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Interactive learning using chatbots in higher education

Aprendizaje interactivo mediante chatbots en la educación superior

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Abstract

This article presents a study on the implementation of AI-based educational chatbots as a tool for interactive learning and the enhancement of digital culture among higher education students. Identifying a gap in the literature regarding the pedagogical use of chatbots, the authors developed an educational system aimed at strengthening digital competencies through automated interaction. The research followed a three-phase design: exploratory, intervention, and evaluation, and was conducted with university students divided into experimental and control groups. Questionnaires, diagnostic tests, and statistical analyses (Student's t-test) were applied to measure the impact of the intervention. The results show a significant improvement

in both motivational and cognitive indicators in the experimental group compared to the control group, thus validating the effectiveness of the implemented system. The study concludes that the use of educational chatbots not only enhances interaction and access to learning content but also promotes the development of essential skills for navigating digital environments. Further research is encouraged to explore specific didactic principles that can reinforce the integration of such tools into educational settings.

Keywords: digital culture, educational chatbots, interactive learning, artificial intelligence, higher education.

Resumen

Este artículo presenta un estudio sobre la implementación de chatbots educativos basados en inteligencia artificial como herramienta para el aprendizaje interactivo y el fortalecimiento de la cultura digital en estudiantes de educación superior. Partiendo de la identificación de una brecha en la literatura sobre el uso pedagógico específico de chatbots, se desarrolla un sistema educativo orientado a mejorar las competencias digitales mediante la interacción automatizada. La investigación se estructuró en tres fases: exploratoria, de intervención y evaluación, y se llevó a cabo con estudiantes de nivel universitario divididos en grupo experimental y grupo de control. Se aplicaron cuestionarios, pruebas diagnósticas y análisis estadísticos (t de Student) para medir el impacto de la intervención. Los resultados evidencian una mejora significativa en los niveles motivacionales y cognitivos del grupo experimental en comparación con el grupo de control, validando así la efectividad del sistema implementado. El estudio concluye que el uso de chatbots educativos no solo optimiza la interacción y el acceso a contenidos, sino que también fomenta el desarrollo de habilidades esenciales para desenvolverse en entornos digitales. Se sugiere continuar explorando principios didácticos específicos que fortalezcan la integración de estas herramientas en contextos educativos.

Palabras clave: cultura digital, chatbots educativos, aprendizaje interactivo, inteligencia artificial, educación superior.

Introduction

Modern society is currently at the stage of information development, which affects human life, the digitalization of all spheres of society – education, scientific research, medicine, production of goods, everyday life, culture, etc. In the global context, trends in the digitalization of society are: the development of cloud technologies, artificial intelligence, mobile technologies, augmented reality, telemedicine, the development and use of chatbots, database protection systems, electronic databases, combating cybercrime, etc.

All spheres of human life are actively influenced by rapid changes in the field of information technologies. This also applies to the field of educational services.

The latest information technologies and developments are increasingly used in the educational process. Modern information technologies are especially in demand during the education of students at universities, because the use of critical thinking by the student, the abstractness and complexity of the conceptual apparatus, the assimilation of one's own nomenclature, the constant need for mathematical calculations in research, conducting laboratory experiments require the teacher to have a modern approach to the educational process and pedagogical skills.

The issue of automating the educational process is quite relevant for the field of education. This may apply to both educational work, where each teacher can find convenient tools for presenting material that facilitate work with students, and convenient tools for organizational work, where the higher school administration automates the processes of information exchange with students and their parents. Therefore, researching the possibility of using chatbots for interactive learning in higher education to form the digital culture of future specialists is a rather important and relevant issue.

Chatbots have rapidly invaded the educational process of higher education institutions, as well as all areas of our lives, which has led to the need for modern specialists to "have virtual assistants in their arsenal" to increase the efficiency of the educational process and professional activities (Hrytsenko & Holiiad, 2024).

Having analyzed the current practice and pedagogical theory of using chatbots for interactive learning in higher education to form a digital culture of future specialists, we can attest to the lack of specific research devoted to this problem.

Literature Review

The problems of digitalization of education, the use of chatbots for interactive learning in higher education, the introduction of digital technologies into professional activities and the educational process at different stages and levels of education are highlighted in the studies of researchers from different countries.

The issue of using and implementing automated student communication systems using virtual assistants is considered by L. Hrytsenko, & R. Holiiad (2024). Special attention is paid to the ways of using virtual assistants in the educational process and chatbots as tools for interactive learning of students, the redistribution of time for interaction between higher education students and teachers when using chatbots. To acquire the necessary skills and abilities for professional activity, improve the assimilation of knowledge, the authors highlight the capabilities of automated systems and reveal the role of the teacher's digital culture for the effective implementation of modern virtual assistants in the educational process. The importance of chatbots for education and their capabilities for individualizing learning, improving the assimilation of knowledge and increasing the motivation of higher education students is proven. In particular, the possibility of using the Telegram chatbot by computer science teachers to organize the educational process is considered by D. Makharadze et al. (2024). Various ways of creating chatbots for the Telegram messenger are considered by scientists, and their main advantages and disadvantages are also given; recommendations are given on the use of virtual assistants in secondary education institutions by computer science teachers in organizing the educational process, and a comparative analysis of various tools is conducted.

The research of N. Morze et al. (2020) is devoted to the digital culture of teachers. Scientists interpret it as “the mastery of skills in using information and communication technologies in professional activities, the need for which arises in the context of the transformation of the global Internet into a space for the realization of a teacher and a means of earning money”, and D. Krugliy (2020), considering digital culture, considers it the main component of “the professional culture of future teachers, which characterizes the ability to use information and communication technologies to search, process, exchange information and solve professional tasks”. Taking into account the scientific achievements of previous researchers, K. Litvinova (2016) proved that a teacher's digital culture is "a system of knowledge, skills, and abilities to determine information needs and search for the necessary information that may be contained in various information resources, as well as its further processing, storage, analysis, structuring, integration, and creation of new information products".

