Experimental Verification of Efficiency of the Formation of Information and Digital Competence of Bachelors of Primary Education based on an Integrated Approach

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Abstract: The article deals with the organization, process and results of the experimental verification of the integrated approach to the modernization of information and digital training of future primary school teachers, which was theoretically grounded in the research. The experiment, which took place in some pedagogical colleges, involved the main forms of the educational process (classes, independent work, practical training, and tests), and included the study of the author's elective course "Modern Information and Digital Technologies in the Educational Process of Primary School". Appropriate methodological support has been developed for the formative stage of the pedagogical experiment. It consists of an electronic textbook "Modern Information and Digital Technologies in the Educational Process of Primary School", lesson plans, tasks for independent work and undergraduate pedagogical practice, test tasks of various types for current and final control, algorithms for practical work, and project topics. The educational process was based on electronic teaching aids such as slide libraries, video clips, interactive exercises and illustrations, electronic textbooks, including the author's teaching aids to the module "Google services in the work of primary school teachers". The two-year formative stage of the pedagogical experiment, which was attended by control and experimental groups of future bachelors of secondary education, confirmed the positive impact of the integrated approach on modernization of information and digital training of future primary school teachers and proved its effectiveness. During the period of its implementation, the levels of formation of cognitive, operational and value components of students' ID competence in the experimental group were significantly higher compared to the levels in the control group. Students in the experimental group were better prepared to conduct online training of primary school children in the conditions of quarantine restrictions caused by respiratory disease COVID-19. The statistical evaluation of the results of formation of students' ID competence in the conditions of realization of the integrated approach to modernization of ID training at the bachelor's level of higher education carried out by criterion 2 proved its efficiency.

1 INTRODUCTION

For the informatized high-tech society, the widespread introduction of information and digital technologies (IDT), their acquisition of the status of a component of the internal quality assurance system of education has become a characteristic feature.

The training of higher education students with the use of IDT is now mandatory, and in a pandemic, its role has increased considerably. The need to improve educational systems using innovative IDT, modern technical means of communication and implementation of innovative activities is emphasized by the Concept of Information Policy for Development and Promotion of the Information Society (UNESCO, 2003), National strategy for the development of education in Ukraine until 2021 (Verkhovna Rada of Ukraine, 2013), and Conceptual principles of

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pedagogical education in Ukraine and its integration into the European education area (osvita.ua, 2004).

Each educational branch has its own peculiarities of using IDT. In institutions of higher pedagogical education, they consist in the fact that in addition to teaching students with a variety of tools, devices, programs, monitoring learning outcomes, prospective teachers are also prepared for effective use of IDT in their future professional activities. Graduates should have the ability to transfer the acquired knowledge and skills to schoolchildren, taking into account their age and individual characteristics.

Under the conditions of implementing the State Standard of Primary Education (KMU, 2018), the National Strategy for Education Development in Ukraine for 2012–2021 (Verkhovna Rada of Ukraine, 2013), the Concept of implementation of state policy in the field of general reform secondary education "New Ukrainian School" for the period up to 2029 (osvita.ua, 2016), the need to modernize future teachers' training and bring educational programs in line with the needs of the digital economy and information educational environment is emphasized.

The analysis of scientific papers showed that the use of IDT in the educational process is the subject of study by many researchers (Andriievska, 2019; Drokina, 2016; Hurzhii and Lapinskyi, 2015; Kuzminska et al., 2019; Morze and Strutynska, 2021; Morze et al., 2017; Onishchenko, 2015, 2016; Petukhova, 2009; Spirin, 2013; Upatova, 2018, 2019).

In (Krumsvik, 2014; Lavrentieva et al., 2020; Mc-Garr et al., 2021; Porlán and Sánchez, 2016; Røkenes, 2016; Vlasenko et al., 2019), information and digital training of future teachers is positioned as one that ensures the quality of higher education and is important for developing their professional competence. Based on the purpose and objectives of our research, detailed analysis was given to the papers related to training future primary school teachers using IDT and to their readiness to use ICT in the educational process of primary school.

