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The effectiveness of multimedia boards/projection systems in teaching humanities

La eficacia de los sistemas de proyección/tableros multimedia en la enseñanza de las humanidades

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Abstract

The relevance of the study is determined by the need to integrate digital technologies (multimedia boards/projection systems) into the training of specialists, in particular in the field of humanities, and the development of professional competencies through the use of modern multimedia tools. This study aims to assess the effectiveness of using multimedia whiteboards (MWBs) in building professional competencies among humanities students. The study employed methods of theoretical and methodological analysis, generalisation of studies, testing, questionnaire surveys, and work with interactive boards (including delimitation of space, selection of stickers, use of tags, and multimedia elements), among others. The study involved humanities students, particularly those majoring in Philology, Primary Education, and Pedagogy. The total number of participants was 300 students, who were divided into an experimental group (EG) of 150 students. And control (CG) of 150 students. All criteria underwent positive changes, especially in the aspects of practically-oriented skills (+30%), experience with information resources (+40%), and the level

of communication skills (+25%). At the control stage of the study, statistically significant differences were found between the EG and CG in terms of the level of professional competence (φcrit = 1.64 < φemp = 2.418). The use of virtual boards significantly enhances students' competence, fostering active interaction and the solution of practical tasks. The questionnaire survey revealed that multimedia technologies increase involvement, enhance motivation and improve understanding of the material (average score 4.17–4.28). Their flexibility in learning was rated the highest (4.28), and their personalised features were rated the lowest (3.99). Overall, their use has a positive impact on the educational process. The academic novelty lies in the use of MWBs for developing competence in the current digital educational environment. Further research may focus on the effectiveness of interactive technologies in other humanities subjects and their impact on professional training. The study has a quasi-experimental design, which involves the participation of experimental and control groups without randomisation, but with precise control of variables and comparison of educational outcomes. This approach enables a reasonable assessment of the effectiveness of using multimedia boards and projection systems in developing students' professional competence. The theoretical contribution of the study lies in the development and testing of a pedagogical model for integrating digital tools into humanities education, covering the principles of visualising complex concepts, developing interdisciplinary thinking, active interaction in a digital environment, and individualising learning. The proposed approach can be adapted to other areas of education, taking into account the specifics of subject training.

Keywords: Digital technologies, humanities subjects, multimedia whiteboards, professional competence, projection systems.

Resumen

La relevancia del estudio se debe a la necesidad de integrar las tecnologías digitales (pizarras multimedia/sistemas de proyección) en la formación de especialistas, en particular en el ámbito de las humanidades, y en el desarrollo de competencias profesionales mediante el uso de herramientas multimedia modernas. El objetivo del estudio es evaluar la eficacia del uso de pizarras multimedia (PTM) para desarrollar las competencias profesionales de los estudiantes de humanidades. El estudio empleó métodos de análisis teórico y metodológico, generalización de estudios, pruebas, encuestas, trabajo con pizarras interactivas (incluyendo delimitación de espacio, selección de pegatinas, uso de etiquetas y elementos multimedia), etc. El estudio involucró a estudiantes de humanidades, en particular a los de Filología, Educación Primaria y Pedagogía. El número total de participantes fue de 300 estudiantes, que se dividieron en un grupo experimental (GE) de 150 estudiantes) y un grupo de control (GC) de 150 estudiantes. Todos los criterios experimentaron cambios positivos, especialmente en los aspectos de habilidades prácticas (+30%), experiencia con recursos de información (+40%) y el nivel de habilidades comunicativas (+25%). En la fase de control del estudio, se encontraron diferencias estadísticamente significativas entre el GE y el GC en cuanto al nivel de competencia profesional (φcrit=1,64<φemp=2,418). El uso de pizarras virtuales aumenta significativamente el nivel de competencia de los estudiantes, contribuyendo a la interacción activa y a la resolución de tareas prácticas. La encuesta reveló que las tecnologías multimedia aumentan la participación, mejoran la motivación y la comprensión del material (puntuación media: 4,17-4,28). Su flexibilidad en el aprendizaje obtuvo la máxima puntuación (4,28) y sus funciones de personalización, la mínima (3,99). En general, su uso tiene un impacto positivo en el proceso educativo. La novedad académica reside en el uso de pizarras virtuales para el desarrollo de competencias en el actual entorno educativo digital. Futuras investigaciones podrían centrarse en el estudio de la eficacia de las tecnologías interactivas en otras disciplinas de humanidades y su impacto en la formación profesional. The study has a quasi-experimental design, which involves the participation of experimental and control groups without randomisation, but with precise control of variables and comparison of educational outcomes. This approach enables a reasonable assessment of the effectiveness of using multimedia boards and projection systems in developing students' professional competence. The theoretical contribution of the study lies in the development and testing of a pedagogical model for integrating digital tools into humanities education, covering the principles of visualising complex concepts, developing interdisciplinary thinking, active interaction in a digital environment, and individualising learning.

The proposed approach can be adapted to other areas of education, taking into account the specifics of subject training.

Palabras clave: Asignaturas de humanidades, competencias profesionales, pizarras multimedia, sistemas de proyección, tecnologías digitales.

