Formation of readiness of future teachers to use augmented reality in the educational process of preschool and primary education

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Abstract

The article substantiates the importance of training future teachers to use AR technologies in the educational process of preschool and primary education. Scientific sources on the problem of AR application in education are analyzed. Possibilities of using AR in work with preschoolers and junior schoolchildren are considered. Aspects of research of the problem of introduction of AR in education carried out by modern foreign and domestic scientists are defined, namely: use of AR-applications in education; introduction of 3D technologies, virtual and augmented reality in the educational process of preschool and primary school; 3D, virtual and augmented reality technologies in higher education; increase of the efficiency of learning and motivating students through the use of AR-applications on smartphones; formation of reading culture by means of augmented reality technology; prospects for the use of augmented reality within the linguistic and literary field of preschool and primary education. The authors analyzed the specifics of toys with AR-applications, interactive alphabets, coloring books, encyclopedias and art books of Ukrainian and foreign writers, which should be used in working with children of preschool and primary school age; the possibilities of books for preschool children created with the help of augmented reality technologies are demonstrated. The relevance of the use of AR for the effective education and development of preschoolers and primary school children is determined. Problems in the application of AR in the educational process of modern domestic preschool education institutions are outlined. A method of diagnostic research of the level and features of readiness of future teachers to use AR in the educational process of preschool and primary education has been developed. Criteria, indicators are defined, the levels of development of the main components of the studied readiness (motivational, cognitive, activity) are characterized. The insufficiency of its formation in future teachers in the field of preschool and primary education; inconsistency between the peculiarities of training future teachers to use AR in professional activities and modern requirements for the quality of the educational process; the need to develop and implement a holistic system of formation of the studied readiness of future teachers in the conditions of higher pedagogical education are proved. A model of forming the readiness of future teachers to use AR in the educational process of preschool and primary education has been developed.

Keywords

augmented reality (AR), digital technologies, teaching aids, educational process, preschool education, primary education, higher education institution (HEI), future teachers

1. Introduction

1.1. Problem statement

In modern society, the development of digital technologies makes it possible to modernize the educational process, using various trends in modern education. The use of digital technologies in teaching can accelerate the transfer of experience, as well as improve the quality of education by maximizing the involvement of the child in the educational process. The real trend of today is augmented reality (AR) – complementing the physical world with real-time digital data. It is actually a technology for applying virtual reality to objects in the physical world. The use of this technology in the educational process of preschool and primary education increases the level of assimilation of information due to the interactivity of its presentation in 3D, allows teachers to quickly and easily explain difficult to imagine educational material, and children easily learn it. Moreover, it promotes creativity, increases the cognitive activity of children, helps to keep their attention longer, because augmented reality causes children to admire and feel something extraordinary. This is especially important for higher pedagogical education, as the future teacher must master these technologies in order to successfully apply them in their further professional activities. The development of the teacher depends on a deep understanding of the child's current needs, prospects and priorities of education, the ability to master new technologies and teach children to achieve a common goal through modern ICT.

1.2. Literature review

We have analyzed a number of studies that focus on the use of AR technologies in a wide range of educational contexts [1, 2, 3, 4, 5, 6] and provide an appropriate understanding of how AR technology helps the education of students [7, 8, 9, 10, 11, 12, 13, 14, 15], pupils [16, 17] and preschool children [18] in educational institutions.

The educational experience of augmented reality, as noted by Billinghurst [19], has a number of reasons: support for the interaction between real and virtual environments; using a tangible interface metaphor to manipulate objects; the possibility of a smooth transition between reality and virtuality.

Kesim and Ozarslan [20] note that combining AR technology with learning content increases the efficiency and attractiveness of teaching and learning, as it improves students' perception

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of and interaction with the real world. With the help of augmented reality systems, students interact with 3D in-formation, objects and events in a natural way. They can move around a three-dimensional virtual image and view it from any point of view, like a real object. The information conveyed by virtual objects helps students complete real tasks.

Dutta [21] believes that the practical and visual aspects of learning also help to speed up the understanding of the content of the material, as visual memory is strongly stimulated. The author's research has shown that the use of AR technology significantly increases the amount of information that students remember, and that, in addition, this information is stored in long-term memory.

Exploring the use of augmented reality technology in a mobile-oriented learning environment of higher education, Syrovatskyi et al. [22], Tkachuk et al. [23] conclude that the use of AR tools provides an opportunity to increase the realism of the study; provides emotional and cognitive experience that helps to involve students in systematic learning; creates new ways of presenting real objects in the learning process; motivates students to experimental and research work.

