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The Impact of Digitalization of Education on the Development of Key Teacher Competencies

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ABSTRACT

The aim of the study is to identify the relationship between the digital competence of a higher school teacher and creativity, critical thinking, communicative, subject methodical, and communicative competence. The main research methods included testing to identify the level of digital competence, creativity, and critical thinking, as well as the interview to determine the level of subject methodological competence. The results of the study indicate that the medium level of the teacher competencies dominates. The level of teachers' digital, subject methodological, communicative competencies, creativity, and critical thinking decrease in persons with 16-25 years of work experience. Digitalization of education most significantly affects the development of communicative and subject methodological competence. The relationship between digitalization and professional competencies is more significant among teachers with 1-15 years of work experience. The obtained results can be used to improve existing educational programmes for teacher training. The prospects for further research include the creation and verification of programmes of formative experiments aimed at clarifying the causal relationship between the digitalization of education and the development of the professional competence of higher school teachers.

KEYWORDS: Education, digital heritage, communication technology, creativity, critical thinking.

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El impacto de la digitalización de la educación en el desarrollo de competencias docentes claves

RESUMEN

El objetivo del estudio es identificar la relación entre la competencia digital de un docente de educación superior y la creatividad, el pensamiento crítico, la competencia comunicativa, metódica de la asignatura y comunicativa. Los principales métodos de investigación incluyeron pruebas para identificar el nivel de competencia digital, creatividad y pensamiento crítico, así como la entrevista para determinar el nivel de competencia metodológica del sujeto. Los resultados del estudio indican que el nivel medio de las competencias docentes es dominante. El nivel de competencia digital, metodológica, comunicativa, creatividad y pensamiento crítico de los docentes disminuye en personas con 16-25 años de experiencia laboral. La digitalización de la educación afecta de manera más significativa el desarrollo de la competencia comunicativa y metodológica de la materia. La relación entre digitalización y competencias profesionales es más significativa entre los docentes con 1-15 años de experiencia laboral. Los resultados obtenidos pueden utilizarse para mejorar los programas educativos existentes para la formación de docentes. Las perspectivas para futuras investigaciones incluyen la creación y verificación de programas de experimentos formativos destinados a aclarar la relación causal entre la digitalización de la educación y el desarrollo de la competencia profesional de los profesores de la escuela superior.

PALABRAS CLAVE: Educación, patrimonio digital, tecnología de la comunicación, creatividad, pensamiento crítico.

Introduction

The effective integration of information technologies into teaching is one of the strategic priorities for the development of modern education. There is a need for the development of the Industry 4.0 elements in education (Durakbasa et al., 2018). The COVID-19 pandemic emphasized the importance of this objective (Dhawan, 2020; Haleem et al., 2022). There have even been opinions that digital technologies will completely replace traditional forms of education (Qureshi et al., 2021). The key role of informational transformation of education for technological progress is obvious despite the radicalism of those views (Jung, 2020). The effectiveness of the digitization of education implies a constant focus on development, in particular, on improving the relevant abilities of specialists (Eglash et al., 2020). Researchers warn against the dehumanization of education,

as the teacher-student interaction remains the focus of education regardless of the intensity and success of computerization (Hołowińska et al., 2022).

The problem of developing ways of building digital competence in the education system has been urged significantly in recent years (Tejada Fernández & Pozos Pérez, 2018). Digital competence is considered as one of the basic competencies in the structure of the teacher's professional skills (Cabero-Almenara & Palacios-Rodríguez, 2020). The teachers' readiness for a harmonious combination of traditional and innovative methods and approaches in their work is a prerequisite for effective teaching (Andrushchenko et al., 2023).

Higher education is extremely relevant as a social system that provides training of highly qualified specialists in various fields. Modernization of methodical and methodological approaches requires significant, scientifically grounded digitization of higher education institutions (Akour & Alenezi, 2022).

The above considerations determine the importance of analysing the development of professional competencies of higher school teachers in the digital environment. Moreover, it is important to resolve this issue in the context of the socio-cultural environment of a particular country. A topical area of research is establishing the relationship between teachers' professional competencies, the level of knowledge of digital technologies, and their work experience. This approach provides guidelines for optimization of training programmes for teachers in the context of university and continuing education.

The aim of the study is to find out the connection between the digital competence of higher school teachers and creativity, critical thinking, communicative, subject methodological, and communicative competencies.

