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Multimodal digital technologies in teaching reading and listening to pre-service foreign language teachers

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Abstract. The rapid transition to distance and blended learning in Ukrainian higher education, accelerated by the martial-law conditions since 2022, has exposed a persistent gap between traditional print-based instruction and the multimodal digital environment in which future foreign language teachers will actually work. The purpose of the research is to develop and empirically validate a pedagogical model for the use of multimodal ICT tools to teach reading and listening to pre-service foreign language teachers at higher education institutions in Ukraine. The study combines theoretical methods of analysis, synthesis, and comparative analysis of Ukrainian and foreign experience with an empirical pedagogical experiment involving diagnostic and formative stages, questionnaires, classroom observations, and standardized reading and listening comprehension tests, processed through independent-samples t-tests, Cohen's d, and Cronbach's alpha using IBM SPSS Statistics 27. The experiment involved 112 second-year students of the Faculty of Foreign Languages at Ternopil Volodymyr Hnatiuk National Pedagogical University, divided into an experimental group (n = 56) and a control group (n = 56), together with a survey of 16 university instructors. After the formative stage, the experimental group demonstrated statistically significant improvement over the control group on all measured indicators ($p < .001$), with reading scores rising by 24.2% and listening scores by 27.2%, compared with negligible, non-significant gains of 2.8% and 3.1% in the control group; effect sizes exceeded Cohen's $d = 1.6$ for every indicator, reaching the highest values for strategic listening ($d = 2.18$) and comprehension of the main idea ($d = 2.04$). Students rated subtitled video podcasts and interactive hybrid-text platforms as the most useful tools, while only 31.2% of surveyed instructors considered themselves methodologically prepared to integrate multimodal technologies, revealing a systemic gap between available resources and teachers' digital-pedagogical readiness. The scientific novelty lies in the development of a structural-functional pedagogical model with a synchronized system of instructional conditions that, unlike existing sequential approaches, ensures the parallel and simultaneous development of reading and listening skills through the same authentic multimodal content, refining criteria for integrating auditory, visual, and textual channels while managing cognitive load and fostering metacognitive strategies. The practical significance of the study is that the proposed model and its set of predominantly free digital resources can be directly implemented by university instructors of practical language courses and foreign language teaching methodology

and used to update methodology-oriented courses and teaching materials within teacher education programmes.

Keywords: multimodal learning, digital technologies, receptive language skills, reading comprehension, listening comprehension, pre-service foreign language teachers, cognitive theory of multimedia learning, pedagogical model, ICT tools, higher education, digital literacy.

Мультимодальні цифрові технології у навчанні читання та аудіювання майбутніх учителів іноземних мов

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Анотація. Стрімкий перехід закладів вищої освіти України до дистанційного та змішаного навчання в умовах воєнного стану, що триває з 2022 року, оголив стійкий розрив між традиційним друкованим форматом підготовки й реальним мультимодальним цифровим середовищем, у якому доведеться працювати майбутнім учителям іноземних мов. Метою дослідження є розроблення та емпірична перевірка педагогічної моделі використання мультимодальних ІКТ-засобів у навчанні читання й аудіювання майбутніх учителів іноземних мов у закладах вищої освіти України. У дослідженні поєднано теоретичні методи аналізу, синтезу та порівняльного аналізу українського й зарубіжного досвіду з емпіричним педагогічним експериментом, що включав діагностувальний і формувальний етапи, анкетування студентів і викладачів, спостереження за навчальним процесом та стандартизовані тести читання й аудіювання, оброблені за допомогою t-критерію для незалежних вибірок, коефіцієнта Коена d та коефіцієнта альфа Кронбаха в IBM SPSS Statistics 27. В експерименті взяли участь 112 студентів другого курсу факультету іноземних мов Тернопільського національного педагогічного університету імені Володимира Гнатюка, поділених на експериментальну (n = 56) та контрольну (n = 56) групи, а також 16 викладачів університету, опитаних щодо методичної готовності. Після завершення формувального етапу експериментальна група продемонструвала статистично значущі переваги над контрольною за всіма показниками (p < .001): результати з читання зросли на 24,2%, з аудіювання — на 27,2%, тоді як у контрольній групі приріст був незначним і статистично незначущим (2,8% і 3,1% відповідно); розмір ефекту за Коеном перевищив d = 1,6 для всіх показників, досягнувши найвищих значень для стратегічного аудіювання (d = 2,18) та розуміння основної думки (d = 2,04). Студенти найвище оцінили відеоподкасти із субтитрами та інтерактивну платформу для читання гібридних текстів, тоді як лише 31,2% опитаних викладачів вважали себе методично готовими системно впроваджувати мультимодальні технології, що засвідчило системний розрив між наявністю цифрових ресурсів і рівнем цифрово-педагогічної компетентності викладачів. Наукова новизна полягає у розробленні структурно-функціональної педагогічної моделі