Determining the didactic potential of virtual information learning, Bondarenko et al. [24] emphasize such features of VR and AR as immersion, dynamism, sense of presence, continuity, causality, intensification of the learning process, saving time on material processing. Supporting the effectiveness of VR and AR training, the authors also point out the shortcomings, including low levels of computerization, little quantity and low quality of software products.

According to Salvador-Herranz et al. [25], this training is experimental. Thus, the more senses involved (sound, sight, touch, emotions, etc.), the stronger is the learning experience. In this context, augmented reality can play an important role in supporting experimental learning and providing students with an attractive technological tool to support their learning activities. Researchers have developed the AR application, which combines 3D models and animation, mini-games and quizzes. The developers chose a subject for primary school "Knowledge of the natural, social and cultural environment". The AR system, called Realitat3, consists of the AR mechanism and six AR applications: the skeletal system, the water cycle, plant development, the metamorphosis of frogs, the solar system, and the sense organs. Parhizkar et al. [26] developed a mobile application for primary school to provide children with a new level of experience in general scientific concepts such as materials, solids, liquids and gases, the various phenomena they pass through, the universe and galaxies, major parts human skeleton, digestive and respiratory systems, etc. Midak et al. [27] created a mobile AR-application for visualization of educational material in natural sciences.

Prospects for the use of virtual and augmented reality in the educational process of the Ukrainian school are studied by Osipova et al. [28]. The problem of forming a culture of reading by means of augmented reality technology is studied by Bessarab [29]. The study of Nezhyva et al. [30] is dedicated to the use of augmented reality in the language and literature of primary education, in particular, researchers note that the visualization of the artistic image by augmented reality contributes to the effectiveness of learning in various areas, namely: created a WOW-effect, surprises, with what deepens the emotional resonance of reading a work of art; becomes a powerful motivation for reading; promote the development of creative imagination; provides the perception of the artistic image by various senses; demonstrates to children the benefits of gadgets for learning and personal development.

In preschool education there is also an opportunity to apply augmented reality technologies.

Such products include toys with AR applications, travel games, coloring books, interactive alphabets, encyclopedias and art books by Ukrainian and foreign writers.

Thus, most publications on this issue indicate the possibility of using AR technologies in education to visually model educational material, complement it with clarity, provide children with emotional and cognitive experience, research and experimentation skills, which accelerates learning and makes this process interesting and active

1.3. The aim of the research

Analysis of scientific sources and practical experience of teachers shows that AR can be used in various activities of preschoolers and primary school children: play, language and literature, sensory-cognitive, research, artistic, etc., in particular to get acquainted with animals, human professions, literary characters, space, numbers, letters, etc.

However, the problem is that the use of AR technology is not provided by the programs of education and development of preschoolers and primary school children, but textbooks (except for the textbook and universal didactic material on AR to the integrated course "I explore the world" for primary school students) do not contain suggestions and tasks that may involve the use of augmented reality in the educational process, teachers study the new technology mostly them-selves and apply it spontaneously. In addition, there are psychological barriers to the use of new technologies by educators. Many of them continue to work as usual. Therefore, it is important to form in future teachers the ability to use AR in the educational process of preschool and primary education.

The purpose of this article is to substantiate the need to form the readiness of future teachers to use AR in the educational process of preschool and primary education, to develop a model of formation of this readiness in students of pedagogical institutes.

To achieve this goal it is necessary to solve the following tasks: to analyze scientific sources on the application of AR in education; consider the possibility of using AR in working with preschoolers and younger students; to analyze the specifics of publications of works of art, encyclopedias, coloring books, toys with AR-applications, which are appropriate to use in working with preschoolers and younger students; to investigate the current state of readiness of future teachers to use AR in professional educational activities; to develop criteria and levels of readiness of future teachers for the use of AR in the educational process of preschool and primary education, the stages of formation of this readiness.

2. Discussion

The results of the analysis of the essence of AR technology and the content of competencies (motor; health; subject-practical, technological; sensory-cognitive, logical-mathematical, research; natural-ecological; socio-civil; speech; digital; speech in the plane of mastering the basics of literacy, in the field of foreign language, financial literacy, etc.), which must be formed in preschool children according to the Basic component of preschool education (State Standard of Preschool Education) [31], allow to state the effectiveness of the use of AR technology in preschool education. Also, the use of AR technology in the educational process can affect the effectiveness of skills that are common to preschool and primary education (express creativity

and initiative; manage emotions; express and justify one's own opinion; think critically; make decisions; solve problems; cooperate in a team, etc.) and promote continuity between preschool and primary education.