Research objectives:

1) analyse the state of knowledge on the problem of teacher competencies in the context of digitalization of education;

2) empirically measure the levels of key competencies of higher school teachers;

3) determine the impact of digitalization of education on the development of key competencies of higher school teachers depending on the work experience.

1. Literature review

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In the most general form, Arisoy (2022) defines the concept of digitization of education as the process of introducing information and digital technologies into education at various levels. Zain (2021) considers gamification, virtual and augmented reality, educational applications of the network, and the Internet of Things (deep penetration of the Internet into everyday life) the determining aspects of the digitalization of modern education. According to Gupta et al. (2022), the main features of education in the era of digital technologies are the possibility of mutual learning, the development of critical thinking, computerized systems of evaluation and analysis of results. Prybylova (2017) confirmed increased creative inclusion of teachers in the educational process in the context of digital interaction. Abad-Segura et al. (2020) substantiated a positive role of digitalization for the individualization of learning and self-development of students.

Armila et al. (2022) believe that the digitization of education can have negative consequences if the current socio-cultural conditions of different population groups are not taken into account. According to Trust and Whalen (2020), teachers identify unpreparedness for the use of electronic resources, adaptation of traditional didactic methods to modern realities, unstable Internet connection, lack of a clear digitalization strategy as the main difficulties of using digital technologies in the educational process. Gogus and Saygin (2019) consider data privacy an urgent problem of the use of information technologies in higher education. Sales et al. (2020) state that a large proportion of teachers feel doubtful about their ability to teach digital skills to learners. Lange and Costley (2019) identify the problems of self-regulation of the participants in the educational process in the context of digitalization of education, which affects its quality.

Digitization of education involves digital competence of employees. Digital competence is the ability to use information technologies for education, work and social life safely, critically, and responsibly. The Council of the European Union identifies the following structural components of this phenomenon: information literacy, the ability to create quality digital content, knowledge in cyber security issues, and critical thinking skills (European Union, 2018). Blayone et al. (2017) identify the following constituent elements: technical competence, social competence — use of digital opportunities for communication, information competence — quality and speed of information search; epistemological

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competence, which includes network time management and presentation of complex information blocks.

The study of teachers' digital competence is relevant in the context of the subject of this research.. Ismail and Hassan (2019) believe that the analysis, interpretation and storage of data; understanding and improvement of informatization processes; maintenance of devices are the main teacher skills in a digital society. According to Basilotta-Gómez-Pablos et al. (2022), low and medium levels of information competence prevail among teachers, as evidenced by the generalized analysis of relevant studies. Basantes et al. (2020) found no significant relationship between the gender of specialists and the level of their technological competence. Nikou and Aavakare (2021) state that the level of digital competence of a higher school teacher directly affects the intentions to use modern technologies in their activities. These results determine the guidelines for improving educational and professional programmes.

Bygstad et al. (2022) distinguished the following basic aspects of digitization of education in higher school: a thorough technical framework, the optimal methodical component of the process, effective distribution of roles between the teacher and the learner, provision of a broad social context of education. Penprase (2018) states that the conditions for successful digitalization of higher education are quick adaptation and flexibility in the use of the latest technologies, development of technical competence, ethical awareness of aspects of informatization of the educational process. Carstens et al. (2021) indicate that the organization of digital competence development trainings becomes an urgent need. The implementation of information technologies in education should take into account the trends of informal, everyday use of technologies by participants in the educational process (Bond et al., 2018). The quality of digitization of higher education during the pandemic depends on a number of factors: relevance — the correspondence of educational materials to the students' needs; optimal pace of the educational process; effective teacher-student communication; constant stimulation of educational activity; several options for implementing the educational process (Bao, 2020).

It is important to determine the main competencies of a higher school teacher in the context of the aim of the research and its objectives. Masych (2014) identifies the following competencies of higher school teachers: social and personal, general scientific, subject

DOI: https://doi.org/10.46925//rdluz.41.10

specialized. The following key skills of a modern specialist can be identified by summarizing information from theoretical literature: complex problem solving; critical thinking; creativity; management skills; interaction with people; emotional intelligence; assessment and decision-making; customer orientation; constructive communication; cognitive flexibility (Khoruzha et al., 2018). Effective use of digital opportunities in the educational space requires a number of competencies: pedagogical, institutional, design, technological, communicative (Albrahim, 2020).