Studying the main characteristics of the digital culture of teachers, V. Oliynyk et al. (2020) prove that the information culture of a person includes the information culture of a specialist, and by it, researchers understand in the information society the readiness to master a new way of life, the ability to form one's own attitude to phenomena and objects of the information world, to build one's own picture of the world, to determine the possibilities of transforming the information space.

Z. Ryabova, & H. Yelnykova (2020) define digital culture through the characteristics of a set of main phenomena, which include: social networks, the Internet, chat rooms, blogs, virtual communities, distance learning platforms, forums, computer games, electronic clips, electronic media, etc. Scientists have identified the main features of the digital culture of the individual: freedom of access; openness to members of the information society; remoteness or distancing; liberalism as the absence of clear rules and norms,

including ethical ones, interactivity in obtaining access to information; virtuality; electiveness; innovation as a process of scientific developments, constant updating of content related to electronic communication, electronic art.

The prerequisites for the emergence of the social phenomenon of digital culture and the transition of the individual to the digital era were studied in detail by O. Skyba et al. (2020), in particular: the transition from physical and analog content to digital, which allows the individual to use existing digital content, manage and create their own and thus build their own trajectory of individual activity; the modification of the function of information and communication technologies, where the main feature is the controllability of the main features of communication activity to network from vertical.

As a social phenomenon, the impact of digital culture on the process of professional training of future specialists was investigated by F. Pimentel et al. (2020) and showed in the context of modern pedagogical science the ways of using this phenomenon, which requires the development of a new type of human thinking, going beyond the simple use of information and communication technologies, the creation of electronic educational resources (digital products), the widespread introduction of innovative forms and methods of educational interaction, which are artifacts of digital culture.

Thus, the problems of digitalization of education, the use of chatbots for interactive learning in higher education, the introduction of digital technologies into professional activities and the educational process at different stages and levels of education are highlighted in the studies of researchers from different countries. Special attention is paid to the ways of using virtual assistants in the educational process and chatbots as tools for interactive learning of students, the redistribution of time for interaction between higher education students and teachers when using chatbots. Scientists have revealed the role of the teacher's digital culture for the effective introduction of modern virtual assistants into the educational process. The importance of chatbots for education and their ability to individualize learning, improve knowledge acquisition, and increase motivation of higher education students has been proven. However, the problem of using chatbots for interactive learning in higher education to form the digital culture of future specialists is insufficiently disclosed and necessary for research.

Research purpose – to prove the validity of the developed system for forming students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education.

Methodology

To achieve the set goal, a set of research methods was used at different stages of the study:

- *Theoretical:* theoretical systematic analysis of psychological, pedagogical, methodological literature on the research problem to generalize the learned experience, determine the conceptual and terminological apparatus of research on the issues of digitalization of education, the use of chatbots for interactive learning in higher education to form the digital culture of future specialists;
- *Empirical:* diagnostic (questionnaires, testing, interviews, conversations, observation of the process of using chatbots, the use of digital technologies for interactive learning in higher education to form the digital culture of future specialists and create electronic educational resources); pedagogical experiment to determine the effectiveness of the developed system of using chatbots for interactive learning in higher education to form the digital culture of future specialists;
- *Statistical methods:* verification of the reliability of the results of experimental work, qualitative and quantitative analysis, use of expert evaluation methods, Student's t-criterion to verify the statistical significance of the research results.

The main task of the experimental study was to verify the effectiveness of the theoretically grounded and developed pedagogical system for forming the digital culture of future specialists through the use of educational chatbots for interactive learning based on artificial intelligence in higher education.

In the conditions of the real educational process, an experimental study was developed and an innovative system of the educational process was implemented in the EG during the 2022–2024 academic years. The experimental study covered higher education applicants, in particular, bachelor's level.

In the unity of three stages – ascertaining, content-organizational, diagnostic – research and experimental work was carried out.

67 respondents were involved in the experimental work.

Experimental verification of the effectiveness of the system for forming the digital culture of future specialists through the use of educational chatbots for interactive learning based on artificial intelligence in higher education was carried out using diagnostic tools: traditional methods of pedagogical research; pedagogical experiment; implementation of projects with the development of digital resources, with the use of digital technologies, participation in events using digital technologies; questionnaires; testing; statistical methods for analyzing the data obtained.

As an assessment tool in our study, we gave preference to questionnaires and testing, since we believe that these methods will allow us to quickly carry out the procedure for measuring levels of formation and cover a significant number of respondents.

We have identified motivational and knowledge criteria that characterize the structural and component composition of students' digital culture and have prescribed indicators.

In the process of research, the levels of formation of students' digital culture were identified: low, medium, sufficient, high.

The main goal of the experimental work was to verify the effectiveness of the developed system for forming students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education based on the analysis of quantitative and qualitative indicators of learning in experimental and control groups.

The study allowed us to draw a conclusion (generalizing the indicators of formation of all components) regarding the positive dynamics in all levels of formation of the digital culture of respondents in the experimental group compared to the control group, which indicates the effectiveness of the system for forming students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education.

In the experimental study, the Student's t-test was used to test statistical significance in a scientific study aimed at assessing the differences in the mean values of two normally distributed samples, which allows us to refute or confirm the effectiveness of implementing a system for forming students' digital culture in the educational process through the use of educational chatbots for interactive learning based on artificial intelligence in higher education with a significance level of 5%.

We reject the null hypothesis and confirm the alternative hypothesis.