та узгодженої системи педагогічних умов, яка, на відміну від наявних послідовних підходів, забезпечує паралельний і одночасний розвиток навичок читання й аудіювання на основі опрацювання одного й того самого автентичного матеріалу через слуховий, зоровий і текстовий канали, а також удосконалює критерії інтеграції цих каналів з урахуванням регулювання когнітивного навантаження та формування метакогнітивних стратегій навчання. Практичне значення дослідження полягає в тому, що запропонована модель і переважно безкоштовні цифрові ресурси можуть бути безпосередньо використані викладачами практичних мовних курсів і методики навчання іноземних мов, а також слугувати основою для оновлення методичних дисциплін і навчальних матеріалів у програмах педагогічної освіти.

Ключові слова: мультимодальне навчання, цифрові технології, рецептивні мовленнєві вміння, читання, аудіювання, майбутні вчителі іноземних мов, когнітивна теорія мультимедійного навчання, педагогічна модель, ІКТ-засоби, заклади вищої освіти, цифрова грамотність.

Introduction

Relevance of the problem. The implementation of martial law in 2022 forced Ukrainian institutions of higher education to transition rapidly to distance and blended learning formats. That shift was not a gradual, carefully planned process. Instead, it was done under the pressure of exceptional circumstances and showed weaknesses that might not have been revealed for years otherwise. The preparation of future teachers of foreign languages is one of the most important problems. Today, teachers operate in a digital information environment that provides text, audio, and visual content concurrently, unlike traditional printed textbooks. In such an environment, digital and foreign language competencies are necessary to go beyond advanced language proficiency. They also cover the ability to organize the study process for future foreign language teachers in multimodal contexts and to select appropriate digital teaching tools, in line with specific pedagogical objectives.

Reading and listening are the two basic receptive abilities that form the foundation of the professional competence of future foreign language teachers. These skills help learners to look at, comprehend, and critically question real information. However, educational practice still largely depends on printed texts and isolated audio recordings, a format that does not reflect the digital context in which graduates will be expected to teach. This study primarily aims to address the disparity between current teacher education practices and the realities of the contemporary digital environment.

Literature Review. Research on the digitalization of education has grown considerably in recent years, but the theoretical and methodological basis for the purposeful development of reading and listening skills through multimodal ICT tools in pre-service foreign language teacher education is much less developed. The present study is based on the cognitive theory of multimedia learning by R. Mayer [1]. According to this hypothesis, individuals process information in two largely separate channels (verbal and visual), and each channel has finite processing capability. The integrated use of both channels prompts deeper cognitive processing and the development of more cohesive mental images than using a single modality alone. Mayer's theory has become one of the most empirically validated frameworks for the design of multimedia learning environments over the years. This is the first of the four pedagogical requirements underpinning the proposed model, the systematic incorporation of authentic multimodal resources based on the semantic congruence of modalities. The meta-analysis conducted by V. Rahmanu and D. Molnar [2], which reviewed 34 studies conducted between 2013 and 2024, showed a consistent positive correlation between the use of multimodal educational strategies and improvements in students' language skills. They found that the success of instruction is not dependent on the amount of ICT tools used but rather on the extent to which the tools are meaningfully embedded in the pedagogical design of the learning

activities. This result became one of the major methodological bases of the instructional approach suggested in the present study.

The second conceptual basis is 'multimodal composing,' developed by J. Lim and M. Kessler [3]. Working with hybrid, multichannel information, where meaning arises through the interplay of verbal, visual, and interactive forms, has become an increasingly significant part of students' language and reading skills. In line with the findings of Rahmanu and Molnar, this position suggests that multimodality should not be seen as a technology-related enrichment but as a basic concept for the organization of instructional content. One reading-teaching technique that is particularly well supported is 'reading while listening' (RWL). Reading and listening are done simultaneously. F. Teng compared traditional reading with the RWL approach and demonstrated that the presence of synchronized audio support significantly enhanced incidental vocabulary acquisition [4]. In an eye-tracking study, Pellicer-Sánchez et al. further clarify the underlying mechanism, reporting that audio support alters readers' visual processing, reducing the cognitive load of lexical recognition and freeing cognitive resources for deeper text understanding [5]. These results fit Mayer's concepts of dual-channel information processing perfectly.