Introduction

Modern technologies are significantly transforming the education system, providing new opportunities for interactive learning (Gurevych et al., 2020). The use of MWBs and projection systems is becoming an essential element of the educational process, especially in teaching humanities (Frumkina et al., 2020). Research into the effectiveness of these technologies in developing students' professional competence is particularly relevant in the context of digital education and the need to enhance its quality (Vali, 2023). According to Filatova & Drobina (2021), interactive multimedia tools not only improve the assimilation of educational material but also contribute to the development of critical thinking, communication skills, and a practical approach to learning. As Kraus et al. (2022) note, digital transformation is significantly altering approaches to managing and organising educational processes, integrating technologies to enhance learning efficiency. Despite the active digitisation of the academic sphere, significant problems persist in the teaching of humanities disciplines, including insufficient interactivity in classes, limited use of multimedia tools, low student motivation to study abstract material, and a lack of individualised learning approaches. Most approaches remain focused on traditional teaching methods, which do not adequately meet the needs of the digital generation. At the same time, the literature only partially covers the specifics of implementing multimedia technologies in humanities education — research focuses mainly on STEM fields. Thus, there is a need not only to evaluate the effectiveness of such technologies empirically but also to develop a pedagogical model for their application in the formation of key professional competencies of humanities scholars.

The study aims to determine the effectiveness of using MWBs and projection systems in building the professional competence of humanities students.

The aim was achieved through the fulfilment of the following research objectives:

- Study the impact of multimedia technologies on the level of students' involvement, motivation, and understanding of educational material.
- Assess changes in the level of development of key students' competencies when using MWBs in the educational process.
- Determine statistically significant differences between the EG and CG in terms of the level of students' professional competence.

To provide a comprehensive understanding of the topic, Section 2 of this article presents an overview of scientific works devoted to digitalisation in education, with an emphasis on the application of multimedia technologies in teaching humanities disciplines. Section 3 provides a detailed description of the research methodology, including the quasi-experimental design, sample characteristics, data collection tools, and stages of the pedagogical experiment. Section 4 presents the results of the empirical study with an explanation of the quantitative indicators of changes in students' professional competencies. The discussion in Section 5 reveals the obtained data in the context of modern scientific approaches and compares them with the conclusions of other researchers. The article concludes with Section 6, which formulates the main findings, outlines the scientific novelty and practical significance of the obtained results, and proposes vectors for further research.

Literature Review

Research into digital technologies in teaching humanities is a promising but still underdeveloped field, especially in terms of the practical implementation of tools such as multimedia whiteboards (MWBs). Contemporary scientific literature generally attests to a positive attitude towards digitalisation. Still, it lacks depth in describing methodologies, application contexts, and quantitative measurement of effectiveness, which complicates the creation of an evidence base.

Thus, Killian & Floren (2020) argue that digital tools contribute to the development of intercultural competence. Their research is based on a survey of students in a multicultural environment; however, the authors do not specify the types of digital platforms or provide quantitative indicators of effectiveness. At the same time, Zhao et al. (2024), using a mixed-methodology approach that includes online surveys, semi-structured interviews, and classroom observations, demonstrate that interactive content improves student engagement. However, both studies acknowledge that digital technologies cannot completely replace traditional methods, especially in the humanities, where critical thinking and discussion play a leading role.

Khrystiuk & Tsymbal (2023), after analysing the educational strategies of Ukrainian higher education institutions, identified a lack of strategic integration of digital tools into humanities training programmes. Their research methodology included the analysis of official documents and surveys of teachers; however, its limitations included a small sample size (15 people) and a lack of empirical testing of the effectiveness of the technologies.

Ali (2022) study employed an experimental methodology, focusing on immersive technologies (AR/VR) in the study of complex concepts. The author noted an improvement in understanding of the material but acknowledged that such technologies require significant resources and are not scalable in regular educational settings, especially in the humanities.

Unlike technology enthusiasts, Baber (2020) emphasises the importance of preserving the interpersonal component in learning. A study based on a qualitative analysis of 40 interviews with teachers emphasises that technology should not negate the role of the teacher as a mentor. Anggraini & Handayani (2022) reach a similar conclusion after conducting a quantitative study of digital literacy among students (n = 247) and finding that humanities students have gaps in critical thinking in the digital environment. However, neither study considers practical tools such as MWBs.

Rajab (2018) analysed the use of online platforms in crises in seven countries. The author demonstrates that digital resources provide basic access to education but acknowledges limitations in the quality of student-teacher interaction. Similarly, Bakhmat et al. (2023) focus on economic specialities, analysing Moodle as an environment for developing digital competencies, without addressing the specifics of humanities education.

Devadze et al. (2022) outline global trends in the digital transformation of education; however, their work is primarily theoretical and does not provide empirical models for the humanities. Similarly, Krymets (2022) and Poperechna (2022) emphasise the changing role of teachers, but without analysing specific digital solutions and their impact on the development of key competencies.

Lund & Aagaard (2020) and Humeniuk & Romaniuk (2023) draw attention to the need to modernise teacher education, particularly in terms of improving cloud services. However, both works lack a focus on interactive tools (such as multimedia boards) and their effectiveness in a classroom setting.

Several authors explore interdisciplinary or STEM contexts that are only partially relevant to the humanities. In particular, O'Leary et al. (2020) analyse culturally sensitive teaching in STEM, Ritter (2022) analyses the use of digital games in primary school, and Santoveña-Casal & Fernández Pérez (2020) analyse pedagogical strategies in distance learning. They demonstrate the effectiveness of the multimedia approach but do not tailor their conclusions to the specific needs of teaching philology, history, pedagogy,

and related subjects. Finally, Tight (2022) and White et al. (2023) focus on the systematic implementation of digital solutions at the administrative level, but ignore the methodological aspects of their application in humanities classrooms.

In summary, it can be stated that:

Most studies focus on the general impact of digital technologies, without detailing specific tools such as MWBs.

There is a significant shortage of empirical studies in the humanities, particularly those employing quasi-experimental designs.

