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Augmented Reality Technology as a Means of Forming Master's Degree Students' Multicultural Competence

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Abstract

Higher education adapts to the challenges of globalization and new priorities of society, the values of students from different countries, expands the range of pedagogical technologies and the ways they are included in the educational process. To train highly qualified specialists, develop the multicultural competence as an integrated personal quality in higher education, blended learning, 3D modeling, augmented and virtual realities are used.

The paper investigates the problems and ways of using AR applications in the educational process and organization of practice, intercultural communication and joint activities of master's level students which are considered as important conditions of formation of a multicultural individual.

Methodology. The main idea of the study is determined by the principle of multicultural education which involves the acquisition of new knowledge, intercultural interaction, formation of a worldview, etc. in augmented reality. The software tool is the Zome application. The study of augmented reality technology and software takes place in a quest format. 42 students of the Vyatka State University, master's degree program in Pedagogical Education, were involved in the experiment.

Results. In the experimental group, master's degree students used AR tools to study theory, consolidate skills of intercultural communication and collaboration. The levels of multicultural competence formed were assessed, and statistically significant differences in the qualitative changes that occurred in the pedagogical system were revealed.

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In conclusion, the peculiarities of using augmented reality as a pedagogical technology to form master's degree students' multicultural competence and improve the quality of education in general are summarized.

Keywords: educational paradigm, intercultural communication, information environment, digital service, personality qualities, Zome.

1. Introduction

National identity and values, equality and pluralism of cultures on which the idea of multicultural environment is based are reflected in the UNESCO declarations on the problems of modern global strategies of education and integration. According to the relevant international legal acts and recommendations, students are considered to understand not only their roots of national identity (Burnet, 2008).

Multicultural learning environment is a new educational paradigm. Modern society challenges the importance of each of its components in terms of the development of an individual, the choice of appropriate pedagogical methods and means of influence.

Due to globalization, integrated socio-economic relations, intercultural communication, developed network collaboration, representatives of different countries, peoples, groups, etc. need to interact with each other.

At the same time, multiculturalism, tolerance, and responsibility are considered as necessary socially significant personal qualities in the information society. K.V. Gasyмова notes that, when building a new educational paradigm, it is important to adhere to the principle of intercultural tolerance (Gasimova, 2019).

There are studies which claim that national didactic systems should meet various person's needs and capabilities, the demands of actively developing digital economy (Soboleva, Karavaev, 2020). As a consequence, highly qualified specialists with not only professional, but also general cultural competencies are required by modern labor market (Khazova, Khatit, 2015). For example, they are considered to be prepared to communicate interculturally, be tolerant, perceive social and cultural differences, etc. These requirements are reflected in federal educational documents.

G.A. Kameneva, T.A. Bondarenko convincingly prove that digital means of training university graduates have a powerful didactic potential to form foreign language competence, intercultural communication, develop the feelings of patriotism, person's emotional and volitional characteristics, etc. (Kameneva, Bondarenko, 2018). For this purpose, video materials, virtual walls, animation, electronic reference books, online excursions are used.

J. Martín-Gutiérrez, C.E. Mora consider augmented reality (AR) technology as one of the innovative pedagogical technologies that meet the demands of the digital economy and the processes of globalization (Martín-Gutiérrez et al., 2017).

Such digital services are included in order to improve the quality of assimilation of new theoretical material, enhance cognitive interest. Much less often, such services are applied to form a foreign language competence, intensify group communication and support teamwork. As a consequence, participants in the information and education interaction (future highly qualified specialists, teachers themselves) do not fully use the resources of AR technology to form in-demand general cultural competencies (intercultural communication, tolerance, patriotism, understanding the values of other nations, etc.). In addition, as M. Elphick notes, problems arise when appropriate applications are chosen and applied technically while developing and educating an individual (Elphick, 2018).

We agree with I.E. Shcherbakov, O.V. Karaseva, D.A. Gorbacheva that targeted methodological activities aimed to form graduates' digital competencies, focused on obtaining fundamental knowledge and in-depth skills in this field should be implemented at the master's level (Shcherbakov i dr., 2021).

Thus, there is a need to study augmented reality further as an innovative pedagogical technology in order to:

1. Include new teaching methods and tools to form higher education multicultural environment;
2. Effectively use AR in the educational and cognitive and professional activities of future highly qualified specialists (in particular, master's degree students).

The following hypotheses were accepted:

Ho: the level of master's degree students' multicultural competence in the experimental group is statistically equal to the level obtained in the control group;

H1: the level in the experimental group is higher than the level of the control group.

1.2. Purpose and objectives of research

The purpose of the study is to understand and take into consideration the peculiarities of using augmented reality technology when training highly qualified specialists, developing multicultural competence as an integrated personal quality in higher education.

The study objectives are:

- to analyze current trends and problems of forming future specialists' multicultural competence;
- to identify prospects and possibilities of using AR technology in training students of higher educational institutions;
- to clarify the concept of "multicultural educational environment" in the context of digitalized society;
- to specify the didactic potential of augmented reality applications and tools while developing multicultural competence and demanded digital skills;
- to describe principles and directions of teacher's support for educational, cognitive and professional activities of master's level students when applying AR in accordance with its functions, challenges of globalization, labor market requirements, and higher education standards;
- to experimentally confirm that the proposed activity is effective when developing master's level students' multicultural competence.

