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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

METHODOLOGY OF TEACHING INFORMATICS APPLICATION PROGRAMS IN UNIVERSITIES IN CONNECTION WITH OTHER PROGRAMS

Specialty: 5801.01 - Theory and methodology of teaching and upbringing (methodology of teaching informatics)

Field of science: Pedagogy

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GENERAL CHARACTERISTICS OF THE RESEARCH

Relevance and degree of scrutiny of the topic. The second decade of the 21st century will undoubtedly be remembered as an epochal period in history. The pandemic that swept across the world at the end of 2019, along with its consequences and impact on the economic and socio-political life of people, left an indelible mark. Covid-19 claimed the lives of millions, testing even the most economically strong and stable countries. The damage inflicted on humanity does not end there. The pandemic brought all areas of social life to a standstill; education and healthcare faced unprecedented challenges, and the labor market, closely tied to the population's livelihood, experienced severe shocks.

It is impossible to quantify the damage Covid-19 has done to the global education system. Determining this impact will require a significant amount of time. This virus also made it essential to address certain urgent tasks within the field of education: First and foremost, it highlighted the relevance of distance learning, particularly online education as a component of it, and turned it into a critical need for society.

The pandemic demonstrated that, like other social disasters – earthquakes, tsunamis, hurricanes, landslides, and so on – it can strike at any time, and society must always be prepared for such events.

Finally, science and education remain society's only hope for compensating the material losses caused by the pandemic. Only by making extensive use of modern technologies can people advance science and education and, accordingly, maintain their material well-being at least at the level it was before the pandemic. In this respect, more efficient use of new information technologies is a necessity of the times. It has always been this way throughout history: time tests humanity by presenting challenges, thereby creating the need to solve them.

Indeed, the law includes distance education among the forms of education (Article 130)[1]. Unfortunately, over more than a decade, the

[1] Azərbaycan Respublikasında təhsilin inkişafı üzrə Dövlət Strategiyası. Azərbaycan Respublikası Prezidentinin 2013-cü il 24 oktyabr tarixli Sərəncamı.

mechanism for distance education has not been developed. It is distance education that demands the widespread application of new information and communication technologies. The country's leadership has supported the development of information and communication technologies through other legal and regulatory acts as well. As early as 1999, the Education Reform Program announced the start of educational reform in our country. This document highlighted the existing shortcomings of that time. It stated that, in order to ensure political, economic, and moral development in the 20th century, it was necessary to build an education system. In the "Goals and Principles of Reform" section, the importance of achieving the democratization of social life through education was emphasized. The document also pointed out deficiencies in information, instructional, and scientific-methodological support, noting that the education system was not adequately equipped with information, instructional, and scientific-methodological resources[2].

Taking into account the above-mentioned deficiency, educational authorities have been assigned the task of summarizing the achievements of leading countries in the field of education, along with the advanced results obtained within our country. More specifically, there is a need to create an information base for the international transfer of information in the education system, particularly focusing on the integration of scientific and public libraries with global information sources. In addition, a state monitoring system has been established to manage and evaluate the implementation of new standards and reforms aligned with these goals.

Two more documents have been adopted that consider the application of information and communication technologies essential in the Azerbaijani education system. One of these is the State Strategy for the development of education in the Republic of Azerbaijan, and the other is the National Strategy for the Development of an information society in the Republic of Azerbaijan for 2014–2020, both of which are of great significance[3].

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[2] Təhsil haqqında Azərbaycan Respublikasının Qanunu. Bakı: Qanun, 2009.

[3] Azərbaycan Respublikasında təhsilin inkişafı üzrə Dövlət Strategiyası. Azərbaycan Respublikası Prezidentinin 2013-cü il 24 oktyabr tarixli Sərəncamı.

Both educational documents are of strategic nature. The first document provides an extensive analysis of the state of education as of 2013, highlighting deficiencies in their full reality. These include:

- Low ranking indicators of universities operating within the borders of the Republic of Azerbaijan, as shown by statistical studies conducted by leading international organizations;
- The lack of high-quality performance indicators among pupils and graduates in general educational institutions;
- Insufficient scientific and methodological quality of textbooks for both general and higher education;
- A mismatch between the qualifications of university graduates and the needs of the economy;
- Unsatisfactory access to higher education across different segments of the population and regions.
- A low level of enrollment in preschool education, which accounts for 16.5 percent nationwide.