Andriievska (Andriievska, 2019) analyzed training future primary school teachers to use information and communication technologies in professional activities at the didactic level, and substantiated the essence of their readiness for this component in professional activities. The researcher developed a model of training future primary school teachers to use information and communication technologies in their professional activities, created the appropriate educational and methodological support, as well as described meta-subject ID skills and their types at the primary school level, and tested the model experimentally.

Drokina (Drokina, 2016) identified the structural components of information competence of future primary school teachers and substantiated the structural and functional model of its formation in the process of professional training. The researcher structurally presented the information competence of the future primary school teacher with information-cognitive, information-methodical, information-computer components and professionally important psychological and pedagogical qualities of future primary school teachers. The analysis showed that both researchers focus on methodological training of students for the use of IDT in primary education, and focus more on the result of training bachelors of primary education in the form of readiness to use IDT in the educational process of primary school and the graduates' information competence.

Onishchenko (Onishchenko, 2016) proved that the formation of future primary school teachers' information competence depends on the informatization of higher pedagogical education.

As in the previous studies, in the monograph and the dissertation of Petukhova (Petukhova, 2007, 2009) attention is focused on the result of developing future primary school teachers' IT competence. It is noteworthy that the researcher revealed the specific features of the use of IDT depending on the information and communication environment of students' professional training.

Upatova's research was devoted to the system of methodical training of future primary school teachers and identifying their readiness for realization of professional methodical activity that "provides ... use of modern pedagogical technologies, methods, receptions and ways of effective training and education of younger schoolchildren" (Upatova, 2019, p. 41). The fact that during the experimental work the teachers – winners of the professional competition "Teacher of the Year" – conducted a master class with students on the topic "Using IDT at different stages of the lesson in primary school", and during the internship students mastered modern methods of primary education, including methods of using IDT in the educational process of primary school" (Upatova, 2019, p. 29), shows that the researcher pays attention to the information and digital training of future primary school teachers. However, IDT and targeted ID training of students were not the main priorities of the research.

Without lowering the value of scientific achievements of the above-mentioned researchers, it should be noted that the modernization of the training of bachelors of primary education, which would comprehensively cover all forms of organization of the educational process, has not yet been the subject of

targeted pedagogical research. Therefore, the formation of information and digital competence as learners' key competence (Shokaliuk et al., 2020) remains a topical task of the theory and methodology of professional education.

In our previous publication (Yaroshenko et al., 2020), the content and component composition of information and digital competence (IDC) of the future primary school teachers, the essence of the integrated approach to modernization of information and digital training of bachelors of primary education were substantiated. The theoretical foundations of training bachelors of primary education based on the integrated approach revealed in it were taken as a basis of development of a technique of a formative stage of pedagogical experiment on verification of its efficiency.

2 RESULTS AND DISCUSSION

The purpose of the article is to prove the efficiency of the integrated approach to modernization of information and digital training of future primary school teachers in the conditions of real educational process of pedagogical colleges at the first (bachelor) level of higher education. The integrated approach to the modernization of information and digital training of bachelors of primary education concerns the content of curricula and lectures, plans of practical and seminar classes, organization of students' independent work, pedagogical practices and control measures (Yaroshenko et al., 2020). There is to be consistently revealed what has been done for each position to provide ID training for students based on the integrated approach and to create appropriate educational and methodological support of the educational process.

The content of disciplines "Information and Communication Technologies, Technical Means of Teaching", "Practical Course of Informatics with Elements of Programming", "Methods of Teaching Informatics Education" is supplemented by information on professionally oriented use of IDT in the educational process of primary school and the possibility of using network services as pedagogical tools. The list of learning outcomes has been expanded due to the following abilities: to use learning tools that involve IDT; to implement IDT to ensure the quality of student learning; to conduct educational activities in the digital educational environment, taking into account the educational needs and characteristics of students; to monitor students' educational activities, their progress in learning and provide appropri-

ate support with digital tools; to adjust and adapt the educational process on the basis of data obtained with the help of digital technologies; to use digital services to create electronic documents and organize online events to communicate with students and parents; to be aware of the role of digital resources in the life of citizens and society.