The dynamics of changes in the level characteristics of the manifestation of indicators of the formation of students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education EG and CG between all stages of the conducted pedagogical experiment confirmed the effectiveness of the developed system for the formation of students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education. Based on the obtained research results, we conclude that the proposed system for the formation of students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education is effective.

Results and Discussion

Content, types of chatbots and their advantages.

Chatbot is software designed to answer users' questions in a chat, which is automatic. A chatbot can perform various tasks, interact in natural language with the user, provide reference information, answer questions, etc. (Hrytsenko & Holiiad, 2024).

Let's name two types of chatbots used in the educational process of higher education:

- Chatbots are created and work according to rules;
- Chatbots use artificial intelligence, which uses machine learning to understand questions, which is necessary for further processing and generating an answer to the task or question posed.

It is chatbots that use artificial intelligence that are difficult for an average teacher to implement in the educational process of higher education, because this process requires access to the platforms of leading developers of artificial intelligence and specific programming skills. However, today, higher education teachers have the opportunity to independently develop and implement rule-based virtual assistants in the educational process. They can reproduce possible, predicted in advance dialogues between a chatbot and a higher education applicant, and answer specific questions. There are a sufficient number of platforms (depending on the level of professional training of the teacher) on which you can create a virtual assistant in any subject for a high-quality educational process. There are free platforms on the market for creating chatbots: Chatfuel, ManyChat, FlowXO, Botsify, and paid services: Rasa, ChatterON, MEOKAY, Botkit (Hrytsenko & Holiiad, 2024).

Let's name several advantages of using chatbots in the educational process of higher education, which facilitate the work of the teacher and student and, due to the rationalization of the time used, make it more productive when interacting with students:

- Accessibility – virtual assistants interact with all participants in the educational process around the clock and simultaneously, which allows teachers and students to attract the attention and additional time of students to study professional disciplines. Students have the opportunity to receive help at a time convenient for them;
- Individualization – chatbots easily adapt to the individual learning needs (repeating the material covered) of each student and their pace, make it possible to move on to studying new topics when the student is ready for this;
- Motivation – for students, the use of chatbots in the educational process is more interactive and interesting throughout the entire period of study. Experiments and demonstrations that took place in class can be repeated to summarize the learned material and reviewed when doing homework (Holiiad & Stukalo, 2023);
- Sending Push-messages to stimulate and encourage the cognitive activity of higher education students by a virtual assistant. In this way, the vocabulary of messages is adjusted so that the virtual assistant morally encourages and supports students in mastering and studying material in specialized subjects. Successes will be appreciated, and temporary failures will be converted condescendingly into the need to continue and not stop at what has been achieved to overcome all difficulties;
- Saving time and reducing the burden on the student and teacher – chat bots partially replace teachers in organizational issues, which usually require the participation of an assistant: briefing on laboratory work or safety, checking those present at the lesson, monitoring the assimilation of knowledge; recording homework, which will be always available and possible to complete at a convenient time for students; reminders to complete tasks and other organizational issues (Hrytsenko & Holiiad, 2024).

Creating chatbots for different platforms.

Many large companies that created virtual interlocutors and their own chatbots were founded back in the 2000s. Several tools have appeared in our time that allow anyone to create their own chatbot for any purpose.

You can create a chatbot both using third-party online designers and independently. With their help, you can create chatbots for different platforms. Let's consider some of them:

- Sendpuls is a designer with which you can create a chatbot for many online platforms. The designer helps you use the landing page designer and create mailings. Sendpuls can analyze user responses and requests, subscriptions, and mailings for a given time;
- Bot kits are a cloud-based service that creates bots using flowcharts and does not require programming skills; allows you to create a bot for websites and messengers. Bot kits provide access to user statistics and users, access to external libraries, the ability to send text, video, photo, audio, the ability to create many combinations of assistant behavior;
- Botmother is a simple platform that supports many platforms for creating chatbots. You only need to connect a few elements to create a chatbot. Botmother has the following capabilities: connecting an operator to a dialogue with the user; quick bot setup; the ability to send messages; the ability to accept payments for training through online services;
- Chatfuel is a multifunctional and free service that can also be used to create chatbots for many messengers. Chatfuel has subscription and mailing capabilities; an unlimited number of bots, the ability to pay for training through online services, speech recognition;
- Aimylogic is a service that allows you to create a real conversationalist, not a regular text bot, that will be used in mobile applications, messengers, and websites. Alexa and Google Assistant voice assistants work with this bot. Aimlogic has the following capabilities: voice assistant integration; speech recognition; nonlinear stories and dialogues data analytics (Semenikhina et al., 2020).

It is worth emphasizing the importance of chatbots that are written manually. Their chat functions work through their own API. To operate and create such a bot, you need a server, hosting, and databases. The capabilities of such a bot are limited only by the programming skills of each student and the capabilities of the platform on which the student will create it. The most popular messengers for creating chatbots are: Viber, Telegram, and Facebook. About 80% of chatbots are focused on these platforms (Shuliak et al., 2022).

If you do not purchase advanced features and functions, then chatbots created using the designer are free. Without programming skills, you can create a chatbot. Such a chatbot, unfortunately, cannot self-learn. The complexity of scenarios with the possibility of refinement in such a chatbot is standard. Using the designer, you can make refinements and edits to the chatbot at any time (Makharadze et al., 2024).

So, there are many chatbots used for various needs, in particular, in the educational process of higher education: to consolidate and acquire knowledge, to check the digestibility of information, to introduce various tests, to generate recommendations, to track the student's efficiency throughout the day and to build a study schedule (Knysh et al., 2024).

The most popular AI-based chatbots that are necessary for use in the educational process of higher education.