2. Methods and materials

Research design provided for the implementation of the following stages:

The theoretical stage (September - October 2022) involved the analysis of theoretical literature aimed at determining the theoretical model of the phenomenon under study, basic theoretical provisions, methodical and methodological guidelines of the research. The analysis of the available information was the basis for advancing a hypothesis about the dependence of the development of digital competence on the teacher's work experience in higher school and its connection with other key teacher's competencies. The structure of the theoretical model provided for identification of digital, communicative, subject methodological competence, creativity and critical thinking of a high school teacher as a subject of research.

Organizational stage (November 2022) involved drawing up a research plan, choosing empirical methods, choosing research background, sampling, settling organizational issues with the administration of educational institutions where the research was conducted. Cross-section was the main research strategy.

The stage of collecting empirical material (November - December 2022) provided for the implementation of research methods. It was carried out in direct interaction and remotely, depending on the features of the social situation. The collection of empirical data was complicated by constant blackouts and a difficult security situation.

The stage of quantitative analysis and interpretation of data (January - February 2023) — processing of the obtained data using the methods of mathematical statistics.

Data interpretation stage (March 2023) – generalization of research results.

Tools.

DOI: https://doi.org/10.46925//rdluz.41.10

Testing was the main method used to collect information about teacher competence. An online digital literacy test for teachers (https://osvita.diia.gov.ua/digigram) was used to study digital competence. The advantage of this tool is the consideration of socio-cultural and professional realities in the test. The method of assessing individual creative potential was used to study the teacher's creativity. The adapted Starkey's Critical Thinking Skills Pretest was applied to identify the level of critical thinking. The validity of the critical thinking test was confirmed in other studies (Lutsenko, 2014). The validity of teacher digital competence and creativity tests was confirmed through expert evaluations by teachers.

Observation of communicative competence was carried out on the basis of diagnostic criteria for the subject-subjective model of pedagogical communication. This method does not simply state the general level of communication skills, it takes into account the professional specifics of communication. Observation was carried out both remotely and in direct interaction.

The conversation was used to determine teachers' subject methodological competence. It was carried out in the following directions: knowledge of the conceptual framework and the main methodological approaches of the subject, knowledge and ability to use teaching methods — reproductive, problem-based, illustrative, game-based, etc. Each of the answers was evaluated according to the indicators and assigned to high, medium, low levels. The questions for the conversation were chosen based on the analysis of theoretical literature and communication with experienced teachers. Research assistants were involved in communication to avoid subjectivity in evaluating the results.

Sample

The sample was formed from among the teachers of the following higher educational institutions: Borys Grinchenko Kyiv University, Kyiv National Linguistic University, Taras Shevchenko National University of Kyiv, National Pedagogical Dragomanov University, Sumy State Pedagogical University named after A.S. Makarenko. Four samples were formed with a view to the hypothesis and objectives of the research: teachers with 1-5 years of work experience (65 people); teachers with 6-15 years of experience (76 people); teachers with 15-25 years of experience (82 people); teachers with more than 25 years of experience (62 people). The total number of subjects was 285 people.

DOI: https://doi.org/10.46925//rdluz.41.10

Data collection was carried out online through the use of Google forms and offline. The teachers showed interest and willingly came into contact with the researchers. No significant difficulties were found during the collection of empirical data.

Data analysis involved the use of percentage and correlation analysis. Spearman's rank correlation was used as the data are presented in an ordinal scale. Data processing was carried out in SPSS.22. The levels of the studied characteristics are reduced to a scale — high, medium, low — to unify the obtained data.

Compliance with *ethical criteria* was ensured through the mandatory consent of respondents to participate in the study. Deontological analysis of research methods gives grounds to assert that their content does not degrade honour and dignity.

3. Results

We will analyse the obtained results for each of the studied teacher competencies.

The indicators of digital competence change depending on work experience (Figure 1). The low indicators of the parameter do not differ significantly in the first and second samples. The number of people with low values of digital competence among people with 16-25 years of work experience is increasing. Among the most experienced teachers, the low level of the parameter becomes less pronounced. The dominant level of digital competence in the studied samples is medium, which ranges approximately from 60 to 77%. The highest percentage of specialists with medium indicators was recorded among persons with more than 25 years of work experience. At the same time, the number of teachers with high values is decreasing in this sample. In general, a high level of digital competence does not exceed 20% in the studied samples.