Preschoolers should be introduced to augmented reality by coloring "Live Notepad" with the 3D Artist application, which turns a painted picture into a dimensional 3D image. It is methodically assumed that first children paint pictures (dragon, car, house, etc.), and then download a special AR-application and through the camera of the mobile gadget watch how painted objects come to life. We also consider 3D coloring pages by Devar Ukraine with the free Devar Kids application from the AppStore or Google Play to be interesting for preschool and primary school children. With the help of coloring pages and AR-application, you can create a small cartoon with your child. Popular is a series of coloring pages with augmented reality Live Coloring with the appropriate application from the Google Play resource for the Android operating system. This application has coloring pages that can be printed out on a printer, which is convenient for the teacher. Valuable from a pedagogical point of view is that these coloring pages are divided into topics: professions (builder, cook, teacher, farmer, scientist, firefighter, astronaut), sea animals (dolphin, shark, octopus, starfish, crab, turtle), dinosaurs etc. It is important that augmented reality allows you to see the character exactly as it was created by the child (figure 1). All colors and patterns are accurately reproduced by the program in augmented reality. These interactive 3D coloring pages become not only an exciting adventure, but also contribute to the development of emotional intelligence, speech and creativity of preschoolers.

Figure 1: Activation of coloring pages with augmented reality Live Coloring.

In the play activities of preschoolers there is an opportunity to use an interactive game set "Animal Cube", which consists of soft toys (monkey, elephant, parrot, panda) with a special cube. By scanning the cube corresponding to one of the toys with the help of the Varus Animal Cube mobile application on the Play Market and App Store platforms, the educator activates

the game of preschoolers with a virtual animal that “lives” inside. Children can enter the reality of their pet and observe the wonders of wildlife, as well as explore the 3D habitat of exotic animals with ARKit or ARCore. Each of the four groups of preschoolers can look after the animal selected from the play set, learn how to take care of the animal: feed it, train, decorate, play and actively interact with it (figure 2). Teachers of preschool education institutions can organize the activities of preschoolers to take care in the virtual world of exotic animals that are endangered in their natural habitat. Thus the tasks of game, sensory-cognitive and research activity for acquaintance with animals are realized.

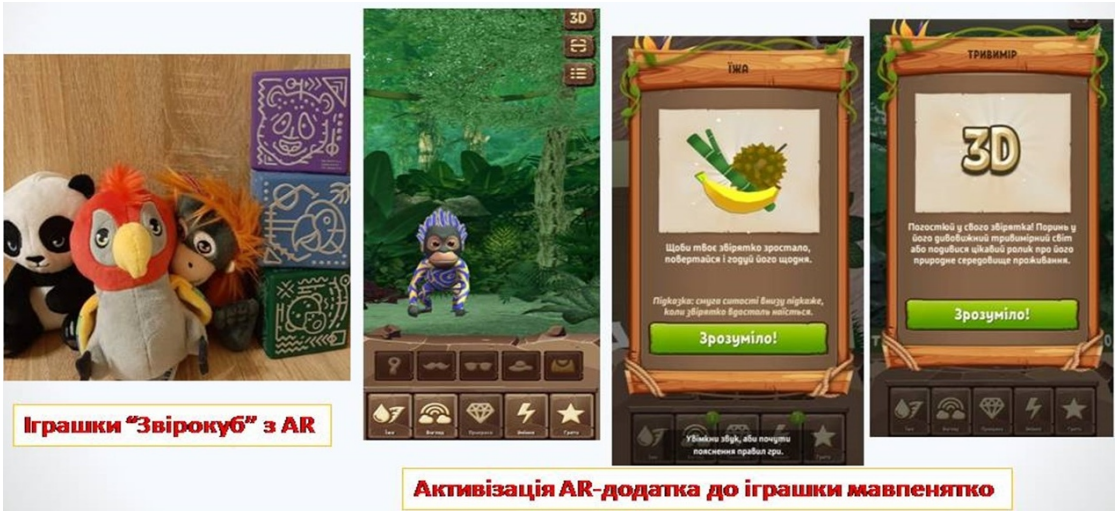

Figure 2: Activation of augmented reality of the game set “Animal Cube”.

In preschool and primary education institutions for educational and developmental purposes one should use a series of books “My creative encyclopedia. The world is waiting for the opening” of the “Ranok” Ukrainian publishing house. In this series, one has created such interactive books as “I am an inventor”, “I want to know everything”, “I want to be able to do everything”, “I am studying “what?” and “how?”. Interactive encyclopedias for children are aimed at developing their creativity to implement their own project. Each of these editions provides independent assembly of the designer with original 3D models, and the book is used as a podium for the designer with a special field where it is possible to place all collected 3D elements. In particular, the encyclopedia “I am an inventor” is about creativity and paper arts, such as origami, quilling, vytynanka, also tells about the model and its creation, how a 3D printer works, how to bring images to life. After reading the information about the balloon, the child has the opportunity to create its 3D model and use the QR code to download the AR application, which will revive the model collected by the child (figure 3). The encyclopedia “I want to be able to do everything” provides information about painting, architecture, the world of computers, the boundless Internet, smart devices and offers to create a 3D model of a wind turbine. It is useful for preschoolers and younger students to work on the project both individually and in groups. The purpose of the characterized encyclopedias is to translate the

initial knowledge of modeling, techniques and technologies, types of arts and crafts, i.e. what the future inventor needs to know.