Let's name the most significant of the AI-based chatbots used in the educational process of higher education:

- *ChatGPT* – introduced in 2022, an AI chatbot developed by OpenAI that can create a variety of creative content, generate text, and provide informative answers to questions (Dergaa et al., 2023);

- *Bard* – launched in 2022, is a large language model (created by Google AI) of an AI chatbot, can include providing informative answers to questions, language translation, text generation, and creating various types of creative content (Rudolph et al., 2023);
- *Replika* – is an AI chatbot platform launched in 2017, designed to help students: can give advice and help students, listen to students' problems, and make them feel less alone (Pentina et al., 2023);
- *Ada* – is a chatbot launched in 2017 and is used for personalized learning for college students. Ada can provide feedback, answer questions, and facilitate individualized learning for students (Alsanousi et al., 2023);
- *Habitica*, used to help students develop good academic, professional, and work habits, launched in 2013. Habitica can be used by all students to manage their study schedules and their academic tasks. Students are more motivated to complete their tasks by turning their to-do list into a game (Zhang, 2023);
- *Socratic* – an AI-based educational platform launched in 2013, which was acquired by Google in 2018. It is not a chatbot per se, but it has chatbot-like features and an interface designed to help students learn new concepts (Wang et al., 2020);
- *Piazza* – is a chatbot that serves to collaborate and facilitate discussion of specific problems, used in the educational process of higher education, in classrooms, and academic institutions. Launched in 2009, it allows teachers and students to ask questions, participate in discussions, share information, and complete assignments related to the content of the course being studied (Labadze et al., 2023).

Content, objectives and main provisions of the experimental study.

Research and experimental work was carried out in three stages: ascertaining, content-organizational, diagnostic.

The first, ascertaining, stage of the experiment allowed us to analyze the methodological, pedagogical, psychological, philosophical literature, during which we clarified the basic concepts of the study; create a CG and EG in compliance with the requirements for sample homogeneity; prescribe a program for a formative experiment; to develop a bank of questions, practical tasks, which allowed to determine the level of formation of the digital culture of future specialists through the use of educational chatbots for interactive learning based on artificial intelligence in higher education according to criteria (motivational, knowledge) and indicators.

The second stage, content-organizational, was aimed at conducting a formative experiment where the pedagogical system for the formation of the digital culture of future specialists was modeled, which determined the goal, educational and methodological support, tasks, results, pedagogical conditions, methods and means of forming the digital culture of future specialists through the use of educational chatbots for interactive learning based on artificial intelligence in higher education, as well as the criteria and levels of formation of the phenomenon under study, its diagnostic tools to measure the effectiveness of the proposed work.

At this stage, based on the modernization of bachelors' professional training, educational and methodological support for the formation of the digital culture of future specialists was developed and implemented in the educational process of higher education (in EG) through the use of educational chatbots for interactive learning based on artificial intelligence in higher education, which included: a special distance course "Digitalization in Education" was developed and pedagogical conditions were developed:

- By the trends of digitalization of education through the use of educational chatbots for interactive learning based on artificial intelligence in higher education, updating the content of professionally oriented academic disciplines;
- Implementation of the developed system for the formation of the digital culture of future specialists through the use of educational chatbots for interactive learning based on artificial intelligence in higher education;

- Creation of a web environment for distance learning for students, which provides for the support and development of distance courses in professional disciplines;
- Providing students with the necessary set of skills, knowledge, and abilities to work with digital content and digital technologies;
- Organizing effective digital communication of students through the use of educational chatbots for interactive learning based on artificial intelligence in higher education by participants in the educational process, developing digital collaboration and netiquette.

In the EG, in the process of implementing a pedagogical experiment on the formation of the digital culture of future specialists through the use of educational chatbots for interactive learning based on artificial intelligence in higher education for applicants of the first (bachelor's) level of higher education, such pedagogical conditions and specific methods for the digital educational environment and innovative means were used that were included in the system for forming the phenomenon under study.

In the process of conducting the formative stage of the experiment, we believed that chatbots can automatically form useful professional information for students during training.

Let us present in more detail several examples of our use of chatbots in the educational process of higher education in the EG:

- Supporting students in learning new topics in the educational process of higher education. The chatbot helped students learn new topics. For example, the chatbot offered additional reading materials or offered videos for viewing, to better understand the new material by students;
- Using a chatbot to answer students' questions. For example, a student had the opportunity to ask about the class schedule or ask about the material that was presented at the lecture. The chatbot answered these questions efficiently and quickly, which reduced the workload on students and teachers of the higher education institution;
- Using a chatbot to support distance learning. A chatbot was especially useful for distance learning where students did not have direct access to teachers. At the same time, the chatbot provided students with real-time support in answering questions;
- Using a chatbot to plan and organize tasks. The chatbot helped students monitor the implementation of tasks and plan them. For example, the chatbot reminded students of deadlines and suggested making a list of tasks that needed to be completed;
- Using a chatbot for evaluation and feedback. The chatbot was used to collect and evaluate feedback from students. For example, after the course, the chatbot suggested that students fill out a questionnaire to find out about the quality of training and students' opinions about the course.

To simplify interaction with applicants, existing and new students, today we in higher education are increasingly using educational chatbots based on artificial intelligence.

The educational process in the CG was organized according to traditional methods.

The third, diagnostic, stage was aimed at determining changes in the levels of formation of the digital culture of future specialists by using educational chatbots for interactive learning based on artificial intelligence in higher education and conducting a final diagnosis. A qualitative and quantitative analysis of the experimental data obtained was carried out at this stage, conclusions were formulated, and prospects for further research were outlined.

67 respondents were involved in the experimental work.

Experimental testing of the effectiveness of the system for forming the digital culture of future specialists by using educational chatbots for interactive learning based on artificial intelligence in higher education was carried out using diagnostic tools: traditional methods of pedagogical research; pedagogical

experiment; implementation of projects with the development of digital resources, with the use of digital technologies, participation in events using digital technologies; questionnaires; testing; statistical methods of analyzing the data obtained.