2. Relevance

2.1. Literature review

In accordance with the purpose of the study, the literature was reviewed in two directions:

- 1) We identified how multicultural educational environment is formed under modern socio-economic conditions;
- 2) We described the range of applications of new digital technologies which are used to develop general cultural competencies and train highly qualified specialists of the future (including master's degree students).

2.1.1. Russian scientific and pedagogical literature review

A.L. Gavrikov, T.V. Mukhlaeva, when describing UNESCO activities within the framework of international cooperation, note that the organization performs such functions as: implementing promising research on forms of education, science, culture, and communication which are necessary in the world of the future; support for the promotion, transfer, and exchange of knowledge (Gavrikov, Mukhlaeva, 2017).

Federal documents in the field of Russian higher education determine the main competencies of in-demand specialists of the digital economy: respect for historical heritage and cultural traditions (Eskindarov et al., 2021), tolerant perception of differences between representatives of different nationalities, etc. As a result, teachers in the classroom are encouraged to actively apply pedagogical technologies to form appropriate general cultural competencies, patterns and values of social behavior in the globalizing world, multicultural communication skills and tolerance (Tikhonova i dr., 2018).

Within the first direction, it was also determined that multiculturalism, according to the conclusions of N.A. Astashova, S.K. Bondyрева, O.L. Zhuk, on the one hand, is a personality quality that allows a person to identify themselves as "an individual with their own culture and value system formed by tolerance towards other cultures and the culture of interethnic communication" (Astashova i dr., 2019). On the other hand, multiculturalism, e.g., according to O.A. Obdalova, O.V. Odegova, is considered as an important characteristic feature of modern education (Obdalova, Odegova, 2018).

S.A. Khazova, F.R. Khatit state that multicultural competence determines a person's ability to live and work effectively, interact in a multicultural society. As a consequence, cognitive,

motivational and value, activity and behavioral components should be distinguished (Khazova, Khatit, 2015).

Within the second direction, we noted that, under the conditions of the dynamically developing information society, the need to establish intercultural interaction with representatives of other countries is increasing (Serostanova, Choporova, 2020).

S.V. Volodenkov concludes that, due to modern information and communication technologies, the borders of states and, consequently, contacts between representatives of different cultures are expanding (Volodenkov, 2016). So, in order to bring peoples closer, a large number of chats, forums and platforms are being created to establish effective interaction between representatives of different cultures. According to E. V. Soboleva et al., innovative technical means, software applications bring the learning process to a qualitatively different level (Soboleva et al., 2020).

A.V. Grinshkun highlights the fact that the use of augmented reality technology while training highly qualified specialists allows overlaying computer graphics or text information into the content of the real physical world in the present time (Grinshkun, 2018). And, indeed, students feel that they can find informational virtual objects in real environment. These circumstances enhance students' interest, cognition, research, and creativity (Kotenko, 2020).

A.V. Ivanova also proposes the structure of augmented reality applications for university education. The designed structure includes the following modules: tracking cameras, object storage, visualization devices, and user interface (Ivanova, 2018).

According to N.N. Serostanova and E.I. Choporova, the use of AR technology meets the requirements of modern educational standards and, when effectively organized, intensifies the didactic process (Serostanova, Choporova, 2020).

M. Rumyantsev, I. Rudov confirm that currently higher educational institutions in Russia use AR and VR mainly when teaching natural science disciplines (Rumyantsev, Rudov, 2016).

In the digital environment, the teacher will have to learn how to organize and direct students' cognitive activity, build multicultural interaction, network collaboration, personalized presentation of the material using modern information technologies.

S.S. Kulikova, O.V. Yakovleva note that the problem of using new technologies when developing general cultural competencies and training highly qualified specialists of the future is of particular importance nowadays when education is designed to prepare a multilingual multicultural individual capable of using digital educational resources to enhance intercultural and interpersonal communication, be part of national and world cultures (Kulikova, Yakovleva, 2022). According to the authors, digital educational environment is a challenge of the new time, a condition, as well as a means of training a specialist of a new breed.

In order to warn teachers seeking to enrich their software and technical tools, A.L. Zhuravlev, T.A. Nestik, focus on potential risks, security threats and problems of personal development (Zhuravlev, Nestik, 2019). For example, when installing applications for AR, teachers must require from students to comply with security measures, maintain the integrity and confidentiality of information and must do it themselves.

So, on the one hand, developing multicultural educational environment, forming person's multicultural competence are the priorities of the country's policy in the international economic sphere; on the other hand, the use of augmented reality technology in education is supported by the provisions of the Education national project.

The Russian literature review allows identifying the problem that developing multicultural competence and in-demand digital skills of students who major in Pedagogical Education needs further study.

2.2. Foreign literature review

When studying the peculiarities of forming multicultural educational environment under modern socio-economic conditions, it was noted that most foreign scholars recognize the significant role of information technologies in terms of enhancing multilingual interaction and dialogue of cultures.

