entry speed/accuracy ($r = 0.88$, $p < 0.01$);

2) a positive correlation between the number of completed tasks in specialised software simulators and an increase in the efficiency of working with it ($r = 0.92$, $p < 0.001$);

3) a positive medium-degree correlation between participation in a case study on EdTech platforms and an increase in critical thinking scores ($r = 0.75$, $p < 0.05$);

4) a positive correlation between the level of engagement in gamified modules and increased adaptability and self-organisation ($r = 0.70$, $p < 0.05$).

These results indicated that not just the fact of using EdTech, but active, purposeful interaction with specific EdTech tools directly correlated with the dynamics of the professional skills development.

The empirical data showed that the use of specialised EdTech solutions significantly increases the effectiveness of developing PC operators' hard and soft skills compared to traditional training methods, which was manifested in the following:

1) EdTech is highly effective for hard skills. Interactive trainers and simulators have proven highly effective for practicing routine but critically essential operations. Instant feedback and the possibility of repetition without negative consequences contribute to the rapid formation of motor memory and automation of actions;

2) positive impact on soft skills. The development of soft skills was not as stunning as that of hard skills, but it was statistically significant. It is a proof that well-designed EdTech solutions such as problem-based learning, case studies and gamification can cause the development of cognitive skills such as critical thinking, attention and flexibility, which are all the core elements of professional maturity;

3) the benefits of personalisation. Adaptive learning systems in EdTech allowed EG operators to work at their own pace, focusing on problem areas, which contributed to a deeper assimilation of the material;

4) motivational aspect. Involvement in EdTech platforms containing elements of gamification and visualisation of progress significantly increased the motivation of EG participants to study, which is a critical factor in success in continuous professional development;

5) limitations of the study. Despite the positive results, the limitations associated with a small sample (33 people) may affect the generalisation of the results. However, for the specific conditions of a small company, the data obtained are highly relevant.

Thus, the experiment's results indicated the high potential of EdTech for optimising the PC operators' professional training. The revealed patterns can serve as the basis for developing targeted training programs and recommendations for further implementing innovative educational technologies.

The scientific novelty of the results lies in clarifying the theoretical foundations of EdTech's influence on skill development – an area that has not been widely explored in empirical studies – and in designing a system of criteria and indicators that afford an objective assessment of skill progression within the context of EdTech integration.

The practical applicability of the study is that employers can utilise the findings to enhance their learning systems through investments in the best EdTech solutions for developing employees, thereby driving productivity and competitiveness in companies.

DISCUSSION OF RESULTS

The study reveals critical insights into the dynamics of professional skill formation among PC operators under the influence of EdTech. It responds to a significant research gap: the absence of empirically substantiated data on the effectiveness of specialised EdTech tools in shaping hard and soft skills within this professional category. This gap is particularly relevant in digital transformation, where PC operators' demand for multifaceted competencies is rapidly growing [16, 17].

Changing Nature of PC Operator's Role. The redefinition of the PC operator's professional profile due to the evolution of digital technologies necessitates a simultaneous enhancement of technical proficiency and cognitive adaptability. The results support that the distinction between hard and soft skills is progressively fading, as effective professional performance relies on combining both. This requirement for dual competencies greatly influences the design and delivery of vocational education.

Empirical Validation of EdTech Effectiveness. The experimental results provide robust statistical evidence of the superiority of EdTech-enhanced training over traditional methods. The most striking gains were observed in hard skills. The ability of EdTech tools to deliver immediate feedback, personalise learning trajectories, and replicate professional scenarios contributed to accelerated skill acquisition. The statistically significant improvements ($p < 0.01$ and $p < 0.001$) validate the hypothesis that tailored EdTech tools can enhance professional training outcomes meaningfully.

Soft Skills Development. Although the impact of EdTech on soft skills was less pronounced, it was nevertheless statistically meaningful. Notably, critical

thinking, self-organisation, and adaptability showed measurable improvement. These results are particularly significant given that soft skills are traditionally seen as more resistant to short-term interventions. The positive correlation between participation in problem-based modules and soft skill enhancement supports the view that cognitive and metacognitive skills can be fostered through properly designed digital learning environments [18, 19].

It challenges earlier assumptions that EdTech is best suited for knowledge transmission and skill automation rather than behavioural and attitudinal development. Integrating gamified elements and case-based learning seems especially promising for stimulating user engagement and encouraging deeper learning strategies.

Implications for EdTech Design and Implementation. The findings underscore the importance of purposeful design in EdTech applications. It is not the mere use of digital tools but the active, targeted engagement with specific functionalities – typing simulators, software emulators, gamified challenges – that drives meaningful skill development. It has direct implications for both instructional design and EdTech platform development.

The study also highlights the importance of adaptability in training programs. Operators who could self-direct their learning and focus on individual weak spots, enabled by adaptive learning systems, achieved higher outcomes. Thus, personalisation emerges as a key success factor in modern professional education, which was highlighted in other works [20, 21].

Limitations and Future Research. The study's limited sample size (n = 33) restricts the applicability of its results, and the unique organisational context might have influenced the motivation and engagement of the participants. Further studies should take these limitations into account. Another area for future investigation is the cost-effectiveness of EdTech implementation in professional training, especially in SMEs and resource-constrained environments.

CONCLUSIONS

A study was conducted to evaluate how EdTech influences the development of PC operators' professional skills and to establish a theoretical and empirical foundation for its effectiveness in improving hard and soft skills.

Recent professional requirements indicate that success in today's digital era requires advanced technical skills and good cognitive and interpersonal abilities. It stressed using a twin strategy for developing skills to enable flexibility and competitiveness.

The research classified EdTech tools relevant to vocational training, including LMS, MOOCs, simulators, adaptive learning, and gamification. It emphasised that their effectiveness depends on applying adult learning principles and aligning with specific training goals.

A specialised assessment toolkit was created to track skill development, using performance metrics for hard skills (e.g., speed, accuracy, task completion time) and a combination of scoring, observation, and surveys for soft skills.

Empirical results showed statistically significant gains in the experimental group using EdTech. Data entry speed rose by 19.5 %, accuracy by 3.9 %, Excel task time decreased by 21.6%, and efficiency in specialised software use improved by 40.6 %—demonstrating EdTech's substantial impact on technical skill enhancement.

Soft skills also improved: critical thinking increased by 35.5 %, errors (indicating attention to detail) fell by 67.2 %, while self-organisation and adaptability rose by 20.6 % and 33.3 %, respectively. These results affirm that problem-based learning, gamification, and case studies in EdTech platforms effectively support cognitive and behavioural skill development.

In conclusion, the study provides clear evidence that targeted use of EdTech significantly enhances both hard and soft skills in PC operators compared to traditional training methods.

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