In line with the main objective of the strategy, five directions have been identified. These are as follows:

– Establishing a competency-based, person-centered education system.

– Developing highly skilled teachers who support purposeful learning content by using modern teaching methods and technologies that consider the unique characteristics of individual learners.

– Forming a modern management mechanism in education that is accountable for outcomes, based on integrity and purposeful work principles, carrying a public state character, and strengthened by state-business cooperation.

– Ensuring an educational infrastructure that meets contemporary demands and supports continuity in education.

– Developing a new financing system for education that relies on reliable and diverse resources.

It should be noted that achieving these five directions, which form the backbone of the strategy, requires revolutionary changes in the field of information and communication technologies. This point is particularly emphasized in the document. Among the strategic goals, there is a focus on modern teaching and assessment technologies and

resources aimed at intellectual and personal development, taking into account the diverse characteristics of pupils. The educational documents mentioned above do not directly address the role of information and communication technologies in education.

The document titled "National Strategy for the development of an information society in the Republic of Azerbaijan for 2014–2020" speaks broadly about the responsibilities of the Ministry of Education in this area. It unequivocally states that ICT has now been established as an effective method for organizing the steady and fundamental development of our country, enhancing intellectual capacity, expanding business, combating corruption, increasing employment, and promoting integrity and equality in society. Some points highlighted here, particularly those related to fighting corruption and enhancing the intellectual potential of pupils, indicate that the importance of ICT goes beyond acquiring knowledge; it also serves as a powerful tool for upbringing.

Theoretical issues analyzing the idea of the informatization of education have been reflected in the research works of scholars such as I.B.Ahmadov, S.S.Hamidov, G.I.Bashirova, and russian scientists like I.I.Antipov, A.A.Kuznetsov [4], Y.A.Pervin[5], I.V.Robert[6] and I.A.Rumyantsev[7]. The use of computer technology and new information technologies during the teaching process in secondary and higher education institutions required identifying the psychological and pedagogical foundations for building the education system on new pedagogical technologies. Considerable efforts in solving these issues have been made by scholars such as J.O.Nabiyeva, A.O.Meh-

[4] Антипов И.Н., Заварыкин В.М., Кузнецов Э.И. Подготовка кадров в условиях компьютеризаци // Советская педагогика.1986. №12.

[5] Первин Ю.А. Учебно-ориентированные пакеты прикладных программ (методика использования технологии проектирования). Изучение основ информатики в средней школе:опыт перспективы. Москва,1987. с.139-162.

[6] Роберт И.В. Средства новых информационных технологий в обучении: дидактические проблемы, перспективы использования. Информатика образование, 1991. №4, с.18-25.

[7] Румянцев И.А. Многоуровневое образование информатике-новый этап подготовки педагогических кадров. Педагогическая информатика, 1993. № 1, с. 29-36. 172

rabov, O.I.Bakhtina, V.G.Boltyansky, Y.S.Branovsky, B.S.Gershunski, O.S.Zaitsev and T.Sergeyeva.

One of the main issues in the informatization of education is training future specialists in the field of informatics. These specialists must meet the requirements of modern pedagogical science. Currently, there is some experience in studying the theoretical and methodological aspects of student training in higher pedagogical institutions. The didactic and methodological support for the informatics course in secondary and pedagogical higher education institutions has been addressed in the research works of scholars such as I.N.Antipov, M.I.Zhaldak, S.A.Zhdanov, A.A.Kuznetsov, E.I.Kuznetsov, Y.A.Pervin, V.I.Pugach and others. As noted in the research of E.I.Kuznetsov, one of the main features of preparing informatics teachers in pedagogical universities is training a new type of teacher. This "new type" of teacher must be a specialist in the pedagogical and organizational application of information technologies. On the other hand, teaching the technology for preparing multimedia training programs requires creators to have extensive knowledge of program development technology as well as the necessary expertise in structuring application program scenarios. Programming tools' capabilities and instrumental means for developing application programs must be considered. Currently, there is a weakness in the systematic training of students in pedagogical higher education institutions in this area, meaning there are challenges in preparing informatics teachers who meet current demands. Nevertheless, both aspects must be considered when training informatics teachers. The goal is not only to teach informatics but also to use it as a tool for teaching other subjects. An informatics teacher can only handle these tasks if they are sufficiently knowledgeable in the aforementioned areas.