Similar trends have been found in research on video-based listening teaching. Researcher Y. Li states that learners with varying levels of language proficiency allocate their attention differently between subtitles and the audio track and that the complexity of visual information significantly influences their reliance on textual support [6]. The success of subtitled video, therefore, rests not on the availability of subtitles but on the suitability of materials to the learners' language proficiency. Similarly, S. Kang found that adolescents who produced their own multimodal video projects improved their digital literacy and motivation to learn [7]. This indicates that the productive use of multimodal resources can be as educationally beneficial as their receptive use.

The second pedagogical requirement included in the proposed model, the stepwise modulation of multimodal task complexity, is based on the cognitive load theory by J. Sweller. This hypothesis suggests that if instructional tasks are not delivered progressively and systematically, an uncontrolled influx of information concurrently offered through multiple modalities may overtax learners' cognitive capacity and inhibit learning [8]. Reading while watching a subtitled video further enhances the instructional benefits. In her comprehensive analysis, M. Montero Pérez [9] concludes that the effect of on-screen text on listening comprehension and vocabulary development is determined by the type of subtitle, level of learners' competency, and the pedagogical design of the associated learning tasks. This conclusion is similar to Li's findings on the influence of language skill on the distribution of learners' attention between subtitles and spoken input [6].

The third pedagogical prerequisite of the proposed model, the formation of metacognitive learning strategies, is corroborated by the meta-analysis of M. Dalman and L. Plonsky, who verified the favourable effect of explicit listening-strategy teaching with statistical significance [10]. They demonstrated the positive influence of extensive listening to podcasts, combined with reflective learning activities, on students' listening comprehension and motivation to study. These findings justified the inclusion of a separate teaching component in the suggested paradigm, namely, the use of podcasts with transcripts.

Ukrainian researchers have also contributed to the study of multimodality and ICT integration in language teaching. K. Mulyk confirms the efficiency of the multimodal method in teaching English for Specific Purposes [11]. In their research on mobile language-learning applications, V. Levkivskyi et al. [12] and L. Petryk et al. [13] demonstrate the increased integration of mobile technologies into Ukrainian educational practice, but not in the context of pre-service foreign-language teacher education.

Another major line of research is the preparation of instructors themselves to work efficiently with multimodal educational tools. Using the DigCompEdu framework, H. Cabero-

Almenara et al. showed that teachers' digital competence is more significantly related to systematic professional training than to years of experience with educational technologies [14]. The study by S. I. Kuru-Gönen and G. Zeybek showed that training pre-service teachers in mobile multimodal learning had a substantial effect on their confidence in using digital technology [15]. In addition, L. Lim Wa and H. Hashim found a favourable correlation between digital pedagogy competence and instructors' intention to implement educational technology into their future teaching practice [16]. Complementing this, E. Bozavlı demonstrated that the targeted use of specific digital formats, such as intensive podcast listening, not only enhances students' language comprehension skills but also has a profound positive impact on their motivation to learn [17]. Taken together, these findings demonstrate that access to technology does not assure its pedagogically effective usage. Hence, the suggested instructional model includes not only the student-centered dimension but also a teacher-oriented dimension, consisting of a survey of sixteen university teachers concerning their methodological readiness to apply multimodal education

Overall, the present evidence reveals the great instructional potential of multimodal technologies. However, most prior research treats reading and listening as independent methodological spheres. To date, no comprehensive instructional model for their integrated development has been proposed, and empirical evidence from student samples at Ukrainian teacher education institutions is exceedingly scarce.

Research gap. Nowadays, digital technologies for language education are becoming increasingly available. However, the pedagogical conditions and the comprehensive methodological model for combining multimodal ICT tools in the professional preparation of pre-service foreign language teachers at Ukrainian higher education institutions remain insufficiently developed. The problem here is not the lack of technology resources. The problem is the lack of an instructional style that would enable the simultaneous development of reading and listening abilities, rather than sequentially and in isolation, in a digital learning environment.

The aim of the research is to develop and empirically validate a pedagogical model for using multimodal ICT tools to teach reading and listening to future foreign language instructors at higher education institutions in Ukraine.

The scientific novelty of the study is briefly outlined here and elaborated in the Discussion section in light of the obtained empirical results: the research proposes a structural-functional pedagogical model that ensures the parallel, rather than sequential, development of reading and listening skills through shared authentic multimodal content.