The elective course "Modern Information and Digital Technologies in the Educational Process of Primary School" was added to the required disciplines of the ID training cycle available in the curriculum. It is aimed at developing students' information and digital competence in the conditions as close as possible to the real educational process of primary school. Such conditions were created by means of developing cognitive tasks, the implementation of which required visiting a general secondary education institution either to do the tasks, or to verify the reliability of the result.

The colleges have created a system of digital education consisting of:

- information resources (media, video, audio, biblio resources, photo, graphics, educational portals, Internet sites);
- telecommunications (network and mobile environments, media, postal services);
- educational process management systems (user authorization, testing, content, ratings, personal and collective information spaces – site, blog, chat, forum, mail, database).

Two credits were allocated to study the course "Modern Information and Digital Technologies in the Educational Process of Primary School" (36 hours of classroom classes and 24 hours of independent work). The final control measure was held in the form of a test. The content is represented by four logically complete modules:

module 1. Theoretical and methodological principles of informatization of primary education and digital competence of pedagogical workers;

module 2. Development of teachers' digital intelligence: a guide to digital tools in the effective management of the educational process;

module 3. Google services in the work of primary school teachers;

module 4. Digital technologies in management, organizational and methodical work of primary school.

Objectives of the course "Modern Information and Digital Technologies in the Educational Process of

Primary School" are to deepen students' understanding of the scientific principles of building the educational process using information and digital technologies; to form higher education students' skills of optimal use of IDT in working with younger students; to find out the influence of the educational and information environment on various aspects of the development of the student's personality; to deepen the knowledge of methods of application of information and digital technologies in the educational process of primary school.

Another feature of this course is the high proportion of creative (project) tasks. The topic of the projects is the development of electronic teaching materials (presentations, demonstration digital teaching materials, which can be used in primary school lessons during pedagogical practice). The educational process of primary school is designed with the use of information and digital technologies in lessons on various subjects and extracurricular activities.

While studying the discipline "Modern Information and Digital Technologies in the Educational Process of Primary School" along with traditional teaching aids, the author's electronic manual presented in digital form is used for the module "Google services in the work of primary school teachers". With its help, students mastered the content of the module with the same name. The manual contains a brief description of the main theoretical material, examples of practical tasks, exercises for independent work; tasks for self-control, including tests. The manual has a convenient navigation; with its help which students can easily move to the section they need.

The electronic manual also contains tasks that involve student group work using network services. During the group learning activities, the resource potential of social networks and mobile applications is used, which allows students to create a group for free communication, online exchange of information and access to the Internet resources. While working, small groups gain access to Google Drive, which downloads all the information needed to complete a group task, giving access to each member of the group, allowing them to work together to create a presentation, make adjustments, suggest ideas, discuss them, and share decisions.

Working in small groups using network services, students have the opportunity to work with other applications and platforms, including messengers such as Skype, Viber, Zoom, Telegram, to create chat groups, which is quite convenient when performing group projects or group tasks.

In the manual "Modern Information and Digital Technologies in the Educational Process of Primary

School" considerable attention is paid to student independent work, which is the main form of development of students' competence in the time free from compulsory education. Independent work is organized using the Google Classroom service. All materials for independent work are placed in the Classroom environment, software and methodical support of remote forms of interaction of students with the teacher through dialogue communication "student – content", "student – teacher", "student – student" is adjusted. Tasks with use of technology of electronic training (E-learning) are offered for students' independent work.

Doing the elective course "Modern Information and Digital Technologies in the Educational Process of Primary School" proved to prepare students of the experimental group for pedagogical practice in distance learning, introduced in spring 2020 through restrictive anti-epidemic measures to prevent the spread of the respiratory disease COVID-19. Under the circumstances, the students were able to organize online learning for schoolchildren, help teachers create and select tasks, grade, comment and organize effective communication with primary students and their parents in distance learning.