The sources reviewed lack a comparative analysis of the control and experimental groups, which is crucial for assessing effectiveness.

That is why there is a need for research that not only evaluates the effectiveness of multimedia boards in humanities education but also offers practical recommendations for integrating digital tools into the learning process, which is the purpose of this article.

Methodology

Research design

The main goal of the experiment was to test the didactic potential of MWBs/projection systems for building professional competencies in humanities students, particularly those majoring in Philology, Primary Education, and Pedagogy. The impact of MWBs and projection systems on students' educational results was also determined.

The preparatory stage of the experiment involved a general assessment of the existing level of theoretical knowledge, familiarity with terminology, skills in performing practically oriented tasks, experience in professional activity, and work with information resources.

The control measure provided for asking students to take tests on topics related to their future professional activities. The test questions were developed by the main criteria for the professional activity of a humanities specialist to determine: the level of theoretical knowledge, knowledge of terminology, the level of skills in solving practically-oriented tasks, experience in working with information resources, the consistency of logical thinking, analytical abilities, methodological competence, interdisciplinarity, and the level of communication skills. For each type of activity, five tasks were offered, resulting in a total of 45 tasks selected for testing. When analysing each criterion, the student received a "pass" rating if they scored three or more points. The testing structure is provided in Tables 1-9 below.

The Structure of Test Items

Table 1.
Level of theoretical knowledge

Item No.	Task
1	Identify the fundamental concepts of the humanities and their applications in professional settings.
2	Describe the key features of the development of the humanities in the context of current academic approaches.
3	Explain the basic methods of humanities research and their practical significance.
4	Determine the role and place of the humanities in shaping social values.
5	Analyse the interrelationship of the humanities and their impact on the educational sphere.

Table 2.
Knowledge of terminology

Item No.	Task
1	Define key terms in the humanities.
2	Distinguish between similar terms and explain their use.
3	Fill in the missing terms in the definitions of academic concepts.
4	State the correct meaning of a term in the context of a scientific text.
5	Choose the correct interpretation of terms from the provided options.

Table 3.
Practical problem-solving skills

Item No.	Task
1	Use humanitarian knowledge to solve a pedagogical problem.
2	Develop a concise teaching methodology that incorporates humanitarian approaches.
3	Suggest a solution to a problem situation in the field of intercultural communication.
4	Analyse the text for its compliance with the socio-cultural context.
5	Identify errors in the texts and suggest their correction based on humanitarian knowledge.

Table 4.
Experience working with information resources

Item No.	Task
1	Use electronic libraries to search for academic sources.
2	Determine the reliability of academic resources.
3	Analyse citations in academic publications.
4	Compare different methods of searching for information in humanities research.
5	Make a brief literature review on the chosen topic.

Table 5.
Sequence of logical thinking

Item No.	Task
1	Identify logical errors in a scientific text.
2	Build a logical chain of arguments in the study.
3	Analyse the text from the perspective of logical coherence.
4	Determine the sequence of presentation of material in an academic article.
5	Propose a logical scheme for solving a scientific problem.

Table 6.
Analytical skills

Item No.	Task
1	Analyse the text for the main idea and supporting arguments.
2	Identify the connection between different humanitarian concepts.
3	Compare various approaches to analysing cultural phenomena.
4	Identify problematic aspects in the proposed study.
5	Substantiate your point of view on the debatable issue.

Table 7.
Methodological competence

Item No.	Task
1	Create a lesson plan using an interdisciplinary approach.
2	Evaluate the effectiveness of different teaching methods in the humanities.
3	Develop exercises to consolidate theoretical material.
4	Analyse didactic materials for compliance with educational objectives.
5	Suggest strategies to enhance student motivation.

Table 8.
Interdisciplinarity

Item No.	Task
1	Determine the relationship between the humanities and natural sciences.
2	Analyse the use of humanities knowledge in technical fields.
3	Compare approaches to solving social problems across various scientific disciplines.
4	Propose an interdisciplinary approach to studying a specific phenomenon.
5	Determine the role of the humanities in modern society.

Table 9.
Communication skills

Item No.	Task
1	Analyse the features of academic writing.
2	Prepare a short report on a scientific topic.
3	Identify stylistic errors in the text.
4	Develop a presentation and explain its content to the audience.
5	Edit a scientific text according to language standards.

The general level of students' professional competence was determined by using the same test items. The student received a "pass" rating if they scored more than 27 points when completing all the tasks in the blocks. Otherwise, the student was considered to have failed the task. Fisher's angular transformation (Fisher's test) was used for statistical data processing.

At the next stage of the experiment, teachers conducted methodological work with the EG students on the possibilities of using virtual sticker boards to organise the study of educational material. Students were offered topics for joint work and individual tasks. The students' professional interests determined the formation of teams and the choice of topics. The indicative topics included: "The use of interactive methods in teaching humanities", "The application of a communicative approach in teaching", "Literary discourse: theoretical principles and practical aspects", etc.

Using virtual sticker boards, students formalised the results of their research and discussions, organised them by the logic of events, utilised graphic capabilities to build arguments, uploaded photos, videos, and audio files, and exchanged comments and tags. In experimental work, the possibility of practising practical skills of humanities students was realised through the use of MWBs and projection systems. Additional conditions for students' self-education were established, and a comprehensive presentation of educational materials was organised. In other words, systematic pedagogical work was carried out that meets the requirements of the digital society.

The CG students studied the topics Theoretical Principles of Text and Discourse, Pedagogical Methods of Teaching in Primary Education, as well as Psychological and Pedagogical Features of the Educational Process" by the work programme, using traditional lectures and seminars.