Diagnostics of the levels of formation of digital culture of future specialists through the use of educational chatbots for interactive learning based on artificial intelligence in higher education.

Let us dwell in more detail on the procedure for diagnosing the levels of formation of students' digital culture by using educational chatbots for interactive learning based on artificial intelligence in higher education, for which the criteria, main indicators and levels of formation of the studied component were characterized.

As an assessment tool in our study, we gave preference to questionnaires and testing, since we believe that these methods will allow us to quickly carry out the procedure for measuring levels of formation and cover a significant number of respondents.

We have identified motivational and knowledge criteria that characterize the structural and component composition of students' digital culture and the prescribed indicators.

The motivational criterion in our study determined the formation of the motivational component of students' digital culture and was revealed by indicators: the formation of interests, needs, motives for using digital technologies in educational activities and future professional activities, awareness in the digital environment of the value of digital communication, the value of information; students' desire to develop their own educational digital resources.

The knowledge criterion in our study determined the formation of the cognitive component of students' digital culture and was revealed by indicators: the formation of the basic thesaurus of digital education, a certain level of information knowledge, forms and types of educational digital content, and when working with digital information – security measures; when working with digital technologies – rules of academic integrity and the use of digital content; the formation of technological knowledge about the features of information processes, students' knowledge of electronic educational platforms, features of digital technologies, ways of their functioning, sequence and methodology of using digital technologies, creation of digital educational resources; norms of behavior in the digital environment, online activities for communication, ethical rules and means of organizing feedback.

The formulated criteria and indicators are considered signs of the formation of students' digital culture.
In the process of the study, the levels of formation of students' digital culture were identified: low, medium, sufficient, high.

At the beginning of the experimental study, the respondents of the experimental groups had approximately the same indicators, which were established by analyzing the level of academic overall success of the respondents and amounted to:

- EG – 72.4%;
- CG – 73.5%.

This percentage ratio ensured the objectivity of the initial indicators for the further conduct of the pedagogical experiment.

Within the framework of the ascertaining experiment, a questionnaire was initially conducted among respondents to identify indicators of the development of the motivational component (motivational criterion) of students' digital culture. Respondents were asked to fill out an online questionnaire developed in the Google Forms service, the questions of which were conditionally divided into three blocks:

- Questions aimed at identifying interest in using digital technologies in professional activities;

- Questions aimed at identifying students' desire to use and develop educational digital resources;
- Questions aimed at identifying interest in participating in and organizing communication events in the digital environment.

Higher education students, answering the questionnaire questions, had to evaluate on a scale from 1 to 5 what corresponded to their own assessment of interests, motives, and needs for the formation of digital culture.

The quantitative analysis of the respondents' responses allowed us to say that students showed high levels of motivation for the formation of digital culture.

As a result of the survey of respondents in the EG and CG, the generalized data obtained demonstrate that the manifestation of aspirations, motives, and goals for the formation of digital culture in general was positively expressed.

Thus, 50% of respondents in the EG and CG have a sufficient and average level of the motivational criterion of the formation of digital culture, which indicates that future specialists have a desire and interest in developing digital educational resources, using digital technologies, and a desire to communicate effectively in a digital environment during their studies in higher education and professional activities.

Due to the qualitative analysis of the respondents' answers, a correlation of sufficiently high quantitative indicators to clarifying open-ended questions for students occurred, which made it possible to say that respondents like to use digital technologies in educational activities:

- EG – 86.7% of respondents;
- CG – 87.4% of respondents.

However, a significant number of respondents cannot independently perform tasks using digital technologies. They resort to the help of other friends, teachers, students, and try to find solutions to problems on the Internet.

The list of digital technologies that students use most often included (Fig. 1):

- Mobile applications and chatbots for interactive learning in higher education to form a digital culture (32.1% in EG, 33.3% in CG);
- Video content (video lessons) (17.3% in EG, 15.2% in CG),
- Online tests (23.1% in EG, 22.7% in CG),
- Other digital technologies used by students (27.5% in EG, 28.8% in CG).

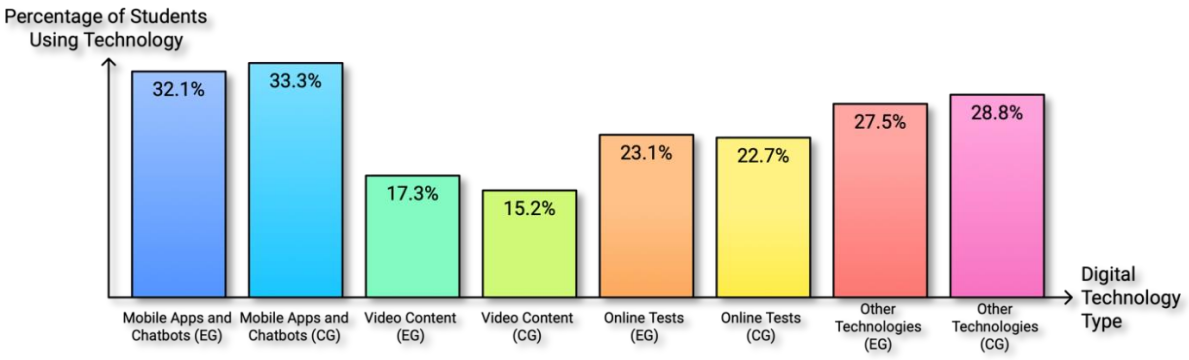

Fig. 1. Usage of Digital Technologies in Education.