M.U. Nadeem, R. Mohammed, S. Dalib prove that the globalization of society is not only accelerating scientific and technological progress, intellectualizing all types of human activity, but also is creating a qualitatively new information environment (Nadeem et al., 2020). Within this environment, the person's creative potential is developed. For example, cloud services, according to

V. Maria-Díaz, M. López-Pérez, B. Fernandez-Robles, are effective tools to obtain all types of information (Marín-Díaz et al., 2020). And the widespread use of VR/ AR technologies contributes to developing the country's economy, significantly increases productivity and efficiency at industrial enterprises, forms new approaches to the learning process, improves the level of education, qualitatively increases the level of healthcare and makes medical care more accessible. In addition, VR/AR technologies create the state-of-the-art ways of communication (Thees et al., 2020).

M.U. Nadeem, R. Mohammed, S. Dalib also state that, in the context of forming a multicultural individual in information and education environment, in-demand specialists of the future need to master not only professional communication skills, but also various technical means of communication with colleagues (Nadeem et al., 2020).

Along with these directions, VR/AR applications and systems are also being widely used in education (Merchant et al., 2014).

For instance, according to T. Liao, such technical means of communication enhance foreign language communication, intensify, individualize and differentiate the learning process (Liao, 2020). However, as noted by R. Raisamo et al., virtual environments and software applications, like any means, have their advantages and disadvantages (Raisamo et al., 2019). The teacher's task is to optimally integrate them into the educational process and communication between all participants of the didactic process.

J. Bacca et al., when describing the range of applications of new digital technologies used to develop general cultural competencies and train highly qualified specialists of the future, argue that augmented reality technology has significant educational potential and is a universal tool of developing memory, attention, thinking (Bacca et al., 2019). This technology makes it possible to achieve a new form of digital managing and ordering data; a new quality of information visualization; a higher level of communication (Geng, Yamada, 2020).

J. Martin-Gutierrez claim that online courses, electronic diaries and textbooks, adaptive individual educational programs are becoming an integral part of the current learning process (Martin-Gutierrez, 2017).

However, according to M. Fan, A.N. Antle, J.L. Warren, teachers and students in higher education use augmented reality tools mainly to model or study phenomena and processes that are difficult to implement in real conditions (Fan et al., 2020).

Network etiquette, respect for the "virtual" interlocutor, and psychological comfort in intercultural communication are studied separately in foreign science (Auwalu et al., 2015).

So, despite the wide range of didactic possibilities of augmented reality technology in university education, training highly qualified specialists, developing general cultural competencies and socially significant personality qualities, there are a number of objective factors that must be taken into account when forming multicultural environment. First, teachers must be prepared to conduct a dialogue of cultures, be tolerant and perceive a different opinion. Second, it is necessary to understand the risks of using AR in terms of the psychological climate within the team, in which students of different nationalities can study. Third, it is difficult to choose an AR application that works as efficiently as possible to achieve the didactic goals.

Thus, there is an objective need to study the potential of augmented reality technology, taking into account training master's degree students to meet the requirements of the digital economy, the challenges of the globalizing society, as well as for the students' benefit.

3. Materials and methods

3.1. Theoretical and empirical methods

The following methods are used in the study: theoretical analysis and generalization of scientific literature on the problems of developing a person's multicultural competence in the context of globalization and informatization; the use of digital tools to improve the quality of higher education; the use of the AR technology potential when forming professional and general cultural competencies.

The main methodological idea of the study is determined by the key principle of multicultural education which implies assimilating knowledge about other cultures by master's level students, implementing effective intercultural interaction, forming a worldview, conducting a dialogue between representatives of different countries, nations, etc.

The Zome application which is an improved version of WallaMe is used as a software tool.

Augmented reality technology and Zome are applied using quest.

Independent and frontal laboratory work, mini-research and creative projects, demonstration, work according to instructions, gamification and m-learning are used at various stages of multicultural information and education interaction.

To obtain up-to-date information about the level of master's degree students' multicultural competence, empirical methods are used: monitoring the communication of all the interacting participants; analysis of messages and results of activities in Zome (virtual texts, the number and quality of images, the choice of geo-location); the number of attempts to find the right solution; time to study theoretical material in published work; the volume and correspondence of the audio files used, etc.

AR tools to design multicultural educational environment were directly studied when teaching Development and Application of Computer Games in Training. AR-tools to communicate in augmented environment of multicultural interaction were applied while teaching Foreign Language in Professional Activities, Interactive Educational Technologies in Specialized Training, Digital Environment of Technological Education. In total, 42 master's degree students (44.04.01., Pedagogical Education) were involved in the experiment. Experimental and control groups (21 students in each) were formed from these students using the author's testing.

The author's testing consisted of 60 tasks divided into blocks according to the components of multicultural competence. In each block, there were 2 tasks for free presentation/designing and 10 closed-form tasks (matching, selection/multiple choice, working with a text fragment, filling in gaps, etc.). Examples of tasks are presented in section 4.3.1.

During testing, adapted diagnostic materials by S.A. Khazova, F.R. Khatit were used. To diagnose the level of the multicultural competence step by step, S.A. Khazova, F.R. Khatit recommend to use the following methods (Khazova, Khatit, 2015):

1. The cognitive component of multicultural competence should be assessed using the results of monitoring students' knowledge in academic disciplines of the corresponding stage or the integrated assessment of the level of knowledge using specially developed tests.