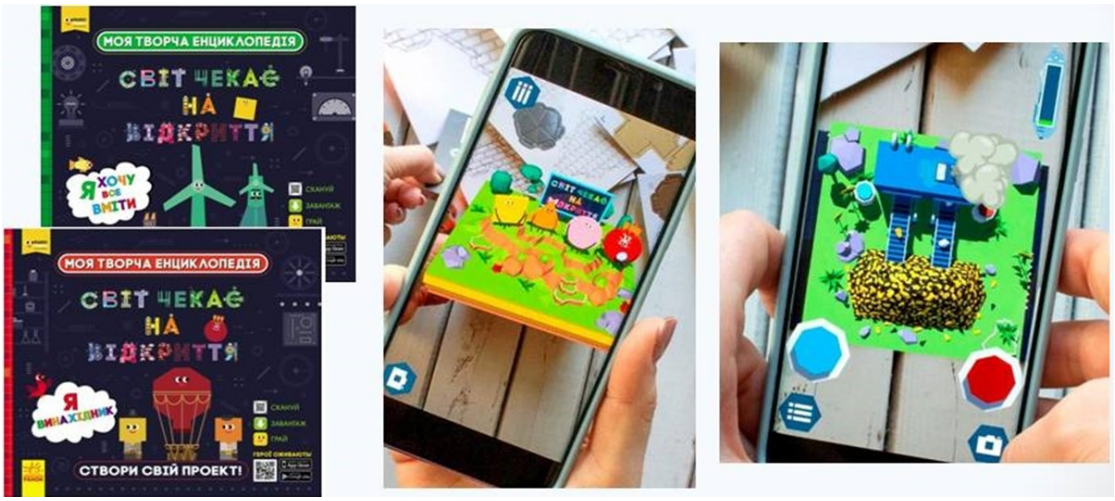

Figure 3: Activation of augmented reality in the book "My creative encyclopedia".

The use of augmented reality book "The Bun" in work with young preschool children contributes to the formation of certain components of sensory-cognitive, logical-mathematical competencies – readiness to direct sensory processes (sensation, perception, attention, etc.) to the knowledge of environmental objects; formation of ideas about the basic mathematical concepts "number", "magnitude", "shape", "space", "time", "color", etc.

With the help of the book "Kobzar's Alphabet", which contains works of Taras Shevchenko for each letter of the alphabet, illustrations to which come to life, move and talk with the free application FastAR Kids in smartphones or tablets (iOS, Android, iPhone), one can form in preschoolers such components of speech competence as understanding that in Ukraine the Ukrainian language is the state language; awareness of the sound composition of the native language, based on the developed phonemic hearing and speech breathing; to cultivate love for the native language, respect for the state language, languages of representatives of national minorities of Ukraine, etc.

The use of augmented reality books in the educational process (Hans Christian Andersen's fairy tales "Wild Swans", "Snow Queen", Charles Perrault's "Sleeping Beauty", "Cat in Boots", etc.) determines the possibility of forming in older preschool children various components of social and civic competence (interest in universal values, communication values; knowledge of the meaning, essence, specific manifestations of personal qualities (independence, responsibility, diligence, leadership), initiative, activity, creativity, etc. in interaction with other people; awareness of the norms of behavior in everyday life, etc.). The use of these and other editions of works of art by Ukrainian and foreign writers with AR applications in primary school is discussed in the study of Nezhyva et al. [30].

The use of AR is also aimed at the formation of digital competence in preschoolers and primary school children – the formation of ideas about information and communication and digital

technologies as modern technical means that expand the information horizons and help navigate the world in high technology; formation of the ability to use information and communication and digital technologies to meet one's own individual needs and solve educational, gaming tasks based on the acquired basic knowledge, skills, positive attitude, interest in computer and digital technology (smartphone, computer, tablet) etc.

At the same time, the results of the analysis of theory and practice indicate the presence of a number of problems in the application of AR in the educational process of modern domestic preschool and primary education. Thus, despite the fact that preschoolers in modern society are accustomed to a variety of gadgets (smartphones, tablets, etc.), which are gradually becoming one of the important means of learning about the environment, most do not have the skills to operate gadgets at home and in the educational process. There is a shortage of mobile AR applications for visualization of experiences that need to be learned by children in early childhood and primary education. The use of gadgets by preschoolers and junior schoolchildren is quite rightly limited by a number of sanitary and hygienic restrictions, based on the features of physical, psychological and emotional development of children of this age.