When asked whether respondents plan to use digital educational resources in their professional activities or whether they consider them effective, most respondents noted (Fig. 2):

- 65.1% in the EG, 63.8% in the CG – digital resources are interesting,
- 28.8% in the EG and 29.5% in the CG – the use of digital technologies allows us to visualize the material being studied;
- 6.1% in the EG and 6.7% in the CG – the use of modern digital resources has a positive effect on the formation of a person's digital culture – noted by a small number of respondents.

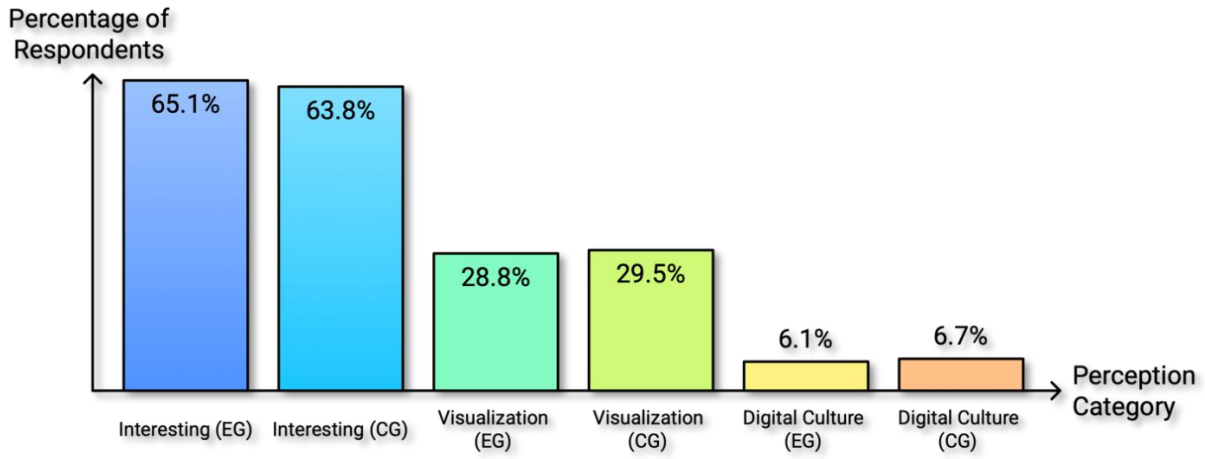

Fig. 2. Perceptions of Digital Educational Resources.

The main method of measuring the formation of the cognitive component (knowledge criterion) of a student's digital culture was testing.

The questions about the methods of work and the essence of digital content included questions aimed at interaction in the digital space, search, critical evaluation, data selection, understanding of digital communication services, sharing digital technologies, digital identity management, netiquette, establishing the level of awareness of respondents on digital content: organization, structuring, storage, use and interpretation of content in the digital environment. The block of questions was focused on determining the level of knowledge in the field of digital culture.

The block of questions about digital technologies concerned the digital educational environment and online services, editing and creating educational content using digital technologies for organizing educational activities. Regarding digital security, the block of questions included questions about the protection of personal data, devices, and confidentiality.

For the convenience of testing, the convenience of collecting and analyzing the results obtained, the testing was carried out using the Google Forms service.

Analysis of the results of student testing showed insufficient knowledge, weak awareness of students in the field of digital technologies, low general level of information activity, lack of knowledge about the rules and norms of online communication, lack of orientation in issues of protecting one's own data and security.

Quantitative analysis of the results obtained (knowledge criterion) allows us to state that more than 70% of respondents (73.6% in the EG, 72.5% in the CG) revealed a low and average level of development of digital culture.

Respondents could not score 100 points, with the maximum score for the test being 455, that is, they demonstrated a lack of knowledge in all blocks of the test related to digital content and awareness in the field of digital communication, digital technologies, and security.

Organization and implementation in the EG of a system for forming students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education.

The purpose of the experimental study was to implement the developed system for forming students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education and to verify its effectiveness, which was ensured by the implementation of the developed and presented above pedagogical conditions.

The use of digital educational resources of various forms, the involvement of the system for forming students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education made it possible to implement the method of digital visualization, increase the level of informativeness of practical and lecture classes, which had a positive effect on strengthening, to form a digital culture, the motivation of future specialists to use educational chatbots for interactive learning based on artificial intelligence in higher education.

The acquisition of the outlined knowledge, skills and abilities took place within the framework of studying the special distance course "Digitalization in Education".

Analysis of the results of the experimental study.

Conducting a control stage of experimental work to verify the effectiveness of the implementation of the developed system for the formation of students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education became the main task of the diagnostic stage of the study.

A control section was conducted in the experimental and control groups and an analysis (quantitative and qualitative) of the results obtained was carried out, the systematization of experimental data and their statistical processing were performed, the effectiveness of the developed system for the formation of students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education was assessed, the main conclusions were formulated, and further scientific explorations were outlined.

In the experimental work, comprehensive testing was chosen to organize the control stage by the diagnostic method to measure the level of formation of each component of the digital culture of students participating in the experiment.

The conducted comprehensive testing consisted of subtests.

The first subtest focused on identifying the level of formation of the motivational component of the phenomenon under study, and the second subtest focused on identifying the level of formation of the cognitive component.

100 points was the total maximum amount of points that respondents could receive during the diagnosis.

This approach to measuring the academic success of students in higher education corresponds to the ECTS grading scale.

For each subtest, the answers to the questions of the comprehensive test were evaluated separately, which made it possible to measure the levels of formation of each component of digital culture in future specialists. By the established weighting coefficient, the distribution of points for each of the subtests took place.

The weighting coefficient of the first subtest was 50 points, the weighting coefficient of the second subtest was also 50 points.

Level Total points
High 90 – 100
Sufficient 89 – 75
Average 60 – 74
Low 0 – 59

Analysis of the results of the first subtest, in which applicants were asked to answer the questions of the questionnaire regarding the formation of the motivational component of students' digital culture, showed that the indicators of the motivational component in the experimental groups increased significantly, compared to the ascertaining stage of the experiment. In the control group, the indicators of the motivational component underwent small changes.