The teachers' communicative competence does not change significantly during their professional activity (Figure 2). The number of people with a low level of parameters is increasing among specialists with 16-25 years of work experience, but the percentage of low indicators is slightly decreasing in the next group. The medium level of communicative competence prevails in the studied samples. The medium level indicators are the most pronounced among teachers with work experience from one to fifteen years. The high level is represented insignificantly — from 3.08% to 14.52%, but it increases with the increase of

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work experience. It can be stated that the subject-subjective model of pedagogical communication among higher school teachers is not sufficiently developed.

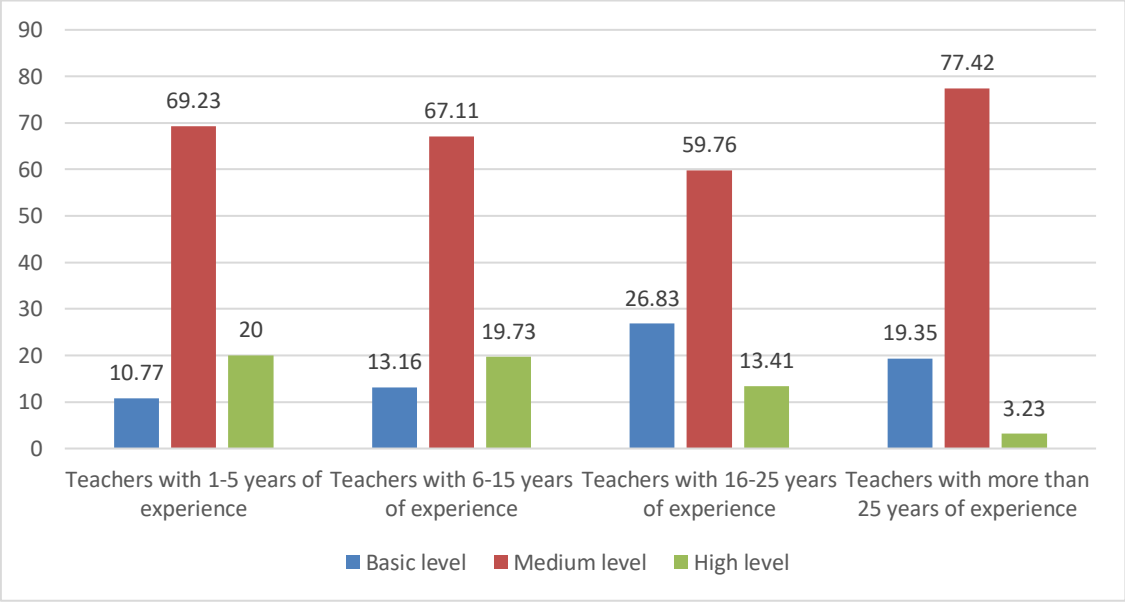

Figure 1. Indicators of digital competence in the studied samples

The dynamics of subject methodological competence are somewhat different from the trends of previous parameters (Figure 3). The number of people with a low level of the parameter is minimal, as it significantly depends on the length of professional activity. The medium level dominates in the first three samples (60.53% - 89.02%). Medium and high indicators of subject-methodological competence were distributed almost equally among specialists with more than 25 years of work experience. A trend of decreasing high indicators of the studied competence among teachers with 16-25 years of work experience was found. The studied parameter is a set of knowledge and skills that reflect the effectiveness of teaching, so obviously its quality depends on the duration of professional activity. At the same time, it is worth noting that the subject methodological competence of young specialists requires increased measures for its development.

The teachers' creativity has the maximum indicators in samples with work experience of 1-5 years and 6-15 years (Figure 4). Low indicators of creativity are represented insignificantly in the first two samples, but increase in persons with work experience of 16-25 years, and further decrease.