The practical relevance of the study is briefly outlined here and elaborated in the Discussion section in light of the obtained empirical results: the proposed model and its instructional materials are designed for direct use by university teachers of practical language courses and foreign language teaching methodology.

Methodology

Research methods. The research was carried out on three interrelated methodological levels. At the theoretical level, literature on receptive language skills development, multimodal learning, and digital pedagogy was reviewed through methods of analysis and synthesis. The comparative analysis was used to examine the Ukrainian and foreign experiences with multimodal technologies in teaching foreign languages.

Empirically, the study was conducted through a pedagogical experiment, which included diagnostic (pre-test) and formative stages, questionnaires for students and teachers, classroom observations, and standardized tests of reading and listening comprehension. The reading test evaluated students' abilities to recognize the main concept, understand detailed material, infer the meaning of unfamiliar terms in context, and critically evaluate written texts. The listening test tested understanding of actual dialogues, monologues, and multi-speaker conversations.

We performed an independent-samples t-test to evaluate whether group differences were statistically significant at the .05 level and calculated Cohen's d to measure the effect size. The internal consistency of the digital literacy self-assessment questionnaire was assessed using Cronbach's alpha.

Data sources. The empirical data were collected during a one-semester pedagogical experiment at the Faculty of Foreign Languages at Ternopil Volodymyr Hnatiuk National Pedagogical University. The students of the second course on the specialties "014 Secondary Education (English Language, German/French Languages and Literatures, Foreign Literature)" and "035 Philology (Germanic Languages and Literatures (Translation Included)". The study included 112 second-year students, including 56 in the experimental group (EG) and 56 in the control group (CG). Group allocation was at the level of entire academic cohorts, not through individual random allocation, as the random dispersal of students across existing classrooms was organizationally infeasible. This quasi-experimental design is well-acknowledged in educational research conducted in authentic teaching settings.

The sample size was justified based on the availability of cohorts and a statistical power analysis. Based on a priori calculations ($\alpha = .05$, anticipated effect size $d \approx 0.50$, statistical power = .80), a minimum of 51 participants per group were needed. Thus, the real sample fulfilled the requisite statistical criteria. The diagnostic phase indicated that the groups did not differ substantially in reading ($t(110) = 0.35$, $p = .73$) or listening comprehension ($t(110) = 0.34$, $p = .74$) prior to the intervention, establishing baseline similarity. In addition, a questionnaire was administered to 16 university instructors in the Department of Foreign Languages, examining the teachers' methodological preparedness for using multimodal instructional technology.

Tools of the analysis. Statistical analyses were performed using IBM SPSS Statistics 27, and initial data entry and organization were performed in Microsoft Excel 365. The normality of the data distribution was assessed using the Kolmogorov-Smirnov test, with all values exceeding the significance threshold ($p > .05$), thus validating the use of parametric statistical procedures.

The effect size was determined using Cohen's method ($d = (M1 - M2) / S_{pooled}$), and the reliability of the digital literacy questionnaire was assessed using Cronbach's alpha ($\alpha = .86$), indicating good internal consistency.

Within the research, the pedagogical model was constructed in four successive stages. *The analytical-diagnostic stage* was represented by a theoretical review of the basic principles of multimodal learning [2-4, 12] and a diagnostic assessment, which confirmed the equivalence of the experimental and control groups and the absence of integrated approaches to the comprehensive development of reading and listening skills. During *the instructional design phase*, the objectives, pedagogical conditions, and structural components of the model were identified. The digital learning resources were selected based on the following criteria: pedagogical relevance, compatibility with the professional content of foreign-language teacher education, appropriateness for students at CEFR proficiency levels B1-B2, free access, and the option to increase task complexity. *The experimental implementation stage* was accomplished by applying the proposed model in the formative stage of the pedagogical experiment. Finally, in *the assessment phase*, the experimental results were statistically analyzed and interpreted. This phase also allowed the proportional distribution of the three instructional phases included in the model to be adjusted.

The proposed model comprises four interrelated components (see Fig. 1). Together, they provide a cohesive framework for the integrated development of reading and listening skills through the deliberate use of multimodal ICT technologies.

(1) The goal-oriented component defines the model's general goal as developing reading and listening comprehension simultaneously, while providing for four pedagogical conditions that enable its realization.

(2) The content-technological component covers the digital resources used in the teaching process and the principles for their selection. The learning environment offers subtitled video podcasts, brief instructional films, platforms for reading multimodal texts, reading-while-listening resources, and podcasts with transcripts. Resources are chosen for their pedagogical relevance, suitability for CEFR B1-B2 learners, availability, and ability to support more complex learning tasks.