2. The motivational and value component of multicultural competence should be assessed using:

- testing involving ranking of multicultural values mastered at a specific stage (a) and the assessment of the personal significance of multicultural values mastered at a specific stage (b);
- a questionnaire aimed at clarifying the relationship of stimuli (motives) that determine or may determine the students' activity in intercultural interaction;
- a questionnaire aimed at identifying the presence, strength, and orientation of students' interests regarding intercultural interaction.

Thus, an integrated set of cognitive, motivational and value, activity and behavioral, reflexive and evaluative components was taken into account in the author's testing.

The average age of respondents was 28 (53 % of girls and 47 % of boys). The number and composition of the sample were justified by the study specifics. When characterizing the relationships of the features under consideration, nonparametric statistical criteria are used, in particular, the Pearson's chi-square coefficient – χ^2 .

3.2. The base of research

The main purpose of the experiment was to test AR effectiveness in the master's level students' educational, cognitive and professional activities while developing their multicultural competence. 42 master's degree students (44.04.01 Pedagogical Education) were involved.

Using the entrance testing, we collected the required initial data about the students. The sample was not random. To fulfill the rules of probabilistic selection, the same teacher supervised the intellectually-directed and cognitive activities of all the master's level students when using AR applications. While networking in the multicultural educational environment, the specific features of future work were taken in account.

AR applications were studied and subsequently applied while teaching Foreign Language in Professional Activities, Interactive Educational Technologies in Specialized Training, Digital Environment of Technological Education, Development and Application of Computer Games in Training.

The teacher formulated research tasks, directed the master's level students' network interaction in multicultural educational environment, educational materials in augmented reality.

AR applications (building links between elements, adding images, various documents, uploading materials, exporting) were used in the same classrooms using the same hardware and software. The test was developed by the authors in accordance with the current standard of higher education in the given field.

3.3. Stages of research

The effectiveness of AR technology in the university environment aimed at educating a multicultural individual and improving the quality of education in general was evaluated during the pedagogical experiment.

The study was conducted in three stages.

At the preparatory stage, various software tools and applications supporting AR technology were analyzed. The following characteristics as criteria for selection were used: open access (free distribution), multilingualism, ability to work individually and in a group, presentation of information in various forms, information security in network collaboration.

As advantages of Zome, we note the possibility of networking, using maps and geo-positioning, adding images (including animation) and texts in various languages, protected account and access to interaction only with the interlocutor's consent, intuitive interface, free software distribution.

Further, the tasks to assess the master's degree students' level of multicultural competence were developed. It was taken into account that when studying the phenomenon of "a person's multicultural competence", an integrated set of cognitive, motivational and value, activity and behavioral, reflexive and evaluative components should be considered. A block of tasks to assess the quality of solving professional tasks by master's level students was also added. Examples of tasks are presented in section 4.3.1.

Students could get from 0 to 100 points for testing. According to the results, the levels were determined as follows: from 85 (inclusive) to 100 points were considered the "high" value, from 61 (inclusive) to 84 – "average", for other cases – "low".

The level of master's degree students' multicultural competence was determined using the results of the presented and discussed individual messages on geometrics and the results of the quest as a whole; the intensity of interaction in AR environment. The methodology to determine the level of master's degree students' multicultural competence is also described in section 4.3.1.

Thus, the collected data on 42 participants of information interaction made it possible to form experimental and control groups (21 master's level students in each).

Conditions for the formation of the control and experimental groups include an approximately equal number of boys and girls, similar factors in the motivation for intercultural communication and collaboration in AR; emotional responsiveness and attentiveness to the conversational partner; ability and readiness for multilingual information interaction; approximately the same user skills in working with digital technologies.

The second stage of the research is devoted to clarifying the principles and directions of teacher's support for master's level students' educational, cognitive, and professional activities when applying AR in accordance with its functions, the challenges of globalization, labor market requirements and higher education standards.

The third stage of the study involves experimental teaching and using AR applications in master's degree students' training.

4. Results

4.1. Clarifying basic concepts

Within the study, augmented reality (AR) is considered both as a learning technology and as information environment for personal development. Text information, graphics, video, 3D models, sound are used to interact with the user in augmented environment. AR was used in the experimental group training in order to solve the following tasks:

- to create additional conditions to study the basics and principles of forming cultural environment in all the diversity of norms, values, traditions, stereotypes; determine the

effectiveness of intercultural communication technologies; take into account the rules and peculiarities of business communication;

- to organize the communication process taking into account the cultural context to achieve the given result;

- to form skills of joint activity in various forms taking into account the peculiarities of the cultural environment;

- to study innovative technologies in accordance with the trends of globalized and integrated society, challenges of the digital economy, and labor market requirements;

- to apply digital technologies to analyze, take into consideration the diversity of interests, cultures in multilingual and intersectoral interaction;

- to use the capabilities of new software tools to highlight the intercultural diversity of society in socio-historical, ethical and philosophical contexts;

- to study the history of Russia and universal history, the place and role of Russia in the history of mankind and in the modern world;

- to forecast and find solutions to philosophical, socio-historical and ethical problems of modern society.

When selecting information resources, digital means for multicultural education, the principles of humanism and tolerance, practice-oriented interaction are used.