Lectures were diversified by interactive work with students, they applied problem-based learning; expanded teaching aids using interactive whiteboards, phantoms, cases, tests, videos; conducted lectures-presentations, dual lectures, lectures-consultations and lectures-press conferences.

The use of audiovisual media, digital devices, telecommunications, video computer systems, multimedia, interactive whiteboards, and virtual reality media has become mandatory in practical classes. The content of tasks for group and individual activities was expanded due to professionally oriented tasks related to the use of IDT in school educational process, introduced modeling and conducting in the classroom parts of lessons (micro-teaching) using ID-tools, as well as lessons the didactic purpose of which was development of students' digital literacy. Educational communication of students in practical classes was provided by organizing group learning activities, and using game modeling of pedagogical situations to develop practical skills.

In the context of the implementation of an integrated approach, independent work has also undergone significant changes. It involved the use of e-learning technology. In order to use them during the study of the course "Modern Information and Digital Technologies in the Educational Process of Primary School", an electronic teaching kit was created which included syllabus, lecture course, instructions

for practical work, recommendations for independent work, test control tasks , criteria for assessing students' achievement, and a glossary. In addition, we suggest using the G Suite network services to create and maintain one's own blog based on Blogger or Sites Creator to create and maintain a personal website. With their help, future primary school teachers have the opportunity to share their own developments and achievements in compliance with copyright and use the experience gained not only during training, but also in further professional activities.

Google services allow to process text documents in almost all formats, build charts, graphs and tables (Google Sheets) without installing additional programs on gadgets, as well as present the results of one's activities in the form of self-created presentations.

All materials for independent work are placed in the Classroom environment, the program and methodical support of remote forms of interaction of students with the teacher through dialogue communication "student – content", "student – teacher", "student – student" is adjusted. Studying the disciplines of general professional training, students independently used electronic dictionaries, encyclopedias, reference books, textbooks, computer simulators and tests, information resources of the Internet.

An integrated approach to the modernization of ID training for bachelors of secondary education also applies to their practical training, which has been and remains an important form of the educational process. At the time of the formative stage of the pedagogical experiment, there were two practices – educational research and student teaching. The program of both kinds of practice provides for trial and credit classes in primary school subjects, and work as a teacher in the performance of all the duties. Student teaching practice allows students to test knowledge, skills, and values acquired during the study period in the real educational process. The internship lasts six weeks, and the curriculum provides for 6 credits. One of the main tasks of student teaching practice is to develop the ability to use modern IDT, working as a primary school teacher. Students were in a real educational environment where they studied the positive experience of using IDT in primary school; analyzed lessons in which digital educational resources were used; produced handouts for young learners using IDT and digital demonstration materials for the lesson. Students gained experience working with parents, in particular, provided assistance in organizing the work of schoolchildren with electronic educational resources; conducting public speeches to teachers and parents with reports and messages on the use of modern in-

novative educational materials with a digital component; formed a methodical treasury of digital educational resources for primary school.

In general, the process of training future teachers uses a wide range of types of control measures (oral examination, written tasks of control work, questionnaires, testing, etc.). All of them were preserved in the experimental methodology, but supplemented by the protection of the internship report, prepared in the form of a presentation, and expert evaluation of projects completed by students (methodologists and teachers acted as experts). Projects performed by students of the experimental group in the conditions of online learning on the topic "Organization of online learning of primary school students in the conditions of restrictive quarantine measures" were evaluated. Students had to create distance materials from one (optional) subject of primary school. The project had to contain methodically processed theoretical material, as well as drawings, videos, interesting presentations, crossword puzzles, tests, interactive exercises, etc., developed at https://learningapps.org.

Under the conditions of quarantine, students implemented the developed projects in the classes assigned to them, where students studied distance courses developed by trainees. Experts evaluated the content of the developed fragment of the distance course, the volume, compliance with the curriculum, the form of presentation of educational material, content with interactive exercises, online tests, audio and video materials.