(3) The procedural component is implemented in a three-stage lesson sequence. The pre-text stage involves activating prior knowledge and making predictions based on titles, key phrases, and visual cues. At the text level, students work on comprehension problems ranging from global understanding to detailed interpretation and inference. The post-textual phase includes reflection, comparison between textual and audiovisual representations of the same topic, and brief production activities (summaries, commentaries, or mini-podcasts). All stages address management of cognitive load and development of metacognitive awareness.

(4) The Diagnostic-Outcome Component offers the assessment framework. Reading is assessed through activities that test general and specific understanding, the interpretation of language in context, and the ability to analyze texts critically. A listening examination includes comprehension of actual dialogues, monologues, and multi-speaker conversations. Achievement tests, surveys, and classroom observations are used to collect evidence of learning, and the data are analyzed statistically using independent-samples t-tests, Cohen's d, and Cronbach's alpha.

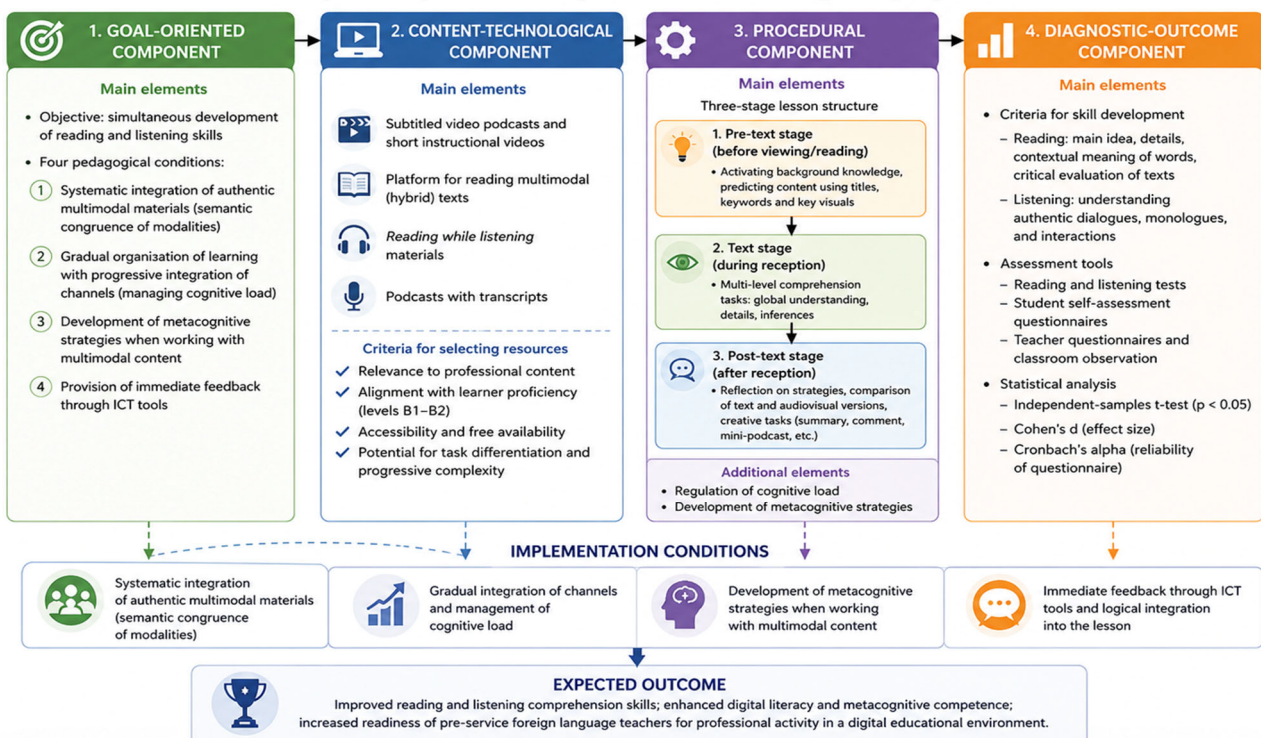


Figure 1. Structure of the pedagogical model for the integration of multimodal ICT tools in teaching reading and listening to pre-service foreign language teachers