After integrating such interactive forms of work into the educational process, re-testing was conducted to assess the level of material mastery in the EG and CG. The questions for the test were developed according to the same principles as at the initial stage of the study.

The questionnaire survey was conducted at the end of the experiment in the EG. The primary purpose of the questionnaire survey was to gather students' perceptions of the impact of MWBs and projection systems on their educational outcomes. A scoring system was used to analyse the survey responses: strongly disagree = 1, disagree = 2, neutral = 3, agree = 4, and strongly agree = 5. The average score for each question was calculated by multiplying the number of responses in each category by its corresponding weight. The obtained values were then summed and divided by the total number of responses (n = 150). This approach enabled the collection of objective, quantitative data on the effectiveness of using MWBs and projection systems in teaching humanities.

Research methods

The research employed the following methods:

1. Experimental method — introducing MWBs and projection systems into the educational process of the EG of humanities students. The CG studied according to the traditional method. The comparison of the results from the two groups made it possible to determine the effectiveness of multimedia technologies in developing students' professional competencies.
2. A questionnaire survey was used to collect data on the subjective perceptions of students regarding the impact of multimedia technologies on their involvement, motivation, and success. The survey was conducted at the beginning and end of the experiment. Analysis of the responses made it possible to determine the dynamics of changes in students' attitudes towards the use of multimedia tools in education.
3. Testing: Students performed test items developed according to the criteria of professional activity for humanities students. The level of theoretical knowledge, knowledge of terminology, skills in solving practically oriented tasks, experience with information resources, consistency of logical thinking, analytical abilities, methodological competence, interdisciplinarity, and communication skills were assessed. The testing results allowed us to compare the level of competence before and after the experiment.
4. An observation method was used to analyse students' activity while working with MWBs, their interaction in the learning environment, and the level of participation in discussions and practical tasks. Observation made it possible to assess how multimedia technologies affect student interaction and their involvement in the learning process.

Sample

An empirical study was conducted at four higher education institutions (HEIs): Volodymyr Vynnychenko Central Ukrainian State University, Rivne State University for Humanities, Vasyl Stefanyk Precarpathian National University, and Bohdan Khmelnytsky National University of Cherkasy. The study involved humanities students, specifically those majoring in Philology, Primary Education, and Pedagogy. This approach contributed to the generalizability of the findings and provided the opportunity to compare the results in different academic contexts. During the experiment, data were collected from 300 students, who were divided into the EG (150 students) and the CG (150 students). The sample was random. The selected number of participants (300 students) was determined to ensure the representativeness of the sample and obtain statistically significant results. The students were divided into the EG and CG (150 students each) to determine the impact of multimedia technologies on the educational process. The number of participants in each group was sufficient to conduct a statistical analysis and test the significance of the changes obtained. The gender distribution (82% women and 18% men) aligns with the typical structure of humanities students, thereby increasing the ecological validity of the study. Ethical principles were observed at all stages of the study. The participants provided informed consent, while their anonymity and confidentiality were guaranteed at all stages of data collection and analysis.

Research instruments

The study employed a quasi-experimental design, comprising a control group (CG) and an experimental group (EG). Complete randomisation was not possible due to the existing structure of academic groups, which justifies classifying the study as quasi-experimental. Preliminary testing was conducted to verify the initial homogeneity of the sample. The results of Fisher's criterion ($\varphi emp = 0.098 < \varphi crit = 1.64$; $p > 0.05$) confirmed the absence of statistically significant differences between the CG and EG before the start of the experiment.

To control for the influence of external factors, both groups studied the same curriculum, had the same teachers, and were allocated the same number of academic hours, all of which were assessed according to the same criteria. The only variable was the use of multimedia boards and projection systems in the EG, which allowed for the isolation of an independent variable (technological intervention) and increased the reliability of the results.

The following tools were used in the study:

Software and interactive multimedia boards (IMBs) — EG utilised IMBs and the Linoit.com platform, which enabled students to collaborate on material in real-time, interacting through interactive stickers, marks, videos, hyperlinks, and other multimedia elements.

Questionnaire — the questionnaire consisted of 10 statements aimed at assessing the impact of MMD on motivation, engagement and understanding of the learning material. Responses were evaluated on a Likert scale (from 1 — 'strongly disagree' to 5 — 'strongly agree'). The content validity of the questionnaire was confirmed by three independent experts in the field of digital pedagogy. Reliability was assessed using Cronbach's α coefficient, which yielded a value of 0.87, indicating high internal consistency.

Testing before and after the experiment — the level of professional competence was assessed using a proprietary test consisting of 45 tasks covering nine criteria: theoretical knowledge, ability to use terminology, skills in solving practice-oriented tasks, logical thinking, analytical capabilities, methodological competence, information literacy, interdisciplinarity, and communication skills. The tasks were aligned with the educational objectives of the discipline. To increase objectivity, parallel forms of the test were used before and after the intervention.

Statistical analysis — Fisher's angular transformation (φ-criterion) was used to test the statistical significance of differences between groups, which is a relevant method for analysing proportional changes. The significance level was set at $p \leq 0.05$.

Thus, the use of a quasi-experimental design, valid and reliable instruments, and multi-stage measurement made it possible to reliably assess the causal impact of multimedia technologies on the formation of students' professional competence. The survey was conducted exclusively in the EG to avoid distortions in the assessment of students who had no experience working with MMD.