In addition, an informatics teacher should primarily establish a connection between information and communication methods and other teaching methods. This approach should be reflected in the syllabus for training specialists in the relevant direction.

Thus, no one can deny the role and significance of application programs in human life. Despite many years of teaching these prog-

rams, the lack of a developed teaching methodology has left the sequence and effective method of teaching their content undefined.

The investigation of the interaction of application programs with other software in the teaching of informatics is relevant for several aspects:

1. Modern educational requirements.

Increase in information: In the modern era, the rapid development of information and technology requires students to adapt to these changes. The integration of application programs helps students learn to work with complex data sets.

2. Importance of an integrative approach.

Interdisciplinary education: The combined use of various programs (e.g., MATLAB, Excel, MS Access, Oracle, PowerPoint, and SketchUp) allows students to develop an interdisciplinary approach. This helps them solve problems across various fields from a broader perspective.

3. Labor market demands.

Modern skills: The job market demands specialists who can use programming, analytical thinking, and various application programs. This research encourages students to develop these skills.

4. Technological advancements.

Use of new tools: The emergence of new programs (e.g., cloud technologies, data analysis tools) creates the need for students to learn how to use these technologies. The interaction of application programs aims at the effective use of these tools.

5. Development of teaching methodologies.

Innovative teaching approaches: The combined use of application programs facilitates the renewal of teaching methods and the creation of a more interactive learning environment for students. This increases student motivation.

6. Practical application.

Real-world problems: Learning how to use application programs to solve real-world problems helps students become more effective in the workplace.

7. Development of scientific research.

New research directions: Research in this area contributes to the development of new scientific directions related to the teaching of informatics and helps identify more effective learning strategies.

The investigation of the interaction of application programs with other software in the teaching of informatics is relevant for the development of the modern education system. This approach not only enhances students' knowledge and skills but also positively impacts their future careers.

The unsystematic and disconnected teaching of application programs in higher education institutions, coupled with the increasing number of such programs and the demand for more effective teaching methods, defines the problem of this research.

The objectives and tasks of the research. The aim of the dissertation is to enhance the effectiveness of teaching the informatics course by ensuring that application programs taught to university students are presented in a sequential, systematic and interconnected manner.

To achieve the set objective of the research, the following tasks need to be completed:

- Studying the current issues of using educational software tools and applying information technologies in teaching, including the use of multimedia in the teaching of informatics.

- Justifying the consistent, systematic and interconnected use of application program environments in the informatics course.

- Identifying the opportunities for developing a teaching methodology for application programs based on multimedia technology.

- Developing methodological recommendations for the use of multimedia training programs and their integration within the framework of application program learning technologies.

Determining the level of assimilation of interconnected teaching of application programs for teaching the informatics course to students of pedagogical higher education institutions during the course of a pedagogical experiment (based on learning MS Excel, Matlab, MS PowerPoint, Sketch-Up, MS Access, and Oracle programs).

Object of the research: The application programs of informatics courses in higher education institutions. This includes various

software and methodologies used to enhance students' knowledge and skills in the field of informatics.

Subject of the research: The methodology for teaching informatics courses in higher education institutions in connection with other programs. This involves the integration of programs with each other, modern teaching approaches, interactive learning methods, project-based learning and the application of other innovative methods.

Research methods: To achieve the set objective, the following research methods need to be employed:

-Analyzing theoretical and practical studies to determine the current state of informatics teaching;

-Analyzing the work experience of leading informatics teachers in secondary and higher education institutions and observing the teaching process in both types of schools;

-Conducting interviews with teachers and surveys with pupils and students;

-Analyzing and summarizing the results of the experimental work.

Main provisions for defense:

- The content concept for learning application programs in the informatics course.

- The organization of courses on application programs for the informatics course in pedagogical higher education institutions.

- The methodology for creating interconnected application program tools in accordance with the content of the informatics course in pedagogical faculties of higher education institutions, based on the technologies of MS Excel, MATLAB, MS Power Point, and MS Access.