The model is implemented through a set of shared instructional principles linking the four components: meaningful integration of multimodal resources, gradual increase in learning complexity, systematic development of metacognitive skills, and continual ICT-supported feedback. It is built on four interconnected pedagogical conditions. The first is the systematic incorporation of actual multimodal resources into the teaching process, based on the semantic congruence of modalities. This condition is based on Mayer's Cognitive Theory of Multimedia Learning, which assumes that information is processed through two complementary, limited-

capacity channels and that the meaningful integration of verbal and visual information promotes learning outcomes [1]. The second condition is the stepwise modulation of multimodal task complexity, informed by Sweller's cognitive load theory, which warns that an uncontrolled, simultaneous influx of information across multiple modalities can overtax learners' processing capacity and impede learning [8]. The third is the systematic formation of metacognitive learning strategies, supported by the meta-analysis of Dalman and Plonsky, who demonstrated the positive effect of explicit strategy instruction on listening comprehension and learner motivation [10]. The fourth is the provision of continual, ICT-supported feedback, which allows the pace and complexity of multimodal tasks to be adjusted in response to learners' ongoing performance.

Limitations of the study. The results are restricted to second-year pre-service foreign language teachers at Ukrainian higher education institutions with English proficiency at CEFR levels B1–B2. Hence, the results cannot be extended to students in more advanced stages of teacher education, to learners in other academic subjects, or to other educational settings without further empirical research. An additional limitation concerns the quasi-experimental design itself. Because group allocation was carried out at the level of intact academic cohorts rather than through individual randomization, the observed differences between the experimental and control groups cannot be fully disentangled from potential confounding factors such as instructor effects, group dynamics, or pre-existing informal peer-learning practices within each cohort. Although the diagnostic stage confirmed baseline equivalence between the groups on the measured reading and listening indicators, unmeasured group-level variables cannot be ruled out as partial contributors to the observed effect. Future studies could mitigate this threat to internal validity through multi-instructor, multi-cohort designs or through statistical control for the instructor as a random effect.

Results

During the assessment phase, the baseline level of reading and listening skills was determined for both groups. The average score on the reading test in the experimental group was 61.5 (SD = 8.2), and in the control group, 61.0 (SD = 8.5); on the listening test, the scores were 58.9 (SD = 9.0) and 58.3 (SD = 9.3), respectively. No statistically significant differences were found between the groups ($p > 0.05$ for both indicators), confirming initial equivalence. The demographic and background characteristics of the sample are summarized in Table 1, while the results of the formative-stage testing are presented in Table 2 below.

Table 1

Distribution of study participants

Indicators	EG (n = 56)	CG (n = 56)	Total (n = 112)
Women	44 (78.6%)	43 (76.8%)	87 (77.7%)
Men	12 (21.4%)	13 (23.2%)	25 (22.3%)
Average age	18.3	18.4	18.4
Level of foreign language (CEFR)	B1–B2	B1–B2	B1–B2

The data in Table 2 show statistically significant differences between the experimental and control groups for all measured indicators ($p < 0.001$). The effect size (Cohen's d) exceeds 1.6 in all cases, a very high value on Cohen's scale, confirming the practical significance of the differences, not just their statistical significance.

The increase in scores on the unified exam from the diagnostic to the formative stage was as follows: for reading, 24.2% (from 61.5 to 76.4 points); for listening, 27.2% (from 58.9 to 74.9 points). In the control group, the increase was significantly more modest: 2.8% in reading (from 61.0 to 62.7) and 3.1% in listening (from 58.3 to 60.1), which was not statistically significant ($p > 0.05$).

Table 2

Results of the reading and listening tests (formative stage)

Indicators	EG (M ± SD)	CG (M ± SD)	t	Cohen's d
Reading score (max. 100)	76.4 ± 7.1	62.7 ± 8.3	9.39*	1.77
Listening score (max. 100)	74.9 ± 7.9	60.1 ± 9.0	9.25*	1.75
Comprehension of the main idea, %	82.6 ± 6.5	66.9 ± 8.7	10.82*	2.04
Comprehension of textual details, %	77.3 ± 7.6	61.8 ± 9.0	9.85*	1.86
Comprehension of implicit information, %	69.8 ± 9.3	53.6 ± 10.1	8.83*	1.67
Strategic listening, %	77.9 ± 8.0	58.4 ± 9.8	11.53*	2.18

* $p < .001$

A comparative analysis of the effectiveness of individual components of the model (Fig. 2) showed statistically significant gains across all measured components in the EG, with the largest increases recorded for strategic listening (+17.1%) and comprehension of the main idea (+16.0%), while gains for the remaining components were more moderate but still substantial. In the CG, by contrast, the increase for any component did not exceed 3.1%, and none of the observed changes reached statistical significance.