Results

The effectiveness of using multimedia technologies in the educational process was assessed through a comprehensive study of changes in students' professional competence levels. A repeated measurement was carried out at the stage of recording the experiment's results, which included 45 questions as the basis for analysing several criteria that determine professional competence. In particular, the level of theoretical knowledge, the ability to operate with terminology, skills in solving practically oriented tasks, experience in working with information resources, consistency of logical thinking, analytical capabilities, methodological competence, interdisciplinarity, and communication skills were assessed.

Based on these criteria, the CG and EG students were tested before and after the experiment. The testing results were used to evaluate the effectiveness of the applied learning approaches. All criteria underwent positive changes, especially in the aspects of practically-oriented skills (+30%), experience with information resources (+40%), and the level of communication skills (+25%). This confirms the effectiveness of the implemented teaching methods. The CG also had specific improvements, but they were less pronounced. The most minor changes are noticeable in the criteria of methodological competence, interdisciplinarity, and analytical skills (only +4-6%). In general, the obtained data demonstrate that the methods used in the EG significantly increased the level of students' training, especially in the practical aspects of professional activity. Detailed results are presented in Figures 1 and 2.

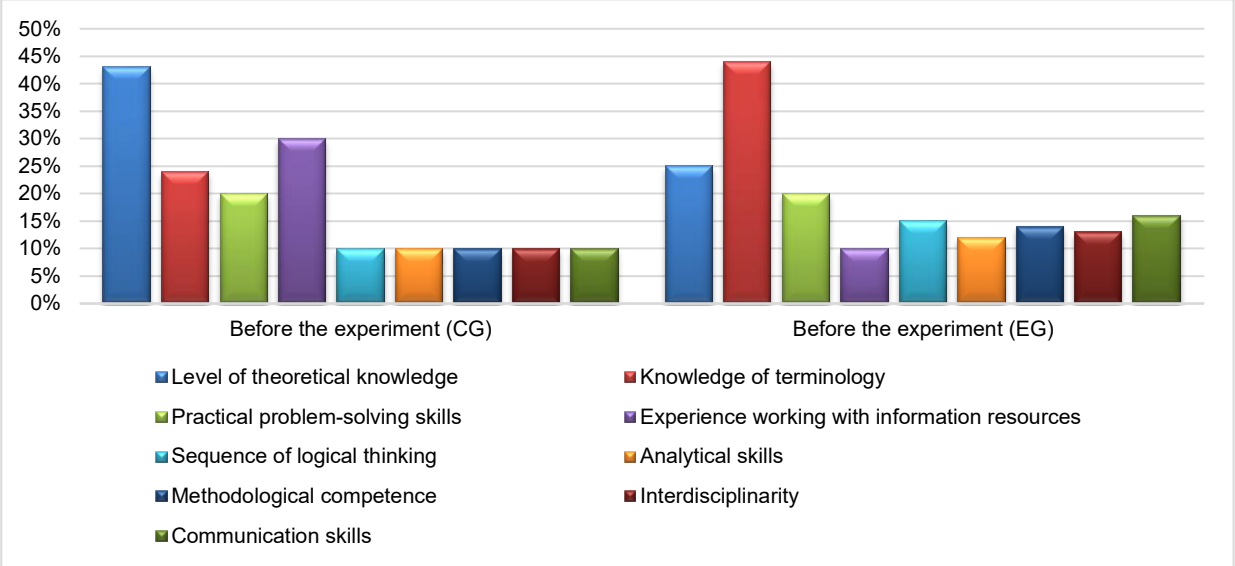

Figure 1. Assessment of the positive level of development of students' key competencies before the experiment.
Source: Developed by the author.

An analysis of the initial results for students in the control (CG) and experimental (EG) groups (Fig. 1) reveals noticeable differences in the level of development of specific key professional competencies, even before the start of pedagogical intervention. In particular, CG students had higher scores on the criteria of theoretical knowledge (43% in CG vs. 25% in EG) and experience with information resources (30% in CG vs. 10% in EG), indicating stronger analytical and theoretical foundations. At the same time, EG representatives demonstrated higher results in terms of knowledge of terminology (44% vs. 24%) and communication skills (16% vs. 10%), which may indicate a greater focus on interactive and practical components in their previous educational experience.

A preliminary analysis of the results also revealed that in both groups, the lowest scores were for methodological competence, analytical skills and interdisciplinarity (10–15%). These competencies belong to the higher cognitive level and are developed gradually, resulting in a minor increase in post-experimental testing, even with the active use of multimedia technologies.

To ensure the accuracy of the comparison of results between groups, homogeneity testing was performed using Fisher's criterion. The result φemp = 0.098 at φcrit = 1.64, with a significance level of 0.05, confirms the statistical absence of significant differences between CG and EG before the start of the experiment. This allows us to discuss the initial equivalence of the samples and justify the reliability of the results obtained.

Thus, despite some natural fluctuations, the initial positions of students in CG and EG were sufficiently comparable to conduct a quasi-experimental study, the results of which allow us to judge the effectiveness of using interactive multimedia technologies in developing professional competencies.