3. Results of the study

In order to verify the results obtained during the theoretical study, an empirical study was conducted. The study involved a group of undergraduate students majoring in "Preschool Education", as well as a group of undergraduate students majoring in "Primary Education" (87 full-time and part-time students) of the Pedagogical Institute of Borys Grinchenko Kyiv University. Questionnaires and diagnostic tasks were used as research methods. The content of the questionnaire questions, tasks were determined on the basis of studying and analyzing the theory and practice of using AR in the field of education.

The content of the questionnaire questions for undergraduate students was as follows:

1. How do you understand the concept of "augmented reality technology"?
2. What tools with augmented reality technologies for teaching and educating preschoolers (junior high school students) do you know?
3. Do you plan to use augmented reality technology in your professional activities?
4. What, in your opinion, is the essence of the concept of "the ability of teachers to use augmented reality in the educational process of preschool (primary) education"?
5. How effective do you consider the educational process in shaping the ability of future teachers to use augmented reality in the educational process of preschool education institutions?.

The content of the diagnostic task for undergraduates majoring in "Preschool Education" was defined as follows: "Develop a synopsis of an integrative lesson for older preschool children in any educational field of the Basic component of preschool education ("Child in the sensory-cognitive space", "Child in the natural environment", "Child in the society", "Speech of the child", etc.) using AR technology for the purpose of visual modeling of educational material, supplementing it with clarity. Identify and justify the use of augmented reality technology. Create a model for using AR. Identify mobile applications for visualization of educational

material and gadgets that are appropriate to operate. Implement the synopsis in the educational practice of the preschool institution".

The content of the diagnostic task for undergraduates majoring in "Primary Education" was defined as follows: "Develop an outline of an integrated literacy lesson for 1st grade students (or literary reading for 2nd-4nd grade students) using AR technology. Identify and justify the use of augmented reality technology. Create a model for using AR. Identify mobile applications for visualization of educational material and gadgets that are appropriate to operate. Implement the synopsis in the educational practice of primary school".

The essence of the basic concept of the study "readiness of teachers to use augmented reality in the educational process of preschool and primary education" we have defined as a holistic, integrated, complex content of personality, which is a set of values, motives, knowledge, skills, personality professional qualities that determine the effectiveness of augmented reality in professional teaching.

Based on the analysis of the scientific literature in order to identify the level of development of the readiness of future teachers of preschool and primary education institutions to use AR, the criteria were determined, which are revealed through the indicators defined by us.

Motivational criterion with indicators: identification of interest in new technologies, the need to study AR and the desire to use it in the educational process; desire to use the trends of modern education, to achieve effective results in professional activities, the desire for creative search.

Cognitive criterion with the indicator: knowledge of augmented reality technology, teaching aids in preschool and primary education with AR applications, the content of the concept of "readiness of teachers to use augmented reality in the educational process of preschool and primary education".

Activity criterion with indicators: ability to develop a synopsis of an integrative lesson for children of preschool (primary school) age in any educational field with the use of AR; determine and justify the use of AR; develop a model of AR application; identify mobile applications for visualization of educational material; choose gadgets that are appropriate to operate; to implement the synopsis in educational practice.

After analyzing the answers of undergraduates to the third, fourth and fifth questions, three levels of development of the motivational component of the readiness of future teachers to use AR in the educational process were identified. Sufficient level indicates the interest of students in the study of AR technologies, the desire for creative use of augmented reality teaching aids in the educational process, the desire to achieve effective results of educational activities with the help of AR. The average level is found in students who understand the importance of using AR in the educational process, but without much interest in new knowledge. The low level indicates a lack of motivation to master the technology of augmented reality and a lack of understanding of the importance and specificity of the use of these technologies in the professional activities of educators and primary school teachers.

According to the results of the analysis of the answers to the first, second and fourth questions of the questionnaire, the undergraduate students were divided into three groups according to the levels of development of their cognitive component of readiness to use AR in the educational process. A sufficient level was found in students who in the content of the studied concept determine: the main components of readiness to use AR in the educational process (knowledge,

skills); the essence of the concept of "augmented reality" as a process ("augmented reality by any virtual elements"; "use of the environment, over which a certain part of virtual information is superimposed"; "introduction into the field of perception of any sensory data", etc.); the purpose of using AR in preschool and primary education. The average level of development of the cognitive component was found in students who in the content of the studied concept do not define reliably or do not name one or more of the main components of teachers' readiness to use AR in the educational process. Low level was found in students who in the content of the studied concept do not define any of the main components of the teacher's ability to use AR in the educational process; do not understand the essence of the concept of "augmented reality", do not formulate the purpose of the use of AR in preschool and primary education.