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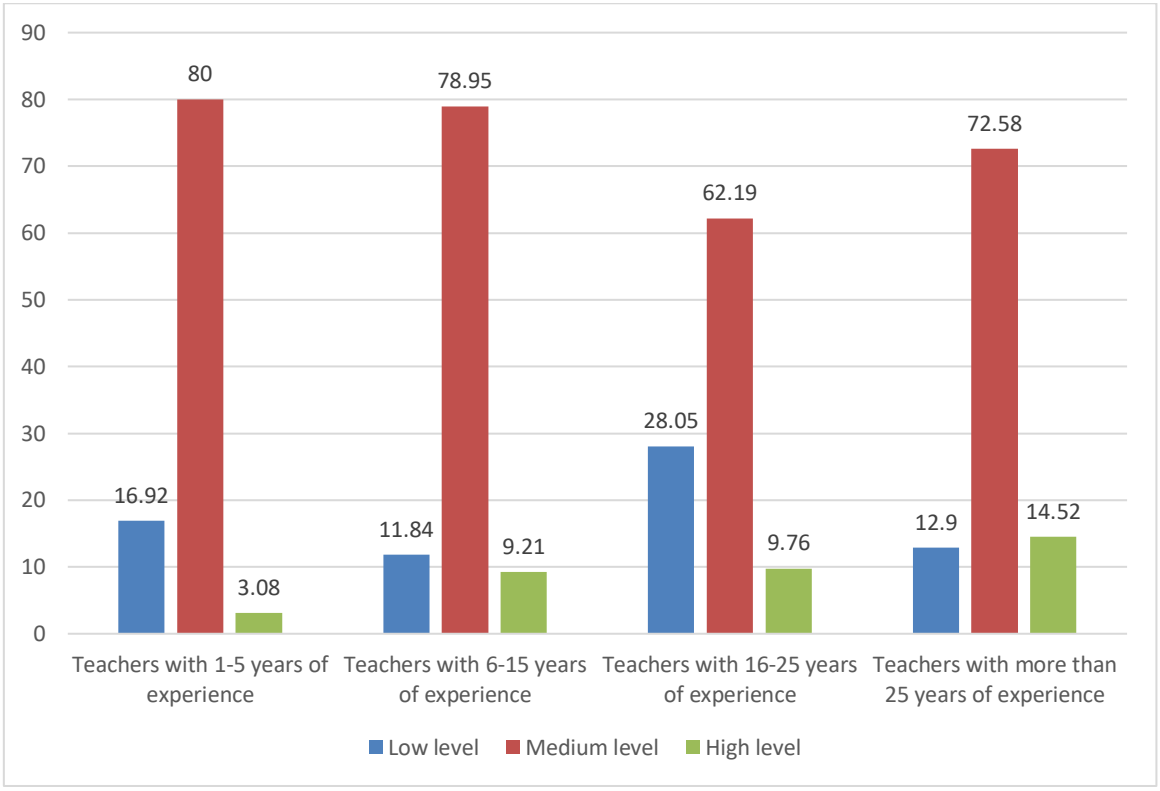