60% of respondents have an average and sufficient level of formation of the motivational criterion of digital culture in the CG.

The proportion of respondents with an average and sufficient level of EG decreased to 22%, and the high level indicators increased to 67% (motivational criterion), which indicates that respondents have an interest in developing digital educational resources, a desire to use digital technologies, and a desire to communicate effectively in a digital environment.

The answers to the test questions allowed us to draw the following conclusions:

1. Familiarizing students with the practical and theoretical foundations of the use of digital technologies in interactive learning based on artificial intelligence in higher education and further professional activity significantly affects the level of formation of the motivational component of students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education. Possessing even elementary knowledge about the place and role of digital culture in professional activity, future specialists show positive, stable motivation for their systematic application in higher education and implementation in further professional activity.
2. Basically, all EG applicants expressed their conviction in the need to constantly improve the level of digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education.
3. In the process of implementing the developed system for forming students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education, respondents were happy to develop their own digital educational resources, using a significant number of online services and digital technologies.

Let us present the visualized and summarized indicators of the formation of the motivational component of the respondents' digital culture at the diagnostic stage.

According to the results of the experiment, the indicators of the motivational component in the EG underwent significant positive changes (Fig. 3):

- The high level increased by 12.1%,
- The sufficient level increased by 9.7%.

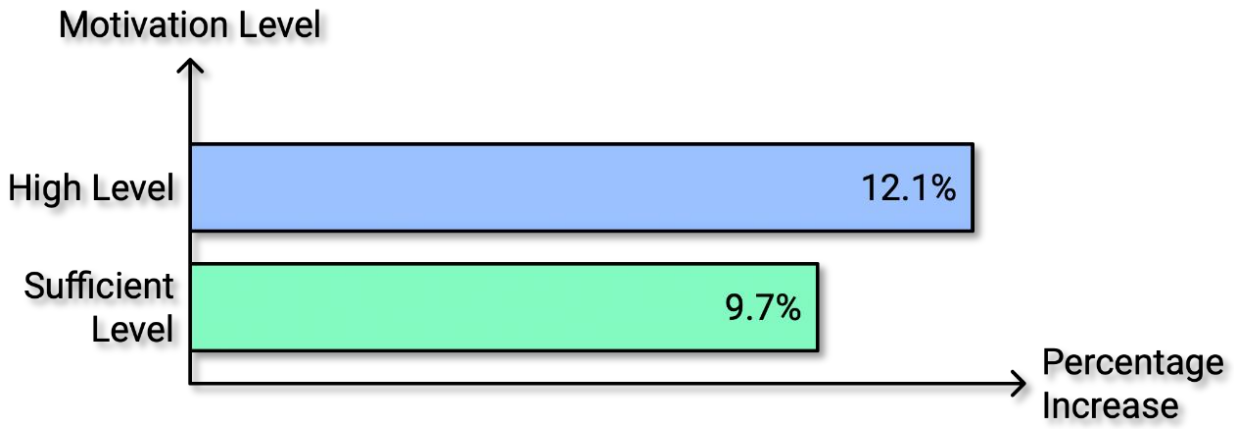

Fig. 3. Changes in Motivational Component Indicators (EG).

Accordingly, the average level and the low level decreased by 12.1% and 9.7%.

The indicators of the motivational component, according to the results of the experiment in the CG, underwent minor changes (Fig. 4):

- High level increased by 2.1%,
- Sufficient level increased by 1.5%.

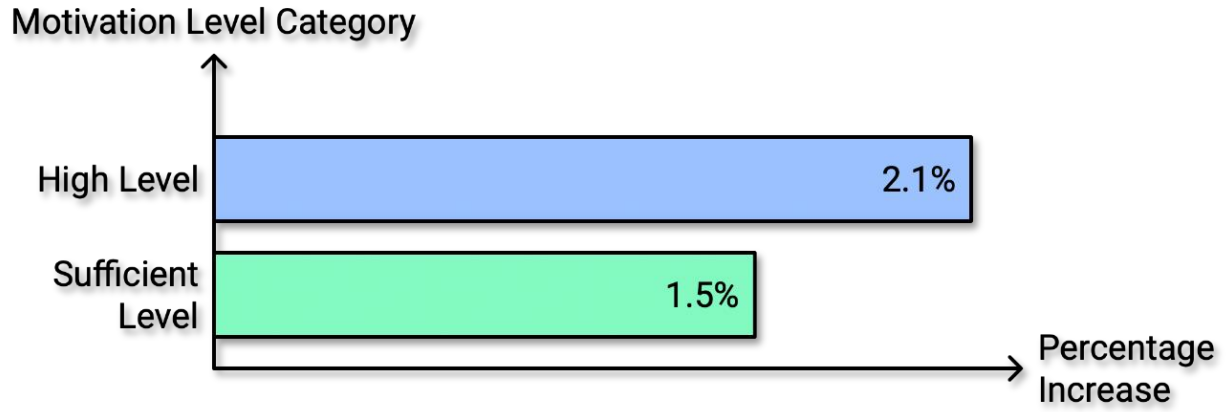

Fig. 4. Changes in Motivational Component Indicators (CG).

Respectively, the average level and low level decreased by 1.5% and 2.1%.

Analysis of the results of the control complex testing of students of the second subtest at the diagnostic stage showed higher results of the formation of the cognitive criterion of digital culture in EG applicants who were involved in the experimental study of the developed system for forming students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education than in CG students (Fig. 5).

In EG:

- High level – 18.4%,
- Sufficient level – 31.1%,

– Average level –33.5%,
– Low level –18%;

In CG:

– High level – 13.4%,
– Sufficient level – 19%,
– Average level – 41.02%,
– Low level – 26.4%.