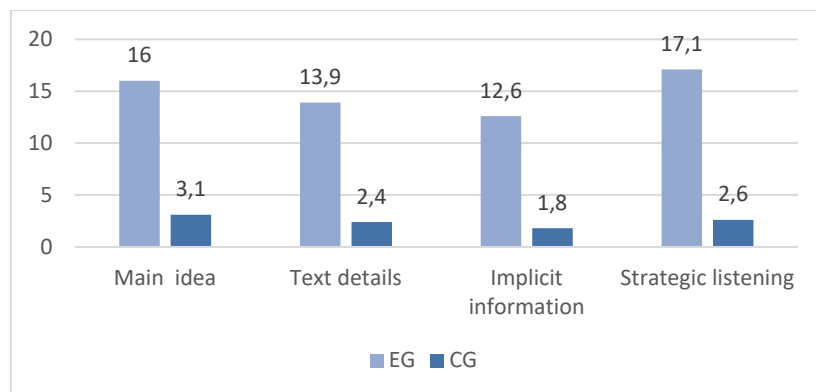


Fig. 2. Improvement in reading and listening scores in the experimental group and control group (in %)

Survey of experimental group students (n = 56) after the formative stage: 85.7% rated the effectiveness of multimodal ICT tools for listening comprehension as "high" or "very high," and 80.4% did so for reading comprehension. Students rated video podcasts with subtitles the highest (91.1% positive responses), followed by an interactive platform for reading hybrid texts (85.7%), video materials with embedded exercises (78.6%), and educational podcasts with transcripts (75.0%).

The survey of university instructors revealed a substantial gap between the perceived importance of multimodal ICT tools and instructors' own methodological preparedness to implement them. Survey of instructors (n = 16): 75.0% consider the integration of multimodal ICT tools to be "necessary" or "very important" for modern foreign language instruction. 68.8% of respondents acknowledged lacking the methodological readiness to apply these tools systematically. 62.5% cited a lack of teaching materials adapted to the conditions at domestic higher education institutions. This discrepancy between instructors' recognition of the pedagogical value of multimodal technologies and their self-reported readiness to apply them systematically is one of the most practically significant findings of the study, as it identifies teacher preparedness, rather than resource availability, as the primary bottleneck to the wider implementation of multimodal instruction in Ukrainian higher education institutions.

Self-assessment of digital literacy (15 statements, a five-point Likert scale, $\alpha = 0.86$) increased in the experimental group from 3.1 to 4.3 points; in the control group, the change was insignificant, from 3.0 to 3.3 points. The greatest increase in the experimental group was observed for statements regarding the ability to create one's own multimodal content and to critically evaluate the reliability of multimedia information.

Discussion

Interpretation of the results. The statistically significant improvement in the EG's receptive skills can be attributed to the systematic integration of multimodal ICT tools, which simultaneously engage auditory and visual information-processing channels. These findings support Mayer's Cognitive Theory of Multimedia Learning [1], which holds that combining words and images leads to deeper understanding and better retention than using a single perceptual channel. The most pronounced gains in identifying the main idea and strategic listening can be explained using subtitled video materials, which enable learners to follow the global structure of discourse through both auditory and visual input while reducing cognitive load when processing lexically demanding segments.

Comparison with Previous Research. The improvement in listening comprehension (27.2% in the EG) is consistent with the findings of Rahmanu and Molnár's systematic review, which confirmed the positive impact of multimodal strategies on students' language competence [2]. The reading results also align with the conclusions of Pellicer-Sánchez et al. [5] and demonstrate that auditory support accompanying written texts reduces the cognitive effort required for lexical recognition, thereby allowing learners to allocate more cognitive resources to higher-level text comprehension. This interpretation is further supported by the greater improvement observed in the EG in inference-making and comprehension of textual details compared with the CG. The increase in strategic listening is consistent with the findings of Li [6] and Montero Perez [9], who reported that the effectiveness of subtitled videos depends largely on learners' language proficiency. Since participants in the present study demonstrated comparable B1–B2 proficiency levels, the instructional intervention yielded relatively homogeneous learning outcomes. The largest improvement observed in strategic listening (+17.1 percentage points) also corroborates the meta-analysis by Dalman and Plonsky, which highlighted the effectiveness of metacognitive strategy instruction for listening development [10]. Furthermore, the combination of video podcasts, audio podcasts, and transcripts recreated learning conditions similar to those described by Bozavlı [17], in which multimodal input contributes not only to improved listening comprehension but also to increased learner motivation.