Thus, the analysis of the results of the study of the level and features of the development of the ability of future teachers to use AR in the educational process of preschool and primary education allows us to show the following. A sufficient level of development of the motivational component of the ability to use AR in the educational process was found in 12 surveyed students, an average level was found in 34 respondents, and a low level of development of this component was found in 41 respondents. A sufficient level of development of the cognitive component of the ability to use AR in the educational process was found in 9 surveyed students, an average level was found in 30 respondents, and a low level of development of this component was found in 48 respondents (table 1).

Table 1
Quantitative indicators of levels of development of motivational, cognitive, activity components of readiness of undergraduates to use of AR in educational process

Levels of development of readiness of future teachers of to use AR	Sufficient level		Average level		Low level	
	Quantity	%	Quantity	%	Quantity	%
Motivational component	12	13.8	34	39.1	41	47.1
Cognitive component	9	10.3	30	34.5	48	55.2
Activity component	11	12.6	32	36.8	44	50.6

Analysis of the answers to the fifth question of the questionnaire allows us to state that 21 respondents consider the educational process to form the ability of future teachers to use AR in the educational process of preschool and primary education institutions effective; 42 respondents – not effective enough; 24 respondents – ineffective.

According to the results of the analysis of the diagnostic task, students were divided into three groups according to the levels of development of their activity component of readiness to use AR in the educational process. Thus, a sufficient level was found in students who methodically correctly developed a synopsis of integrative classes for preschoolers (junior high school students) in any educational field with the use of AR; identified and justified the feasibility of using AR technology; created a model of AR application; identified mobile applications for visualization of educational material and gadgets that should be used; methodically expediently implemented the developed synopsis in educational practice. The average level of development of the activity component of readiness was found in students who made methodological mistakes in developing a syllabus for preschoolers (junior high school students) with the use of AR and

the model of AR; did not sufficiently convincingly determine and substantiate the feasibility of using AR; had difficulties in the process of implementing the synopsis in educational practice. The low level is characteristic of students who could not methodically develop a synopsis of integrative lessons for preschoolers (junior high school students) with the use of AR; did not implement classes with the use of AR in the educational process.

Quantitative ratios of levels of development of motivational, cognitive, activity component of readiness to use AR in the educational process of preschool and primary education institutions in students of the Pedagogical Institute of Borys Grinchenko Kyiv University are presented in table 1.

As a result of diagnosing the readiness of future teachers to use AR in the educational process of preschool and primary education institutions, it was found that according to certain criteria, most students (average 87.7%) have a medium and low level. Low indicators were established for cognitive (10.3%) and activity (12.6%) criteria. Thus, future teachers need additional knowledge and skills to carry out such activities, including knowledge of the theoretical basis of AR, the variety and specifics of augmented reality teaching aids, methods of using AR in preschool education, ways to organize children in practice with AR applications. We consider it positive that 52.9% of students showed interest in new technology in education and a desire to implement it in practice, which indicates the presence of positive motivation of future teachers to organize and establish the use of AR technology, to understand the importance of introducing innovative tools in the education of preschoolers and primary school children. Indicators of the levels of development of readiness for the use of AR in the educational process of preschool and primary education institutions in students of the Pedagogical Institute are shown in the diagram in % (figure 4).

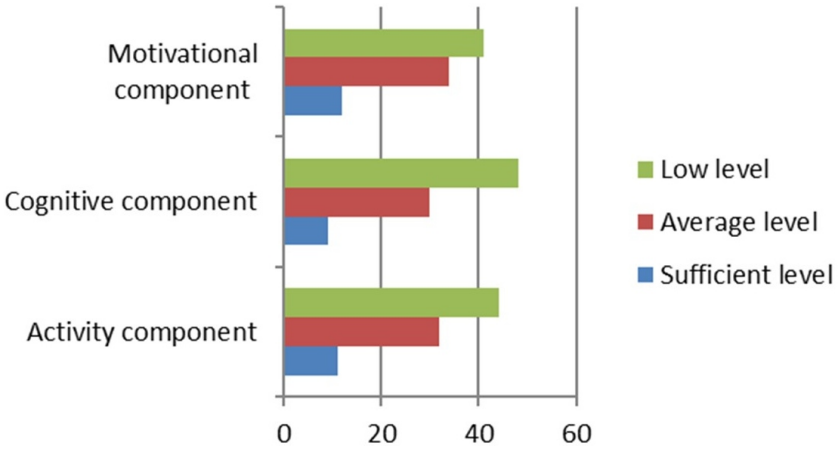

Figure 4: Indicators of levels of development of readiness to use AR in the educational process of preschool and primary education institutions for undergraduates (%)

Therefore, the results of the diagnostic study indicate a significant number of future teachers who have a medium and low level of readiness to use AR in the educational process of preschool and primary education and necessitate the formation of the studied readiness in university pedagogical training.