Figure 2. Indicators of communicative competence in the studied samples

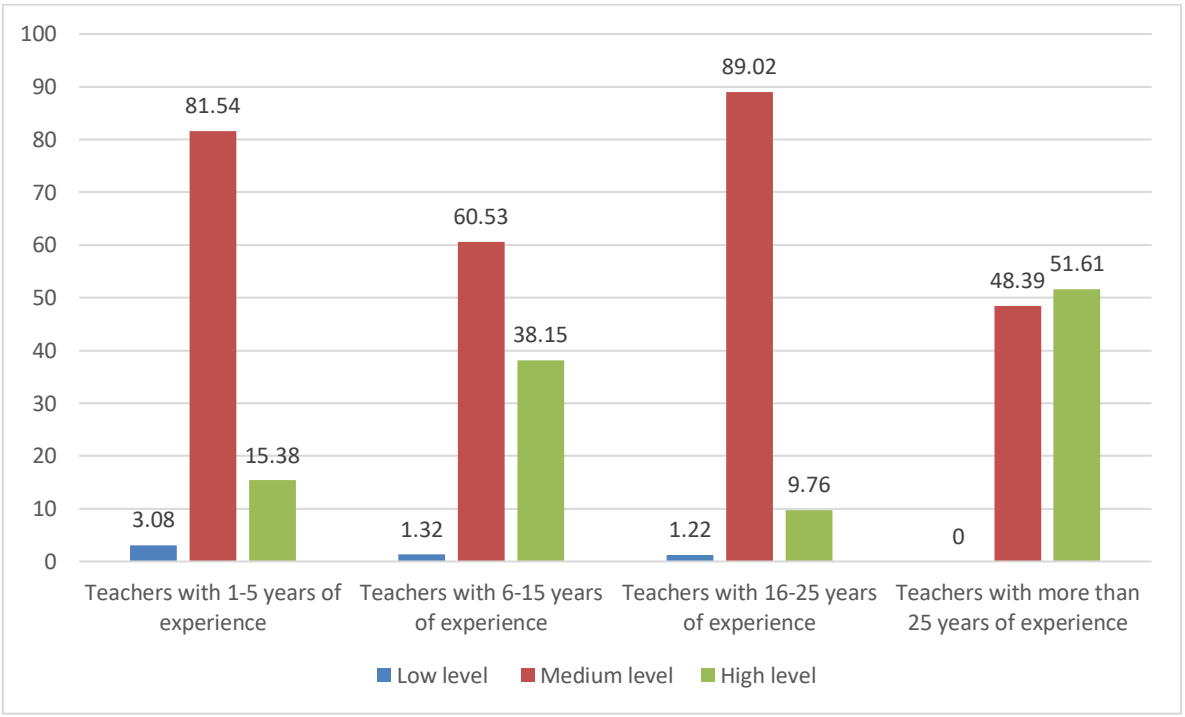

Figure 3. Indicators of subject methodological competence in the studied samples

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The medium indicators of the parameter dominate among the most experienced teachers with maximum values. A tendency to decreasing number of persons with high indicators of this competence is observed. This means that work experience does not contribute to the search for creative ways to implement the educational process in higher school.

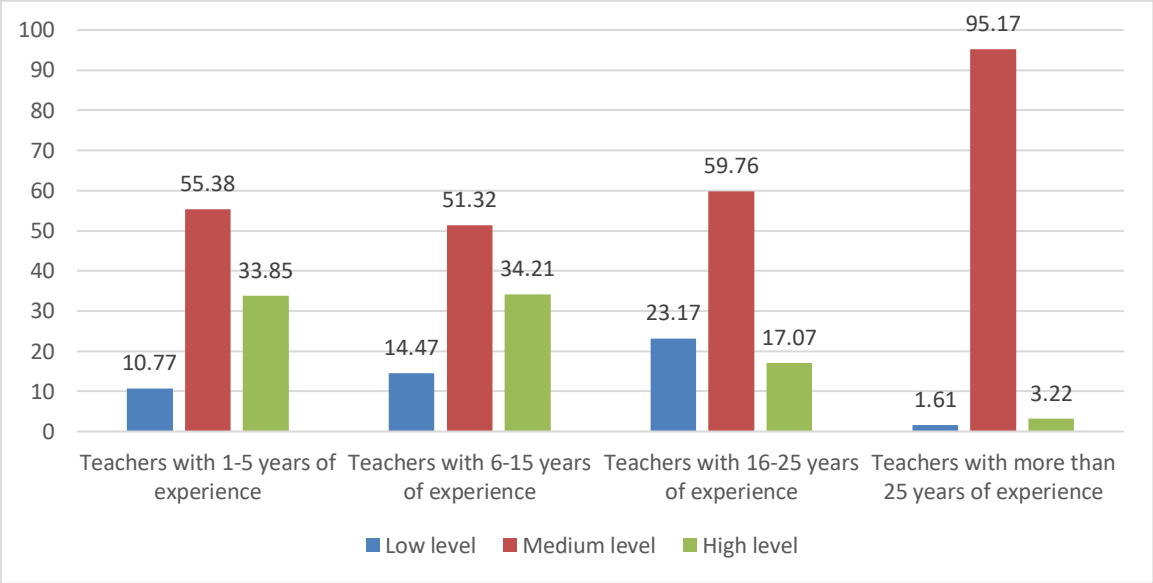

Figure 4. Indicators of creativity in the studied samples

The level of critical thinking of the studied specialists is mostly medium in all studied samples (Figure 5). Average indicators of the parameter are presented at 6-10% and do not change significantly. The medium indicators increase with the work experience of teachers and acquire maximum values for the most experienced specialists. On the contrary, the number of people with a high level of critical thinking decreases.

Correlation analysis was used to determine the impact of digitalization of education on the development of teachers' competencies (Table 1). Coefficients marked with an asterisk indicate the relationship at p=0.05, and indicators with two asterisks reflect the relationship at p=0.01. The relationship of digital competence with each studied parameter is described below.