Thus, in order to conduct a pedagogical experiment, all forms of organization of the educational process and types of educational activities provided for in Article 50 of the Law of Ukraine "On Higher Education" were modernized. This allowed organizing and conducting an experimental test of the effectiveness of the formation of ID-competence of bachelors of primary education based on an integrated approach.

The purpose of the ascertaining stage of the pedagogical experiment was to identify residual knowledge and practical skills that characterize the digital competence of college graduates who have obtained the educational qualification level of junior specialist (professional junior bachelor) and expressed a desire to continue their studies at the bachelor level. At this stage, 112 students of Bar Humanitarian Pedagogical College named after Mikhailo Hrushevsky, Uman Humanitarian Pedagogical College named after T.H. Shevchenko and Khmelnytsky Pedagogical College of Khmelnytsky Humanitarian and Pedagogical Academy took part in the experiment. All of them were entrants on the basis of basic general secondary education, and after obtaining the degree of profes-

sional junior bachelor they continued their training at the first (bachelor's) level of higher education with a reduced period of study (120 ECTS credits).

Before the formative stage of the pedagogical experiment, the participants of the statement stage formed a control (54 people) and experimental (58 people) groups. The training of students in the control group was carried out according to the established method, and in the experimental, it was based on an integrated approach to training modernization. The formative stage of the pedagogical experiment lasted 2 years. At the stage, it was necessary to study such disciplines of information and digital training as "Practical Course of Informatics with Elements of Programming" and "Methods of Teaching Informatics Education", an elective discipline "Modern Information and Digital Technologies in the Educational Process of Primary School" and do teaching and undergraduate practices.

Special for the formative stage of the pedagogical experiment was the fact that throughout the period of its implementation, college students were under the active influence of the educational environment of primary school, in person and remotely interacted with students and teachers of primary school. Prospective teachers studied the course "Modern Information and Digital Technologies in the Educational Process of Primary School" included in the variable part of the curriculum; higher education students carried out classroom and independent work as described above. Group learning activities were optimally combined with frontal and individual work. A mandatory task of all types of practices was the systematic use of information and digital technologies in the educational activities of educational institutions of the first degree (Yaroshenko et al., 2020).

The initial and final results of the formation of students' ID-competence during the formative stage of the pedagogical experiment are shown in table 1.

The dynamics of the formation of components of ID-competence of higher education students, during the formative stage of the pedagogical experiment is analyzed using histograms of figures 1–3.

In figure 1, it can be seen that after the formative stage of the pedagogical experiment the number of students with a high level of cognitive component of ID competence in the experimental group increased by 25.8% and there were 25.9% less students with an average level. In the control group, the number of students with a high level of formation of the cognitive component of ID competence increased only by 7.4%. One third of students in the control group (35.2%) had an average level of cognitive component of ID competence, which is 12.8% more than in the experimental

group.

Figure 2 shows that during the formative stage of the pedagogical experiment the number of students with a high level of formation of the operational component of ID competence in the experimental group increased by 34.5% and at the same time the number of students with an average level of the studied phenomenon decreased by 34.5%. In the control group, all the three levels underwent inconspicuous changes (changes ranged from 1.8% to 3.7%).

Comparison of diagnostic data on the levels of formation of the value component of ID competence of students in control and experimental groups (figure 3) indicates a tendency to change the levels of formation of ID competence, which took place in the previously considered cognitive and operational components. Thus, in the experimental group, the number of students with a high level of formation of the value component of ID competence increased by 38%. The number of students with an average level decreased by 34.5%. In the control group, students with an average level of the value component formation of ID competence dominated (46.3%), and only 20.4% of higher education students had a high level of the value component.

The results of the formative stage of the pedagogical experiment were processed using statistical evaluation by the criterion χ^2. Using the formula for calculating the empirical value $\chi^2 = 7.13$ was obtained. After comparing the obtained value with the critical value given in the statistical tables, the ratio $\chi^2 = 7.13 > \chi^2_{0.05} = 5.99$ was obtained, which indicates the statistical reliability of the results of the formative stage of the pedagogical experiment.