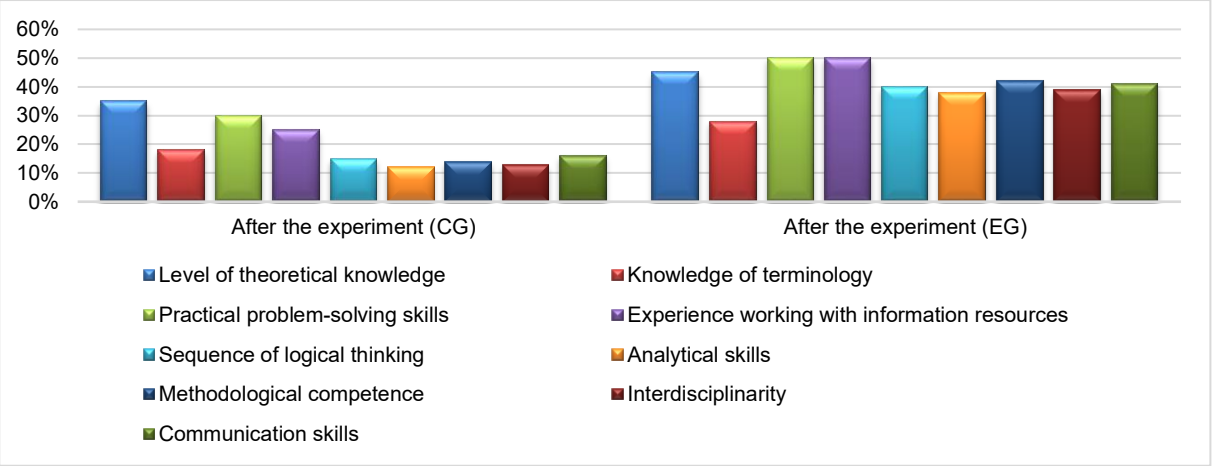

Figure 2. Assessment of the positive level of development of students' key competencies after the experiment.
Source: Developed by the author.

A comparative analysis of the results from the control (CG) and experimental (EG) groups, following the completion of the experiment, reveals a significant advantage for the EG in all criteria for assessing professional competencies. The most crucial progress is observed in the following competencies:

Practical problem-solving skills: 30% increase (from 20% to 50% in EG, compared to 30% in CG).

– Experience working with information resources: 40% increase (from 10% to 50% in EG, while in CG, only 25%).

Methodological competence: increased from 14% to 42% (+28%) in EG, compared to 14% in CG.

Analytical skills: growth from 12% to 38% (+26%) in EG.

Communication skills: 25% increase (from 16% to 41%), demonstrating the effectiveness of interactive methods.

These results confirm the hypothesis that the use of multimedia interactive whiteboards (MWBs) is particularly effective in developing applied and communicative skills, as opposed to purely theoretical knowledge.

In contrast, the smallest increase was observed in terms of 'knowledge of terminology' — only 4% (from 44% to 28% in the EG, compared to 18% in the CG). Several factors can explain this:

– High initial level in EG (44%), which limits growth potential under this criterion.

MWBs focus on visualisation and practical interaction rather than memorising terms.

The absence of specialised exercises in the programme specifically aimed at developing the vocal apparatus.

To verify the reliability of differences in competency progress between CG and EG, separate Fisher's exact tests were applied for each of the nine indicators. In all cases, the φemp value exceeded the critical value (1.64), which allows us to reject the null hypothesis of no statistically significant changes and confirm the effectiveness of implementing interactive technologies.

According to preliminary observations, MWBs are most effective in practical, interpersonal, and information-analytical areas that require visualisation, interactivity, adaptive tools, and rapid feedback — precisely the capabilities that MWBs provide.

Thus, the results confirm the conclusion that interactive technologies are disproportionately effective, with the most significant changes being achieved in applied competencies. At the same time, fundamental theoretical indicators remained stable or changed insignificantly.

Information on the overall test results (average percentage of the overall level of professional competence) before and after the experiment is presented in Table 10 and Figure 3.

Table 10.
Students' professional competence before and after the experiment

Item	Before the experiment		After the experiment	
	CG	EG	CG	EG
Students who failed the test	52% (78)	50% (75)	48% (72)	20% (30)
Students who passed the test	48% (72)	50% (75)	52% (78)	80% (120)

Source: Developed by the author.

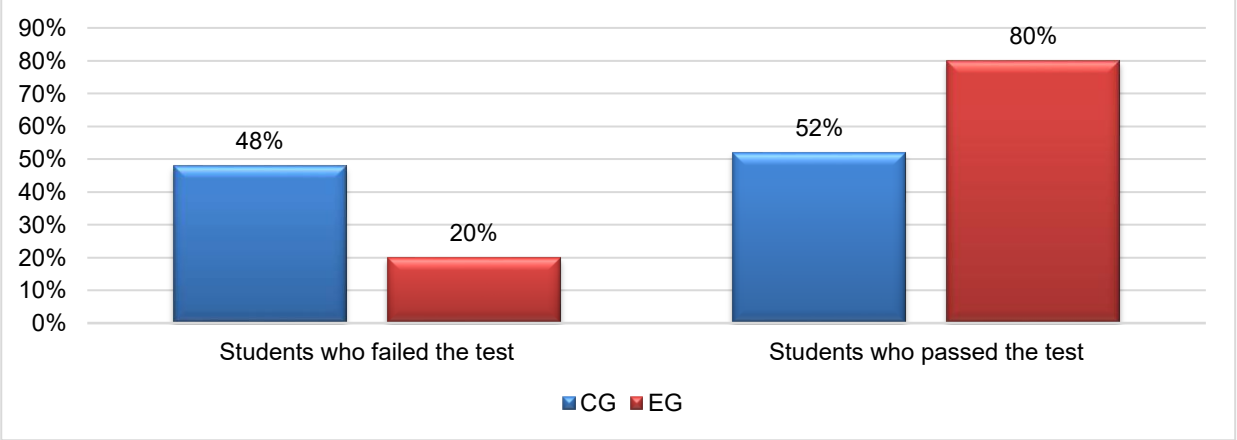

Figure 3. Results of testing students' professional competence after the experiment.
Source: Developed by the author.