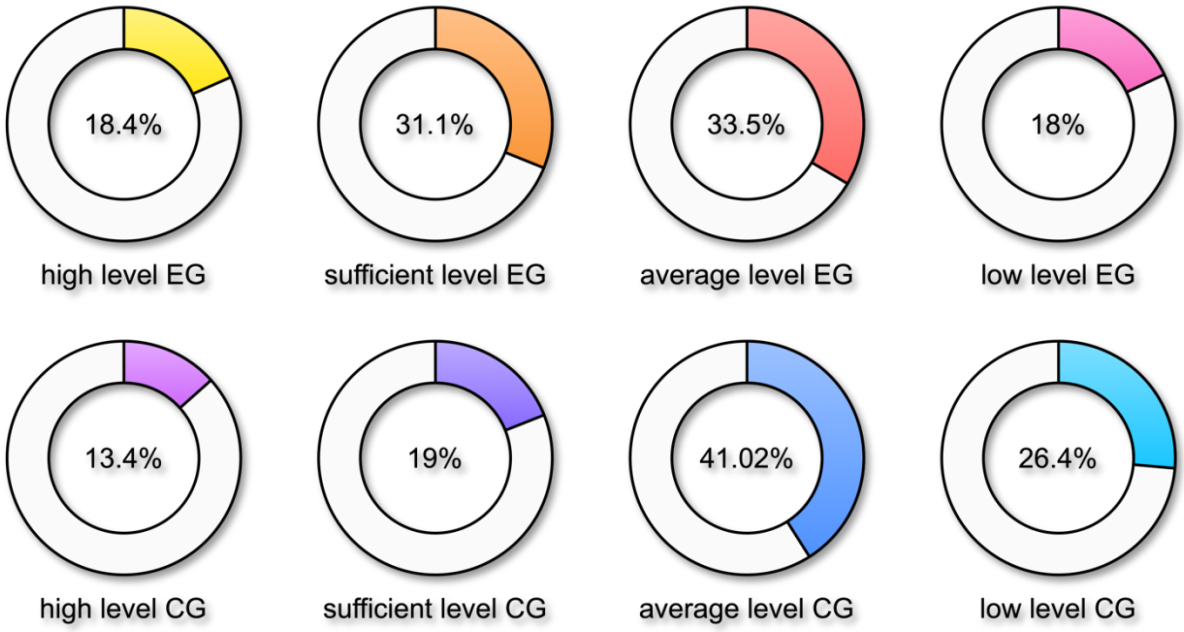

Fig. 5. Comparison of Levels in EG and CG.

A comparative analysis of the dynamics of changes in the cognitive criterion indicators showed that in the EG, the indicators of sufficient and high levels increased by 17.4% and 4.7%, and the low and average levels decreased by 13.6% and 8.3%, respectively.

These indicators for the CG changed as follows: we observe an increase in the high level by 1.7%, sufficient by 4.0%, the average level increased only by 0.5%, and the low level decreased by 6.3%.

We can conclude (generalizing the indicators of the formation of all components) about the positive dynamics in all levels of the formation of the digital culture of respondents in the experimental group compared to the control group, which indicates the effectiveness of the system for forming the digital culture of students through the use of educational chatbots for interactive learning based on artificial intelligence in higher education.

We formulate the hypotheses – null and alternative:

H0: taking into account the arithmetic mean of the scores in the control groups and the arithmetic mean of the scores in the experimental groups – the proposed system for forming students' digital culture by using educational chatbots for interactive learning based on artificial intelligence in higher education does not affect the level of digital culture of respondents 2 1 x x = 1x 2 x.

H1: the proposed system for forming students' digital culture by using educational chatbots for interactive learning based on artificial intelligence in higher education is effective for forming the level of digital culture. 1x 2x.

The tabular value of the Student's t-test for all respondents who participated in the experiment and the significance level of 5% is ttab.= 1.9679.

temp=7.356 is the empirical value of the criterion and significantly exceeds the tabular value, therefore we reject the null hypothesis and confirm the alternative hypothesis.

Therefore, the differences in the mean scores of respondents in the control and experimental groups are not accidental, and are the result of the implementation of the system for forming students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education, as evidenced by a significantly higher level of success in the experimental groups.

Conclusions

Having analyzed the modern practice and pedagogical theory of using chatbots for interactive learning in higher education to form the digital culture of future specialists, the lack of specific research devoted to the outlined problem was confirmed.

The article describes the content, identifies the types of chatbots and lists their advantages. The ways of creating chatbots for different platforms are described. The most significant AI-based chatbots used in the educational process of higher education are named.

The purpose of the experimental study was to implement the developed system for forming the digital culture of students through the use of educational chatbots for interactive learning based on artificial intelligence in higher education and to verify its effectiveness, which was ensured by the implementation of the developed author's pedagogical conditions.

The dynamics of changes in the level characteristics of the manifestation of indicators of the formation of students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education in the EG and CG between all stages of the pedagogical experiment confirmed the effectiveness of the developed system for the formation of students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education.

Based on the obtained research results, we conclude that the proposed system for the formation of students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education is effective.

Further research requires substantiation of the principles that will contribute to the effectiveness of the system for forming students' digital culture through the use of educational chatbots for interactive learning based on artificial intelligence in higher education: specific principles that are characteristic of digital education (principles of distance learning, adherence to convergence, academic integrity, communication, visualization, adherence to a culture of behavior on the Internet, etc.); general didactic principles that will ensure the coordination of the tasks and goals of the study with the forms, methods, and content of the educational process (systematicity and consistency, scientificity, integration of practice and theory, activity and consciousness, critical self-assessment, interdisciplinary connections, self-development and self-improvement of future specialists).

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