Thus, the results of the pedagogical experiment indicated the effectiveness of ID-competence formation of bachelors of primary education based on an integrated approach.

3 CONCLUSIONS

1. Based on the analysis of the scientific publications, it was found out that the ID training of students of higher pedagogical education has its peculiarity. Its essence is that the IDT is both a means of professional training of students, and the subject of comprehensive study for further effective use of the IDT in future professional activities. The interconnectedness determines the formation of future primary school teachers' ability to use information and digital technologies in the educational process of primary school, in order to develop digital literacy of primary school chil-

Table 1: The results of the initial and final measurements of students' ID competence in the control and experimental groups.

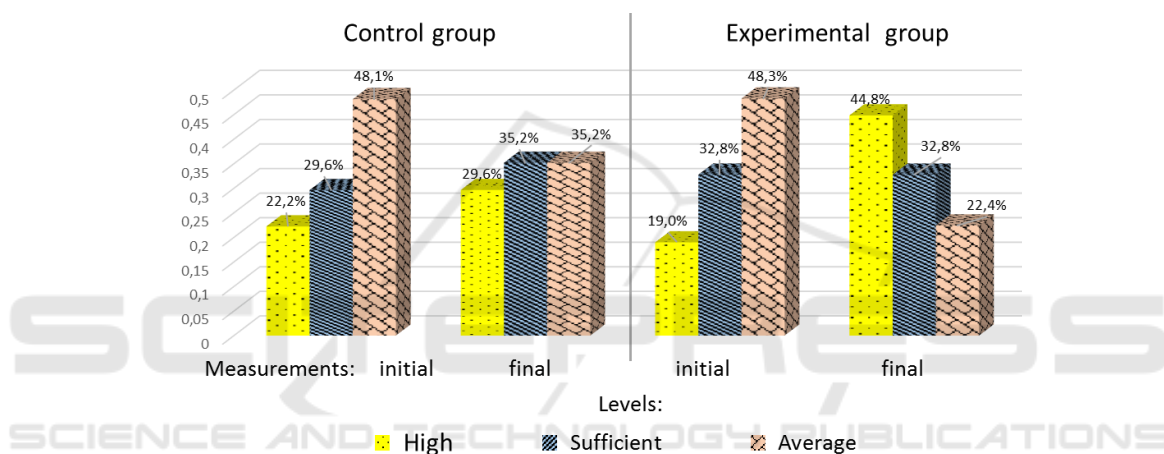| ID competence components	Levels	Control				Experimental			
		Initial		Final		Initial		Final	
		People	%	People	%	People	%	People	%
Cognitive	High	12	22.2	16	29.6	11	19	26	44.8
	Sufficient	16	29.6	19	35.2	19	32.8	19	32.8
	Average	26	48.2	19	35.2	28	48.3	13	22.4
Operating activity	High	11	20.4	12	22.2	12	20.7	28	48.3
	Sufficient	17	31.5	18	33.3	18	31	21	36.2
	Average	26	48.2	24	44.4	28	48.3	8	13.8
Value	High	13	24.1	11	20.4	10	17.2	32	55.2
	Sufficient	13	24.1	18	33.3	22	38	20	34.5
	Average	28	51.8	25	46.3	26	44.8	6	10.3

Figure 1: Dynamics of formation of the cognitive component of ID competence of control and experimental group students.

dren.

2. The developed educational and methodical support of the integrated approach to modernization of information and digital training of future bachelors of primary education is described. It applies to all major forms of educational process. In the experimental teaching, it was implemented in the content of curricula and lectures, plans of practical and seminar classes, students' independent work, pedagogical practices and control activities.

3. The experiment was aimed at confirming the effectiveness of implementing the integrated approach to the formation of future primary school teachers' ID competence. It was based on the systematic use of information resources (media, video, audio, library, photo, graphics, educational portals, websites), telecommunications (network and mobile) environment, media, postal services); educational process management systems (user authorization, testing, content, ratings, personal and collective information spaces such as site, blog, chat, forum, mail, database).