The reliability of the results was checked using the Fisher test, which was performed using an online calculator.

The critical value of the Fisher test for a significance level of 0.05 ($f$crit) is 1.64.
The following hypotheses were put forward:

- H_0: the level of knowledge, skills and abilities that form the basis of professional competence of humanities students studying with the use of MWBs /projection systems (EG) is statistically no different from the level of students studying using traditional methods (CG).
- H_1: The level of development of knowledge, skills, and abilities in the EG students is higher than in the CG.

The empirical value of Fisher's test before the experiment was 0.098 ($f$emp = 0.098 < $f$crit = 1.64). Therefore, the null hypothesis (H_0) is accepted at the initial stage.

After the experiment, the value of Fisher's test was 2.465 ($f$emp = 2.465 > $f$crit = 1.64), which indicates the rejection of the hypothesis H_0 and the confirmation of the alternative hypothesis H_1.

Therefore, the differences in the levels of general, professional, and specialised competencies between the CG and EG students after the experiment are not accidental, but rather a natural consequence of the use of MWBs and projection systems in the educational process.

The survey on the impact of using MWBs and projection systems was conducted among EG students only, as they directly participated in the educational process using these technologies. Such tools were not used in the CG, which makes it inappropriate to survey their effectiveness on technologies with which they did not work.

Analysis of the results of the CG students' survey (Table 11) also indicates the high effectiveness of using MWBs and projection systems in teaching humanities. The highest average score was received for Question 10, which concerned the flexibility of using MWBs and projection systems, enabling work at an individual pace. The average score for this indicator was 4.28, confirming the significant positive impact of visual and interactive tools on students' interest.

Table 11.
Results of a study of the impact of using MWBs and projection systems in teaching humanities

Questions	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Average score
1. Using MWBs increases my involvement in discussions and active interaction during classes.	3	8	18	70	51	4.05
2. Interactive MWB opportunities improve my understanding of the learning material.	2	5	15	72	56	4.17
3. Using projection systems helps me perceive complex information more effectively through visualisation.	4	10	20	65	51	3.99
4. Interactive presentations and multimedia elements in classes enhance my learning motivation.	2	6	12	75	55	4.17
5. Sharing multimedia projects and assignments in classes helps me interact more actively with other students.	3	9	18	70	50	4.03
6. Access to recorded lectures using multimedia enables me to learn the material more effectively.	1	5	15	72	57	4.19
7. Using multimedia technologies makes lectures more interesting and exciting.	2	6	12	75	55	4.17
8. Personalised MWB functions (adaptive tasks, interactive exercises) meet my learning needs.	5	10	18	65	52	3.99
9. Using multimedia helps me to better prepare for independent work and tests.	3	7	15	70	55	4.11
10. Flexibility in the use of MWB and projection systems allows me to work at my own pace.	1	3	10	75	61	4.28

Source: Developed by the author

The lowest average score was recorded for Question 3, which assessed the ability of projection systems to facilitate better perception of complex information through visualisation. Despite this, the average score of 3.99 also indicates that students have a positive perception of the use of projection technologies in the learning process.

Other indicators also show high scores. For example, Questions 6 (4.19) and 7 (4.17) indicate that students highly value the ability to access recorded lectures and consider multimedia technologies to be a key factor in making the learning process more interesting. Overall, the obtained data confirm that MWBs and projection systems have a significant positive impact on the learning process, contributing to enhanced motivation, engagement, and increased quality of learning.

Discussion

The results obtained confirm several conclusions from previous studies regarding the positive impact of digital technologies on the quality of the educational process. According to Williams et al. (2023), the use of multimedia increases student engagement. In our study, this aspect is confirmed by high ratings in the questionnaire (average score 4.17–4.28), especially in terms of flexibility to work at one's own pace. The study by Gurantz et al. (2020) emphasises the link between interactive technologies and the growth of students' practical success, which is consistent with our result of a 30% increase in practical skills in the EG.

Khan et al. (2019) substantiate the effectiveness of interactive whiteboards in developing professional competence. Our study confirms this, as the communication skills of EG students increased by 25%. Hendawi & Nosair (2020) also point to the significant positive impact of MWBs on academic performance, which correlates with our indicator of improvement in information resource skills (+40%).

The theoretical value of these results can be viewed through the prism of J. Bruner's ideas (Bruner, 1966), who emphasised active student participation in the learning process, a constructivist approach to cognition, and the importance of creating ‘learning situations’ that stimulate thinking. The use of MWB creates an environment where students are not passive consumers of knowledge, but instead participate in the visualisation, analysis, discussion, and application of the material. This is consistent with Bruner's spiral learning concept, which posits that each new concept builds upon prior knowledge, allowing complex cognitive structures to be formed in a more convenient and accessible manner. The theoretical and methodological basis for understanding these results is expanded by the conclusions obtained in the works of Córdova Lapo & Lino Pérez (2024), which emphasise the role of interactivity as a key factor in actively engaging students in the learning process, particularly when using virtual whiteboards 2.0.

Arguello Mogrovejo & Vásquez Guerra (2023), summarising meta-analysis data, argue that the impact of digital technologies in the educational process depends not only on the type of tool but also on pedagogical design. In turn, Concha Abarca et al. (2023) emphasise the importance of digital tools for ensuring the inclusiveness and adaptability of the learning environment. Finally, Velasteguí López (2019) emphasises that digital whiteboards in higher education contribute to increased didactic effectiveness through visualisation, interactivity and personalisation of content. All these statements are consistent with the findings of our study, particularly regarding the high practical and communicative effectiveness of MWBs, as well as the need for clearer methodological design for the development of theoretical knowledge.