Based on the results of the analysis of scientific sources on the application of AR in education and the results of diagnostic research, we have developed a model of forming the readiness of future teachers to use AR in the educational process of preschool and primary education. Such integration is due to the presence of related specialties at the Pedagogical Institute of Borys Grinchenko Kyiv University (013 specialty "Primary Education", specialization 012 "Preschool Education", also 012 specialty "Preschool Education", specialization 013 "Primary Education"). The leading idea is the organization of work of teachers of pedagogical institutes on formation of readiness of students for application of the augmented reality in educational process. The realization of this goal requires the solution of the following tasks: to form the motivation of teachers, understanding the importance of the application of augmented reality technology in professional activities; to expand and deepen students' knowledge about the specifics of AR, a variety of educational tools with AR applications; to promote the mastery of techniques for working with learning tools with AR, ways to organize children when working with AR applications. The model consists of the following stages: cognitive (study and analysis of scientific sources on the research problem; defining the essence of the basic concept of research "readiness of teachers to use augmented reality in the educational process of preschool and primary education" in its components; analysis of curricula and work programs disciplines of a number of domestic pedagogical universities in order to identify disciplines aimed at the formation of the studied readiness); activity (study of the current state of readiness of future teachers to use AR in professional activities; development of the content module "Fundamentals of readiness of teachers to use AR in the educational process of preschool (primary) education" (lectures, practical and laboratory classes, independent work and formative assessment); introduction of this module to the content of the discipline "Methods of teaching professional disciplines" for the preparation of masters in the specialty "Preschool Education", "Primary Education"); creative (development of master classes, trainings, webinars, quests on the problem of application of augmented reality technology in the educational process of preschool and primary education). Schematically developed model is presented in figure 5.

4. Problems and prospects

The results of the analysis of the theory and practice of preschool and primary education indicate the presence of a number of problems in the application of AR in the educational process of modern educational institutions. Thus, despite the fact that preschoolers and younger students in modern society are accustomed to a variety of gadgets (smartphones, tablets, etc.), most do not have the skills to operate them in the educational process. There is a shortage of mobile AR applications for visualization of experience, which must be learned by children in early childhood and early school age.

The analysis of the results of diagnostic research and observation of pedagogical practice in the conditions of preschool and primary education institutions allows to outline the following problems: insufficient formation of the studied readiness of future teachers in a certain field; inconsistency between the peculiarities of training future teachers to use AR technology in professional activities and modern requirements for the quality of the educational process; insufficient training of teachers for the formation of the studied readiness in the conditions of