4. It was proved that the elective course "Modern Information and Digital Technologies in the Educational Process of Primary School" is a system forming factor in the integration of knowledge, skills and values acquired by students. In the context of the restrictive anti-epidemic measures caused by COVID-19, this was particularly topical. Students who successfully completed the course created distance-learning materials for primary school subjects. They demonstrated the ability to organize the educational process using the platform Google Classroom for distance and blended learning.

5. The obtained results of initial and final measurements of levels of formation of components of students' ID competence in control and experimental groups proved methodical expediency of organization and carrying out of pedagogical experiment
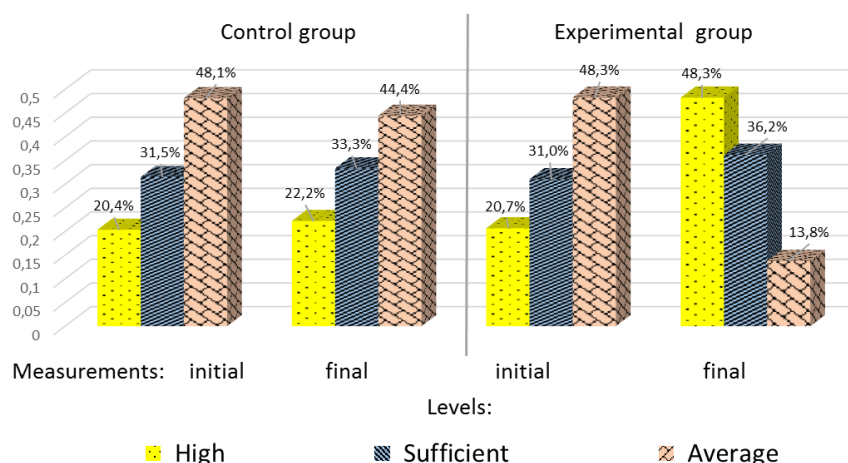
650

Figure 2: Dynamics of formation of operational-activity component of ID-competence of control and experimental group students.
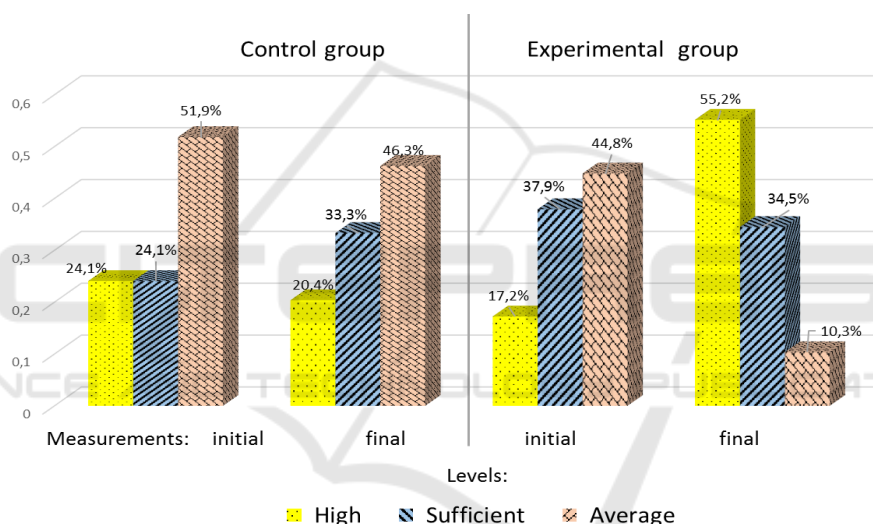

Figure 3: Dynamics of formation of the value component of ID competence of control and experimental group students.

which experimental factor was the integrated approach to modernization of ID training of future bachelors of primary education. During its implementation, ID competence of students in the experimental group was formed more successfully, and they achieved better indicators of the formation of cognitive, operational and value components of the studied phenomenon than the students of the control group. Statistical evaluation of the results of the pedagogical experiment using the criterion χ^2 proved the reliability of the obtained results, and, consequently, the effectiveness of modernization of ID training of future primary school teachers based on the integrated approach.

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