At the same time, the present study extends existing research. Most previous studies, including those by Lim and Kessler on multimodal composition [3], have focused on reading, listening, or multimodal content creation as separate instructional activities. In contrast, the proposed pedagogical model promotes the parallel development of receptive skills through an integrated sequence of tasks that requires learners to process the same authentic content across multiple modalities. Such an approach more closely reflects authentic educational practice, in which teachers integrate multiple receptive channels simultaneously rather than addressing them sequentially.

The findings concerning teachers' readiness are equally noteworthy. Only 31.2% of instructors considered themselves methodologically prepared to integrate multimodal technologies effectively. This result is consistent with the conclusions of Cabero-Almenara et al. [14], who, drawing on the DigCompEdu framework, demonstrated that teachers' digital competence depends primarily on targeted professional training rather than on years of teaching experience. These findings also corroborate the conclusion that there is a persistent gap between the availability of ICT resources and teachers' methodological readiness in Ukrainian higher education institutions. Therefore, alongside the development of students'

multimodal receptive skills, higher education institutions should prioritize the systematic enhancement of teachers' digital-pedagogical competence to ensure the effective integration of multimodal technologies into language education.

Scientific novelty. Building on the summary provided in the Introduction, the scientific novelty of this study can now be substantiated in detail, in light of the empirical findings. This study substantiates and empirically validates, using a sample of pre-service foreign language teachers at a Ukrainian higher education institution, a system of pedagogical conditions that enables the integration of multimodal ICT tools into the simultaneous development of reading and listening skills. Unlike existing approaches, in which reading and listening are typically taught as separate receptive skills, the proposed model implements the principle of multimodal convergence, whereby the same authentic content is processed through auditory, textual, and visual channels, producing complementary learning effects for both receptive skills simultaneously. The study further refines approaches to selecting and pedagogically adapting digital learning tools by considering the specific context of Ukrainian higher education institutions. In addition, it extends the application of the cognitive theory of multimedia learning to the professional preparation of future foreign-language teachers in digitally enriched educational environments.

Practical significance. Building on the summary provided in the Introduction, the study's practical relevance can now be substantiated in greater detail in light of the empirical findings. The proposed pedagogical model can be readily implemented by university instructors teaching practical language courses and foreign language teaching methodology to support the development of students' receptive skills during both classroom instruction and independent learning. The validated set of multimodal ICT tools—including subtitled video podcasts, a platform for reading hybrid texts, reading-while-listening activities, and educational podcasts with transcripts—consists primarily of free or low-cost resources, making the model economically feasible for widespread implementation. Consequently, adopting the model in Ukrainian higher education institutions does not require substantial additional financial investment. The findings may also inform the design and revision of syllabi for courses such as Practical Oral and Written Communication, Methodology of Foreign Language Teaching, and related components of teacher education programs.

Conclusions

The results obtained empirically and theoretically in the study confirm the structural-functional pedagogical model as an effective paradigm for modernizing foreign language teacher education. This approach directly addresses the multimedia-processing realities of today's learners by moving away from traditional linear training and toward the concurrent development of reading and listening skills. The strong quantitative increases in reading and listening scores suggest that the organized use of auditory, visual, and textual channels improves linguistic reception without cognitive fragmentation. The practical viability of the model hinges on the congruent orchestration of its core pedagogical parameters: semantic congruence across modalities, throttling informational streams to moderate cognitive load, the explicit cultivation of metacognitive strategies, and the embedding of real-time digital feedback loops. Students recognized the great usefulness of subtitled video podcasts and interactive hybrid text platforms as scaffolding. A key finding of this study, with direct implications for practice, concerns the instructional side's readiness. While 75.0% of surveyed university instructors recognized multimodal ICT tools as necessary for modern foreign language instruction, 68.8% simultaneously acknowledged a lack of methodological readiness to apply these tools systematically, and 62.5% cited insufficiently adapted teaching materials. This gap indicates that the effectiveness of student-centered multimodal models is constrained not by the availability of digital resources but by instructors' digital pedagogical competence. Accordingly, this finding should be treated as a primary practical implication of the study, on a

par with the demonstrated gains in students' reading and listening performance: the implementation of multimodal instructional models in Ukrainian higher education requires a parallel, systematic investment in faculty development.

Ultimately, this research links Cognitive Theory of Multimedia Learning with classroom practice. This study, while reaffirming the pedagogical advantages of synchronous, channel-rich environments, also points to promising directions for future research. In order to maximize the potential of multimodal digital pedagogy, further research is needed to test the model with other higher education profiles, to develop standardized psychometric tools to assess pre-service teachers' multimodal literacy, and to longitudinally follow up on graduates to secure the successful transfer of these digital competencies into their independent teaching practices.

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