Augmented reality is a technology that includes virtual information in the real world which seems to coexist with the person within the same environment. The information received by the user is not perceived only visually. Both hearing and touch can be used what makes the feeling of “immersion” of augmented reality. AR tools allow replacing or supplementing existing spatial objects which combines computer-generated information with the real environment. Due to this, AR-based applications can work interactively in real time.

In order to come into contact with augmented reality, it is enough to have a smartphone, tablet, computer or AR glasses, which are the technical shell of the technology. Gadgets must have special software and a camera. If all the conditions are met, it is possible, e.g., to immerse in the Lewis Carroll’s world, see a variety of ghost towns, visit the Island of Lost Ships and Nautilus. Due to the interactive guide, the user has a real opportunity to get acquainted with the history of various architectural structures, monuments, exhibits. Ordinary people can experience the world from that “fabulous” side, which existed, in their opinion, only in the Emerald City.

It is the analogous “glasses with green emerald glass” – the AR application – which allows students from different ethnic groups (representatives of different peoples) to find mutual understanding and equally emotionally perceive the “augmented” world.

To combine educational, cognitive and educational goals while training specialists, the Zome service was used. This is a messenger and augmented reality network with tools to create and share digital content anywhere in the world; it does not imply just being online.

4.2. Using AR in the university information and education environment to enhance multicultural interaction

AR applications were used in the experimental group to achieve the goals of personal development and obtain high-quality professional knowledge and skills. Augmented reality technology was applied in training master’s level students in order to stimulate communication in multicultural environment, foreign language communication, research and creativity, find solutions to educational tasks, work out speech structures, etc.

As a result, after AR was included in the information and education environment of multicultural, intersectoral interaction, a software product was developed that allows supplementing the surrounding reality which is seen by the smartphone camera with virtual objects. In this case, new theoretical material is applied in practice, and additional conditions are created to develop person’s emotional and volitional qualities, feelings of patriotism, and tolerance.

Within this study, the Zome application is not just a messenger/network for augmented reality where participants of information interaction can create and share their own digital content. The Zome environment in the experimental group is multicultural educational environment that promotes communication of representatives of different cultures in different languages, exchange of opinions and emotions, develops communication skills in the network (network etiquette both at

the household and professional level), supports information security measures, etc. The algorithm to use an augmented reality application is as follows:

Step 1. To download the application using any platform

- <https://apps.apple.com/pl/app/zome-augmented-reality/id1382123356?l=ru>,

- <https://play.google.com/store/apps/details?id=com.zomecorp.zome&hl=ru&gl=US>, and run it.

Step 2. To register. There are two ways to do this: using e-mail or phone number (for the user's convenience, there is a Sign Up button in the interface).

Step 3. To enter the main screen of the application. It looks like a regular phone camera. There are several working tools on the screen that help create one's own messages and search for other users' tags.

When studying new material within the discipline, in particular "Educational Quests: Use at Various Stages of the Educational Process", participants of the experimental group develop the quest content: the number of locations to find a solution, the content of each station. For example, the quest task is "to determine the year in which Charles Wheatstone, an English physicist, invented a stereoscope that allows users to "dive" into a three-dimensional image." The answer is 1837.

We describe the influence of the presented task on the formation of each of the components of the person's multicultural competence.

The students start their journey in the university classroom. They use the application to find a "superimposed" message on the wall – the text of the task. The background is the Rembrandt Museum signboard in Kirov. The task is to find the figure which is used in the Bible to denote one single true God. The correct answer is 1.

Then the students go to the Museum. On the facade, together with information on the museum history, Rembrandt's biography, a new task is given which says: if you put tangerines on a platter in a circle or an octagon, well-being gets an infinity symbol. As a hint to the next station, an audio recording of the bell ringing from the St. Trinity Church in the settlement of Makaryevskaya is used. The correct answer is 8.

At the bell tower of the St. Trinity Church, the students receive an augmented reality message "Third Person is a 2013 romantic drama film directed and written by Paul Haggis." The task is to determine the original quantitative numeral for the ordinal numeral from the film title, translate it into Russian. The next point of the quest is the cultural place where this film was released. The correct answer is 3.

At the fourth station (the Kolizeum cinema hall in Kirov), the students again find the text of the task using smartphones and the Zome application camera with the help of the QR code. The initial message contains the following sequence of attractions: the Lighthouse of Alexandria, the Hanging Gardens of Semiramis, the Statue of Zeus in Olympia, the Temple of Artemis in Ephesus, the Mausoleum in Halicarnassus, the Colossus of Rhodes, the Pyramid of Cheops. The correct answer is 7.

Thus, the participants of information interaction really immersed themselves in the multicultural educational environment supported by augmented reality. The students showed knowledge of the foreign language, their native land, world religion, culture, and art. The cognitive component was formed due to various ways of encoding information, conceptual structures and connections used.

When completing the quest tasks, the students made judgments, formulated statements, gave arguments, i.e. expressed their social stance.

While choosing the answer at the discussion stage and summing up the results, the reflexive evaluation component was developed.

During the journey through the stations, while distributing roles and functions, the conditions to enhance cooperation, joint activities and network collaboration (activity and behavioral component) were created.