Communicative competence is significantly related to digital competence among professionals with 1-5 years of experience and 6-15 years of experience. The significance of

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this relationship decreases for teachers with 16-25 years of work experience, but the correlation remains.

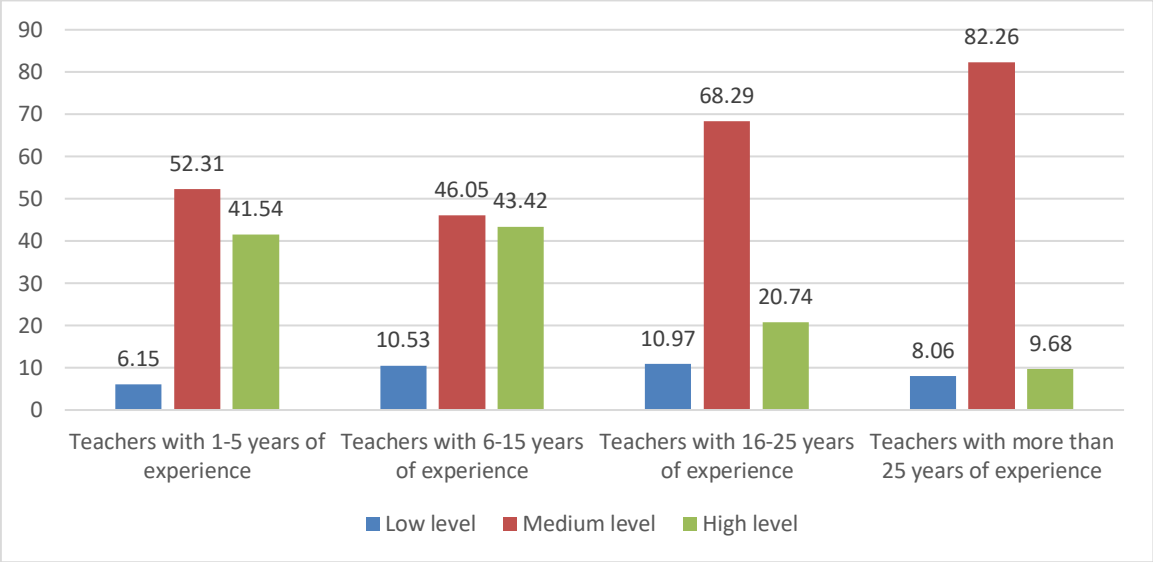

Figure 5. Indicators of critical thinking in the studied samples

Subject methodological competence is related to digital competence in all studied groups. At the same time, the significance of the detected relationship decreases to 0.05 in persons with 16-25 years of work experience and more than 25 years. Therefore, the digitization of education determines the acquisition of academic knowledge and learning modern pedagogical methods by specialists.

Creativity of teachers is related to digital competence only in the sample of teachers with 1-5 years of work experience. The significance level of the detected correlation is 0.05. No significant relationship between these competencies was recorded in other studied groups. Therefore, the use of digital opportunities in education affects the development of creative potential of beginning teachers only.

Critical thinking is related to digital competence in samples of novice and experienced teachers. No relationship between competencies was found in the groups of teachers with work experience of 6-15 years and 16-25 years.

The results of the observation gave grounds to distinguish the following types of specialists depending on their attitude to the digitization of education (author's classification):

DOI: https://doi.org/10.46925//rdluz.41.10

Stubborn conservatives — methodical, academic and psychological training at a high level. Give preference to traditional forms and methods of education. The attitude towards digital technologies is negatively biased. There is a pronounced reluctance to acquire new skills. They usually rely on younger colleagues in matters of information literacy and distance learning.

Table 1. Indicators of correlation of digital competence with other professional components of teachers

Competencies	Digital competence			
	Teachers with 1-5 years of experience	Teachers with 6-15 years of experience	Teachers with 16-25 years of experience	Teachers with more than 25 years of experience
Communicative competence	0.41**	0.47**	0.23*	0.11
Subject methodological competence	0.39**	0.41**	0.24*	0.27*
Creativity	0.29*	0.19	0.11	0.09
Critical thinking	0.31*	0.24	0.09	0.29*

Flexible conservators have a high level of knowledge of traditional methods and means of education. At the same time, there are individual attempts at self-development and adaptation of common methods to modern informational realities. Attempts at self-education are episodic and inconsistent.