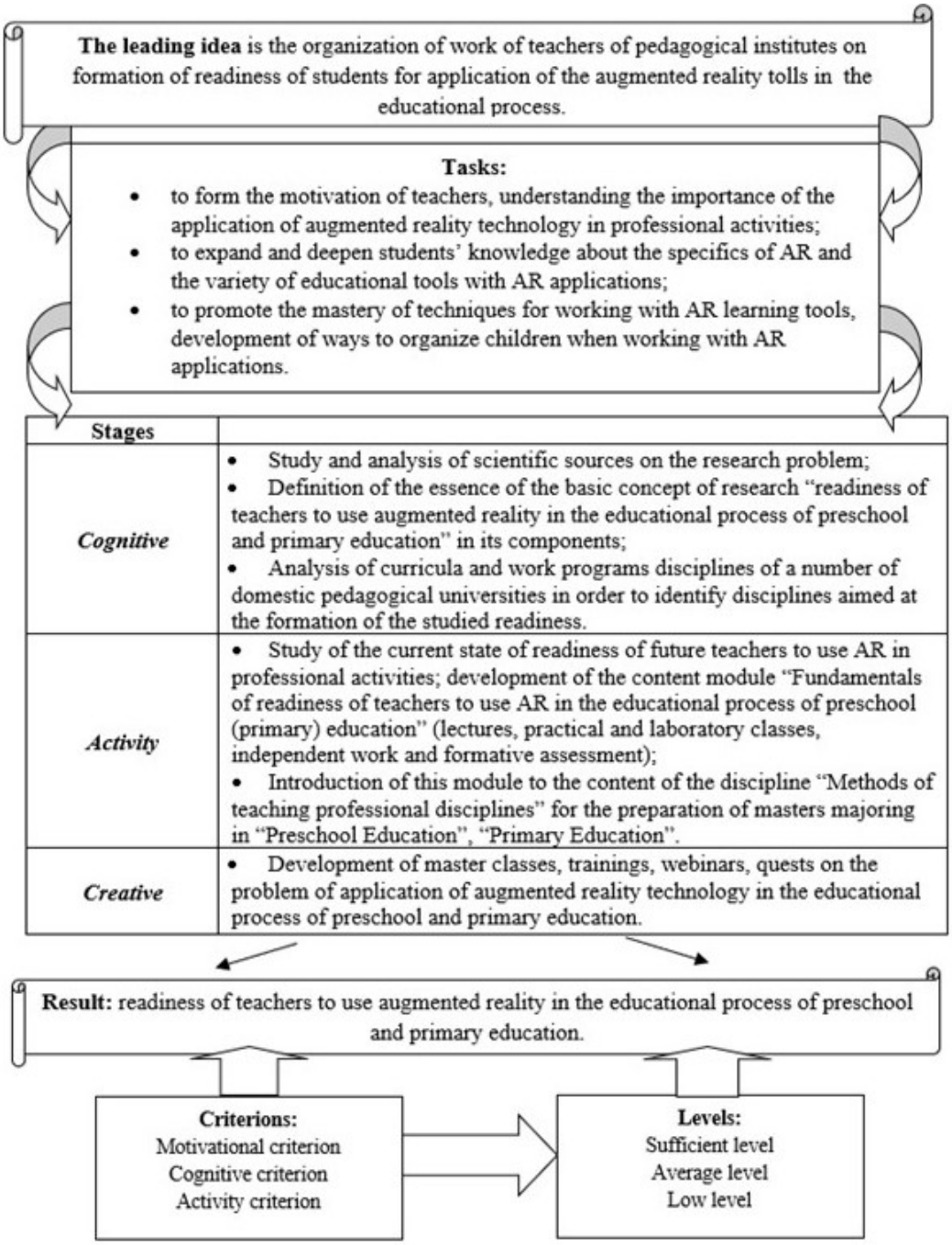

Figure 5: Model of formation of readiness of future teachers to use AR in educational process of institutions of preschool and primary education.

higher education institutions; the need to develop and implement a holistic system of formation of the studied readiness of future teachers in the conditions of higher pedagogical education.

Prospects for further research are to develop scientific and methodological support for the formation of the readiness of future teachers to apply augmented reality in preschool and primary education; preparation of generalized results of experimental work of scientific and methodical recommendations on the researched problem.

In order to ensure the effectiveness of the system of formation of readiness for the introduction of AR by future teachers in preschool and primary education, it is planned to use an innovative class created at the Pedagogical Institute of Borys Grinchenko Kyiv University, which is designed as an innovative educational center for training future teachers, formation of their innovative competence, implementation of STEAM-education tasks [32]. The innovative class is equipped with computers, an interactive whiteboard, a projector and a multifunctional device – printer, scanner, copier, as well as digital means – laptops, tablets, electronic flipchart, interactive whiteboards and projectors, 3D printers (XYZprinting) with laser engraving module, etc.

5. Conclusions

In the conditions of informatization of society, computerization and introduction of modern technologies into the educational process, the problem of application of digital technologies has become a leading one in pedagogical theory and practical activity of educational institutions of Ukraine. Therefore, it is time to prepare future teachers for the use of AR technology in the educational process of preschool and primary education. The study identified the relevance of the application of AR technology for the effective education of preschoolers and primary school children. Scientific sources on the problem of AR application in the field of education are analyzed. Problems in the application of AR in the educational process of modern domestic preschool and primary education institutions are outlined. Possibilities of using augmented reality technology in work with preschoolers and junior schoolchildren are considered. The specifics of teaching aids and publications of works of art with AR applications, which are appropriate to use in working with preschoolers and younger students, are analyzed. The possibilities of alphabets created with the help of AR, creative encyclopedias, coloring books, educational games for children are characterized.

The current state of readiness of future teachers to use AR in professional educational activities is studied. For this purpose the following methods were used: questionnaire, diagnostic task in order to study the state of formation of the studied readiness; description of factual information for the purpose of analytical interpretation and study of specific facts and phenomena; quantitative processing of research results.

It is concluded on the insufficiency of the formation of a certain readiness of future teachers in the field of preschool and primary education; inconsistency between the peculiarities of training future teachers to use AR technology and modern requirements for the quality of the educational process; the need to develop and implement a holistic system of formation of the studied readiness of future teachers in the conditions of institutions of higher pedagogical education. The model of formation of readiness of future teachers to use AR in educational process of establishments of preschool and primary education is developed: the leading idea, tasks, criteria and levels of the defined readiness, stages, forms of the organization of educational process are defined.

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