Each of the areas of information interaction described corresponds to the specific task of the teacher's professional standard: to be able to give objective assessment; to possess knowledge of forms, teaching methods, and modern information technologies; to organize various types of extracurricular activities, etc.

To move the quest stations into the augmented reality, the participants of the experimental group performed the following actions:

- they created a group for information interaction, sent out requests and accepted invitations from all the quest participants;
- filled in the subject of the quest;
- added content (images, videos, text, sound, animation) using the buttons at the bottom of the screen;
- determined the location for the tag/message;
- set the time for the message to appear and disappear, the number of possible views by users using the Clock icon;
- set a password for the message using the Lock icon;
- checked the settings of all the elements for the message and clicked Send To button.

Thus, each master's level student performed the following roles: the role of a developer of their own quest for stations in augmented reality; an active quest participant in augmented reality, they were invited there through the Zome application.

The master's degree students in the experimental group studied and applied the following Zome features:

1. Creating message capsules with attachments for storage and distribution in space and time;
2. Setting the timer for the content to appear and disappear;
3. Creating individual maps (by profession, by cognitive interests);
4. Setting up the availability of messages when collaborating only to a certain group;
5. Limiting the number of message views;
6. Searching for the messages left in this location (inside it, the number of dots – left messages – is seen).

4.3. Experimental evaluation

4.3.1. The ascertaining stage of the experiment

At the first stage of the experiment, the materials specially developed by the author's team were used to evaluate the input. Below are the examples of tasks.

We took into account the provision that when studying the phenomenon of “a person's multicultural competence”, an integrated set of cognitive, motivational and value, activity and behavioral, reflexive and evaluative components should be considered. A block of tasks to assess the quality of solving professional tasks by master's level students was also added.

Block 1 (motivational and value component). As a task to establish compliance, master's degree students are given several situations of communication between representatives of various professions, peoples, cultures. Situations are simultaneously presented in text/sound form and in images. It is required to match them. The correct completion of the task is estimated as 1 point.

An example of the free presentation task is when students are given a set of words: “Germany”, “nation”, “development”, “culture”, “thought”. They are required to write a short story (at least seven sentences) using each of these words. The maximum mark for completing the task is 5 points.

Block 2 (activity and behavioral component). For example, when the task to select an answer from the list is considered, students are given a text from the field of intersectoral, intercultural interaction with missing words (set expressions). To fill in the gaps, students need to insert those words that, in their opinion, most accurately convey the interlocutors' emotions and feelings. The words to choose from are presented in a separate line. 1 point is given if the task is correctly completed.

An example of the free presentation task is as follows. In order to write the course paper, Maria needed to analyze at least ten information resources for learning English which could form personal educational results. Students are supposed to recommend Maria websites, Internet services, teaching materials, which, in their opinion, will allow her to solve the research tasks. The maximum score for completing the task is 5 points.

Block 3 (reflexive and evaluative component). For example, it is required to complete the sentence “Persons... are not allowed to teach” according to the norms of the current professional standard. In the first case, the master's level student receives multiple choice options. The correct completion of the task is estimated as 1 point. In the second case, the student independently constructs the answer. The maximum score for completing such a task is 5 points.

Block 4 (cognitive component). For example, students are given the task to select an answer from the list. From the suggested options, they choose what is traditionally eaten for breakfast, lunch, and dinner in a particular country. 1 point is given for the correct completion of the task.

As a free presentation task, students suggest their own version of the origin of Japan or construct their own version of the Pyramid of Cheops. The maximum score for completing the task is 5 points.

Block 5 (to assess the quality of educational results). For example, students work with a text. Using a fragment from K.Y. Polyakov's teaching materials, they note those factors that (according to the text) are disadvantages of the Roman numeral system. The correct completion of the task is estimated as 1 point.

To complete the free presentation task, students with the help of search engines for each of the given situations of intercultural (or intersectoral) interaction are to select materials: media publications, images, audio files, animated videos and analyze them by the following criteria: novelty, objectivity, reliability, tolerance, patriotism. The maximum score for completing the task is 5 points.

Master's degree students could get from 0 to 100 points for testing. According to the results, the levels were determined as follows: from 85 (inclusive) to 100 points were considered the "high" value, from 61 (inclusive) to 84 – "average", for other cases – "low". Thus, it was possible to collect data on 42 master's degree students, from which the experimental and control groups were formed (21 people in each). The experimental group consisted of 53 % of girls and 47 % of boys.

A set of criteria for evaluation is as follows: being motivated to perform multilingual (intercultural) communication and collaboration in AR; being emotionally responsive and attentive to the interlocutor; possessing systematic and integral knowledge about the language, the history of their country and other cultures; understanding the problems of modern society and the use of new digital technologies (in particular, AR) to solve them; the presence of their own reasoned points of view (positions /opinions) in the context of intercultural interaction; tolerant attitude; implementing measures to protect information; compliance with the rules of communication, network etiquette.

The high level of multicultural competence was determined if the master's degree student was strongly motivated; was able to design intercultural communication using AR technology; was emotionally responsive, attentive to the interlocutor regardless of their race, religion, etc.; used AR resources to gain knowledge about the specifics of the country's culture, history and took these facts into account when organizing foreign language communication; had their own moral stand in the context of intercultural interaction; performed measures to protect information in the AR application account and on the Internet; observed network etiquette.