Impulsive innovators have a very positive attitude towards information technologies, active self-development in this area. The insufficient level of methodical and academic training, which they try to compensate for by active use of digital technologies. Creativity is unsystematic and can be counterproductive.

Rational innovators — a positive attitude towards digitization is combined with restraint and self-control regarding the introduction of modern technologies into educational practice.

DOI: https://doi.org/10.46925//rdluz.41.10

However, they may be too careful in integrating informational aspects. Creativity is moderate, productive.

Theoreticians — have sufficient knowledge in the digital sphere, but do not use the acquired knowledge in practice.

As a result of our observations, we cannot state significant differences in the development of digital competence by gender.

5. Discussion

The results of the study show that the indicators of the key teachers' competencies depend on the work experience in higher school. Medium indicators of digital competence prevail, which corresponds to the findings of other researchers (Basilotta-Gómez-Pablos et al., 2022). It should be noted that indicators of digital, subject methodological, communicative competence, creativity and critical thinking of teachers decrease in persons with 16-25 years of work experience. This situation can be explained by the trends of the professional crisis in this period. We note a more significant development of the teachers' digital skills in the period from one to fifteen years. The most significant impact of the digitization of education on the professional development of specialists is recorded in novice teachers, which is confirmed by the results of correlation analysis. The impact of digitalization on the development of subject methodological competence is the most significant, which can be associated with the active use of network resources for professional development.

We agree with the conclusions that digitalization of education should focus on the current needs and structure of students' individuality (Akour & Alenezi, 2022). The obtained results are consistent with data on the absence of pronounced gender differences in the level of digital competence (Basantes et al., 2020). One should also agree with the conclusions about the lack of proper regular training of teachers for work in a digital environment (Blayone et al., 2017).

We agree with the importance of the ethical component of digitalization of education (Penprase, 2018), because the results of conversations with specialists give us grounds to conclude that the perception of modern technologies is somewhat disconnected from the content of social relations. We support the idea of developing special digital competence

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trainings (Carstens et al., 2021). We only note that such work should be based on the data of specific empirical studies, and not on general considerations. Teachers with long work experience encounter difficulties in adapting traditional forms of education to the realities of the digital educational community. This conclusion confirms the opinions of other researchers (Trust & Whalen, 2020)

At the same time, we cannot confirm the systemic positive impact of the digital society on critical thinking (Gupta et al., 2022). The contradictions of the obtained results are explained by the differences in the socio-cultural conditions of the respondents, in particular, the specifics of training in higher educational institutions. No positive impact of digitization of educational systems on teachers' creativity was found (Prybylova, 2017). We explain the discrepancy in the data by the fact that our research was conducted on several samples that differed in the work experience — this enabled clarifying the results. The opinion that the level of a teacher's digital competence directly correlates with its use is also debatable (Nikou & Aavakare, 2021). It was established through diagnostic conversations and observation that teachers may have developed digital skills, but not use them in the educational process.

Conclusions

Digitization is a prerequisite for modern progress in general and education in particular. Despite the increasing impact of technologies, the interaction in the teacher - learner system remains the focus of the educational process. Therefore, the study of the transformation of teachers' competencies in the digital society is relevant. These studies will contribute to optimizing the theoretical constructions of the problem, and will become the basis for the optimization of educational programmes. Studies of the impact of digitalization on the development of the higher school teacher competencies are particularly significant.

The research findings indicate that the medium level of teacher competencies is dominant. Indicators of digital, subject methodological, communicative competences, creativity, and critical thinking of teachers decrease in persons with 16-25 years of work experience. We explain this situation as manifestations of a professional crisis. Digitalization of education most significantly affects the level of communicative and subject methodological competence. The impact on the development of creativity and critical thinking of teachers is less pronounced. The relationships between digitalization and other

competencies are more significant among teachers with 1-15 years of work experience. The relevance of such a correlation decreases in groups of more experienced specialists. The obtained results can be used to improve existing educational programmes for teacher training. The prospects for further research include the development and implementation of programmes of formative experiments with the aim of clarifying the causal relationship between the digitalization of education and the development of the professional competence of higher school teachers.

Limitations

It is advisable to more clearly differentiate the samples by work experience to improve the reliability of the research results. Conclusions about the dynamics of competences depending on the work experience will be more valid when combining longitudinal and cross-sectional data.

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