At the same time, specific results of our study indicate the need for a more critical analysis. For example, knowledge of terminology improved by only 4%, despite overall progress in most competencies. This may be due to the following factors: a high initial level for this criterion in the EG (44%), which limited growth potential; the indirect influence of multimedia boards on vocabulary formation; and the absence of targeted lexical tasks in the teaching materials.

This imbalance between applied and theoretical results allows us to draw an important conclusion: MWBs proved to be particularly effective for the development of practical, communicative, and information-

analytical competencies, while basic theoretical knowledge requires additional methodological approaches, possibly a traditional component or a hybrid model.

However, as noted by Alzubi (2023) and Wong et al. (2023), the effectiveness of multimedia tools largely depends on students' digital literacy. This may explain the lower scores on some parameters (for example, the use of personalised MWB features received only 3.99 points). Tang et al. (2023) and Zhylin et al. (2023) emphasise that the success of interactive technologies also depends on the level of teacher training — our results confirm this, as EG students demonstrated significantly higher results after the targeted use of multimedia in teaching.

It is worth noting the methodological limitations of the study:

Non-randomised nature of the sample: the formation of the CG and EG was not random, which potentially influenced the results.

Initial differences between groups: although Fisher's test did not reveal any statistically significant differences, graphical analysis (Fig. 1) shows differences in individual competencies prior to the experiment.

Possible measurement errors: the assessment tools used were based on questionnaires and tests without additional standardisation.

Lack of control over maturation effects: changes could have been caused not only by the influence of MWB, but also by the natural development of students during the semester.

Contextual factors, including differences between educational institutions, teaching styles, previous experience, as well as the level of digital culture and infrastructure, can significantly influence the perception and effectiveness of technologies.

Thus, although the study's results generally demonstrate the high effectiveness of interactive technologies in teaching humanities disciplines, their impact appears to be selective, with greater benefits for applied skills than for purely theoretical knowledge.

Therefore, interactive multimedia whiteboards (MWBs) are effective mainly for developing practical and communication skills. The formation of terminological and theoretical knowledge requires separate tools and cannot be based solely on visualisation. Teachers require specialised training to effectively integrate digital technologies into the learning process, taking into account the subject-specific aspects. It is essential to consider students' digital readiness when working with such tools.

Recommendations

The use of multimedia boards and projection systems is advisable to increase student engagement, improve understanding of the material, and visualise complex concepts. The effectiveness of learning increases due to interactive elements, personalised tasks, and access to recorded lectures. It is advisable to implement joint multimedia projects that enhance the development of communication skills and foster group interaction.

Conclusions

The study confirmed the positive impact of multimedia technologies on the development of students' professional competence, particularly in the development of practically oriented skills, the ability to work with information resources, and communication skills. All criteria demonstrated positive dynamics during the study, with particular increases in practically-oriented skills (by 30%), experience with information

resources (by 40%), and the level of communication skills (by 25%). A comparative analysis of the results of the CG and EG revealed statistically significant differences in the level of professional competence development (φcrit = 1.64 < φemp = 2.418). The use of MWBs contributed to a considerable increase in students' competence, active involvement in the educational process, and effective completion of practical tasks. The survey confirmed that multimedia technologies have a positive effect on motivation, involvement and understanding of the material (average score 4.17–4.28). Their flexibility in learning received the highest score (4.28), while personalised features received the lowest score (3.99)

The study confirmed the positive impact of interactive multimedia technologies on the development of students' professional competence in the field of humanities education. At the same time, the results should be interpreted with consideration for the specifics of the research design. The quasi-experimental approach did not involve randomisation, which, to some extent, limits the possibilities for complete control over all external factors. It is also worth considering the possible influence of factors such as students' digital literacy, their previous experience, the specifics of teaching individual disciplines, and the educational context of the participating universities.

The results of the study are essential for teaching practice in higher education institutions, particularly those specialising in the humanities. They demonstrate the feasibility of integrating multimedia technologies into the process of developing applied, informational-analytical, and interpersonal competencies. At the same time, less pronounced improvement in the acquisition of terminological material indicates the need to combine interactive tools with methods aimed at systematic work with the conceptual apparatus.

The scientific novelty lies in the empirical substantiation of the specific impact of multimedia solutions on various components of students' professional competence. The practical value lies in identifying effective approaches to increasing engagement, motivation and learning effectiveness through visual and digital resources.

In further research, it is advisable to focus on several areas that will deepen our understanding of the effectiveness of interactive multimedia technologies in the educational process. Firstly, randomised experiments should be conducted, taking into account the control of maturation effects, which will ensure the higher reliability of conclusions and avoid distortion of results associated with the natural development of students during the learning period.

Further research may focus on assessing the long-term impact of interactive technologies in various fields of humanitarian education and their role in the training of specialists. Of particular interest is the study of the effects of students' digital literacy levels on the assimilation of various types of educational content, including theoretical, practical, glossary, and analytical content. This approach will enable digital tools to be more effectively tailored to the needs of specific audiences. Another promising area is analysing the effectiveness of combining interactive multimedia boards with other pedagogical strategies, such as gamification, project-based or blended learning, which could potentially increase student engagement and ensure comprehensive competence development. In addition, a relevant area of research is the comparison of the results of using multimedia technologies in different educational environments, including technical and humanitarian specialities, urban and rural institutions, with varying levels of material and technical support. Such an analysis will enable the formulation of differentiated educational strategies for implementing digital tools in the learning process.

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