The average level of multicultural competence was registered if the master's degree student was not always motivated to be involved in multilingual, intersectoral interaction; could design intercultural communication using AR technology only with the mentor's help; was emotionally responsive, attentive to the interlocutor, most often depending on their race, religion, etc.; rarely used AR resources to gain knowledge about the specifics of the country's culture, history and could not take these facts into account when organizing foreign language communication; the student was not always able to argue their own moral stand in the context of intercultural interaction; they could forget to take measures to protect information in the AR application account and on the Internet; sometimes they violated the rules of network etiquette.

The low level of multicultural competence was determined if the master's degree student was most often not motivated to be involved in multilingual, intersectoral interaction; experienced difficulties in designing intercultural communication using AR technology; in most cases, the student was not emotionally responsive, attentive to the interlocutor; used AR resources for entertainment, not for foreign language communication; did not seek to argue their own moral stand in the context of intercultural interaction; could forget to take measures to protect information in the AR application account and on the Internet; often violated the rules of network etiquette.

4.3.2. Forming stage of the experiment

This stage of the experiment was aimed to determine the options for using AR applications to stimulate communication in multicultural environment, foreign language communication, research and creativity, find solutions to educational tasks, work out speech structures, etc.

Using this application, the participants of the experiment could create message capsules with attachments that existed in space and time. The service made it easy to add a timer for the content to appear and disappear. Configuring availability of messages was also implemented. In particular, it was possible to send them not to all users, but only to a certain circle of people, e.g., by interests – a healthy lifestyle, learning the languages of the peoples of the North. The number of views of this capsule can also be limited. For instance, in order to collect information about the speed of execution (those who managed to do the task received a new task, those who did not manage the task, did not receive a new one). Zome helps create, explore and share knowledge and memories with each other.

The initiator of the project activity carried out preliminary methodological work with all the participants of the didactic process on mastering the functions of the AR application.

No special engineering skills or additional utilities are required to install the application. The interface is similar to Google Maps design and functions. To master the application successfully, minimal knowledge of English is sufficient (“message”, ‘subject’, ‘profile’, ‘welcome”, “PM”, “key”, etc.).

Augmented reality technology was studied and Zome was applied in the experimental group using quest. Quest, as an organizational form of master’s level students’ educational and cognitive activity, makes it possible to use new digital means to provide new theoretical material (including foreign language), intercultural communication, develop responsibility, integrity, tolerance, and feelings of patriotism.

The master’s degree students in the control group studied topics according to the curriculum in the traditional way through a series of lectures and seminars. In the classroom, the teacher used interactive simulators, text mazes, programming environments, multimedia presentations, cloud services and other Internet information resources.

After using augmented reality tools and methods to design multicultural information and education environment, another control event was held.

4.3.3. Control stage of the experiment

To assess the effectiveness of AR technology in the university environment aimed at fostering multicultural information and education environment, the control testing was held. The questions were developed in accordance with the principles described earlier.

The evaluation results before and after the experiment are presented in [Table 1](#).

Table 1. Results of using AR applications in the educational process and organization of intercultural communication of master’s level students

Level	Groups			
	Experimental group (21 master’s degree students)		Control group (21 master’s degree students)	
	Before the experiment	After the experiment	Before the experiment	After the experiment
High	1	7	1	1
Average	9	11	10	13
Low	11	3	10	7

Using <http://medstatistic.ru/calculators/calchit.html>, the values of the criterion before ($\chi^2_{\text{observ.1}}$) and after ($\chi^2_{\text{observ.2}}$) experiment were calculated. For $\alpha = 0.05$ according to the distribution tables, the χ^2_{crit} is 5.99. Thus, we get: $\chi^2_{\text{observ.1}} < \chi^2_{\text{crit}}$ ($0.10 < 5.99$), and $\chi^2_{\text{observ.2}} > \chi^2_{\text{crit}}$ ($6.27 > 5.99$). Consequently, the shift towards increasing the level of master’s degree students’ multicultural competence can be considered non-accidental.

5. Discussion

The sample of master’s degree students was not probabilistic since the experimental and control groups were formed in such a way that the presence of the same personality qualities in each group was guaranteed, combining the motives of cognition, acceptance of the general and

specific in each culture as values; knowledge of laws, ways of life and development of the multicultural world; skills to apply them while educating a future student as a person of culture.

The experimental group consisted of 53 % of girls and 47 % of boys. Reason: there were 21 master's degree students in each group.

For diagnostics, the results of the input control event were taken into account. The participants selected for the experiment and the sample size are substantiated by the study specifics. In particular, the study of theoretical material on AR technologies, the use of interactive educational tools for professional multilingual interaction are included in the training program for a limited number of specialties.

When implementing the experiment, the basic principles of an educational quest were taken into account (setting the goal, inventing the plot, the venue of the quest, the presence of search activity tips, a variety of stages and tasks, thinking over the educational and cognitive trajectory), the functions of the service for modeling multicultural dialogue in the university's information and education environment.

Based on the quantitative analysis of the data obtained, it can be concluded that after the experiment was completed, 33 % of master's degree students in the experimental group had the "high" level of multicultural competence (7 students out of 21), while initially this percentage was equal to 5 % (1 undergraduate out of 21). The number of students with the "low" level significantly decreased from 52 % to 14 %. For the control group, there was no dynamics registered at the "high" level; after the experiment, 62 % (13 students out of 21) had the "average" level (initially, 10 respondents out of 21); the indicator for the "low" level changed from 48 % to 33 %.

While discussing the results on the development and content of the AR Zome application (virtual texts, the number and quality of images, the choice of geo-location), the choice of topics for intercultural communication, the number of attempts to find the right solution to the philosophical, socio-ethical problems of modern digital society, person's emotional and volitional qualities were evaluated. Summarizing the observation materials, we conclude that the participants of the network interaction in the educational environment of the experimental group highlighted the following Zome functions:

- activating various coding methods and forms of information presentation;
- setting up access to view messages when collaborating only for a specific group, e.g., by interests (for those interested in computer science, for travelers);
- moving through time and space, e.g., to post a message about Paris from home. Such a technique can be useful if world discoveries, international events are overviewed;
- limiting time and attempts to respond. For example, master's level students used this opportunity to collect information about the time spent and resources used to find the "secret key".

Among the disadvantages of the technology, the students of the experimental group noted users' excessive enthusiasm for the technology itself and the digital medium; fatigue in the eyes; dependence of the pace of work on the quality of the Internet or mobile connection; the functions of AR Zome largely depend on the smartphone model and the country for which the device was released.

Thus, the AR application (in particular, Zome) helped, on the one hand, create, explore and share theoretical knowledge and professional skills; on the other hand, the learning environment was enriched with augmented reality tools to exchange opinions, emotions, and memories among the representatives of different cultures, in different languages. To solve educational and cognitive tasks, the master's degree students of the experimental group needed to use such socially significant qualities as conscientiousness, attentiveness, empathy, responsibility, patriotism, and tolerance.

Thus, innovative pedagogical technologies (in particular, AR) allowed not only creating additional conditions to form professional competencies, but also developed intercultural communication, cooperation and international interaction (Burnet, 2008). The obtained conclusions about the didactic potential of AR technology in terms of improving the quality of education, the demanded digital skills are confirmed by A.V. Grinshkun (Grinshkun, 2018), J. Martín-Gutiérrez, C.E. Mora (Martín-Gutiérrez et al., 2017). In addition, it was possible to confirm the opinion of E. V. Tikhonova, A. S. Potapova, A.V. Krider regarding the didactic possibilities of digital services while developing general cultural competencies (tolerance, intercultural communication, etc.) (Tikhonova i dr., 2018).

6. Conclusion

Based on the analysis and generalized capabilities of AR technology to develop multicultural educational environment, the need to organize additional methodological work when training master's degree students as highly qualified specialists, the authors reasonably identify a promising direction in the new educational paradigm – the use of AR to form master's level students' multicultural competence.

The study revealed how augmented reality methods and tools that influence the level of multicultural competence as an integrated personal quality and improve the quality of education in general should be applied:

1. Modern AR applications make it possible to effectively simulate virtual environment for joint activities and dialogue of cultures, multilingual communication and collaboration due to the capabilities of the interface and built-in functions: language setting, geo-location, account setup and location access, data transmission in different formats. Due to these capabilities, AR digital services can be used while studying various cross-cultural and professional topics, intensify the educational process and increase the effectiveness of socio-cultural integration of students.

2. AR applications increase motivation, develop socially significant personality qualities (tolerance and patriotism, responsibility, emotional empathy, etc.).

3. Activities in augmented reality educational environment provide new resources to improve the quality of professional training. This is due to the increase in information interaction between participants of the didactic process, intersectoral communication. The roles of teachers and students are being transformed.

4. AR technology supports the principles of visibility, accessibility, completeness, interactivity while forming imaginative thinking and spatial imagination (3D visualization, adaptation to the specific needs of each user).

Innovative pedagogical technologies activate cognitive interest in fundamental scientific theory, modeling and search for solutions to cultural and historical, socio-economic problems.

5. AR environment allows implementing the “feedback” mechanism at a qualitatively different level. Augmented reality imposes “external” visual, audio and tactile signals on the “internal” field of human vision. Navigation data, remote projection make it possible to accompany epistemological processes.

6. When using AR services, perception and the nervous system (increased excitability, emotional burnout, headaches) may be overloaded. When working in digital environment, information protection measures, rules of network etiquette and professional communication should be carefully observed. When choosing an application, functions for delimiting access to personal data (geo-location, message history) should be available.

7. Digital applications are not an end in themselves in terms of their studying and practical application. Their use is justified by the logic of educational, cognitive activity in multicultural educational environment.

8. Augmented reality tools should not become tools to manipulate a representative of another culture, to implement terrorist intentions.

The conducted experiment confirmed the undoubted advantages of using augmented reality technology to organize and support students' design and creative activities aimed at studying scientific world discoveries and achievements, the peculiarities of different peoples, their mentality, etc.

As an important methodological recommendation, we note that all participants in intercultural communication are to be ready and able to objectively analyze and evaluate information they acquire from augmented reality environment.

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