The scientific novelty of the research lies in the fact that the study of the interaction of application programs with other software in the teaching of informatics can demonstrate scientific innovation in the following aspects:

1. Integrative approach. The research contributes to the development of modern teaching methodologies through the integrative approach of different application programs. This enhances the

synergy between programs and allows students to apply their knowledge in a broader context.

2. Interactive use of data. The development of new methods for data exchange and analysis between application programs. For example, the integration of Excel and MATLAB enables students to analyze more complex data more effectively.

3. Practical application of the research. The presentation of new approaches related to the practical use of programs in the teaching process. For instance, new teaching plans designed to enhance the effectiveness of application programs in solving real-world problems.

4. New teaching materials and resources. The creation of new teaching materials and resources to study the interaction of various programs. This improves students' ability to transition between programs.

Approval of the research results: The results of the research were primarily discussed in presentations and speeches at scientific seminars and various scientific-practical conferences of the Institute of Education of the Republic of Azerbaijan. Through presentations made at the Department of mathematics and informatics at SSU and the department of computer sciences at ASPU; approved at theoretical and practical conferences at MSPU: at the scientific conference of students and teachers (MSPU, Derbent branch, 2018), etc. The practical aspects of the dissertation were implemented within the teaching process at the pedagogical faculties of SSU and ASPU. The main findings of the research were presented and discussed. Additionally, articles and theses related to the dissertation topic were published.

The dissertation was carried out at the Institute of Education of the Republic of Azerbaijan.

The total volume of the dissertation with the indication of the volume of the structural sections of the dissertation separately. The dissertation consists of an introduction, two chapters, each consisting of eleven paragraphs and eight clauses, a conclusion, a list of used literature and appendices.

Introduction – 10 pages, 17925 characters; Chapter I – 46 pages, 88467 characters; Chapter II – 79 pages, 129198 characters; conclusion – 4 pages, 6955 characters; a list of used literature – 15

pages, appendices – 3 pages, the dissertation work consists of 160 pages, 242545 characters in total.

MAIN CONTENT OF THE WORK

In the "Introduction" the relevance of the topic is substantiated and the object, subject, objective, tasks, methodological basis, research methods, main provisions for defense, scientific novelty, theoretical and practical significance are determined, along with information about the obtained results.

The first chapter of the dissertation, consisting of five paragraphs, is titled "**The current state and theoretical foundations for the development of the use of information technologies in the teaching process**". The first paragraph of the chapter is dedicated to "***The current state of the use of information technologies in the teaching process***".

The use of information technologies in the teaching process has significantly increased in recent years. This increase aims to enhance the quality of education, facilitate the learning process and ensure the effective development of students' knowledge.

Among the methodological principles of pedagogical activity, the comprehensive study of psychological and pedagogical events and processes holds an important place. Any pedagogical phenomenon is connected to other events and processes. Considering it in a one-sided, isolated manner inevitably leads to incorrect conclusions. From this perspective, the isolated use of application programs is not advisable; instead, it is necessary to utilize them in an interconnected manner.

In the process of converting teaching into data, the need arises to reassess the conceptual technique for expressing reflections at different levels. According to another perspective, ICT-based teaching fundamentally changes the meaning of the word “to know”. The phrase “retaining information in memory” is replaced with the concept of “accessibility of information”. The pre-computer human thought system is associated with the system of printed text, characterized by linearity, analyticity and rationality. In contrast, in the computer-driven, imitation-based society, features such as imagery,

flexibility, integration and structured thinking are more pronounced[8]. Typically, the psychological effects of informatization can be contradictory. The enhancement of mental skills may initially succumb to the sensory influence of cognition. A computer can aid the development of an individual's thinking abilities while also providing information that a person might not be able to learn without it. Additionally, it can act as a dominant stimulus for external, fundamental motivation. At this point, the following question arises: can a computer support the development of creativity? Undoubtedly, the answer to this question is definitive: yes. However, there are certain conditions that must be met for this to be achieved:

1) Benefiting from the advantages of computers in the development of creativity

2) Verifying the relevance of the achieved result to the goal

3) Using psychological knowledge for the methods and technologies applied to achieve this goal

As a result, there are certain theories regarding information perception that highlight the benefits of using specific psychological techniques to ensure the efficient functioning of this system. Once a concrete goal is set and relevant content is selected to achieve this goal, the activities of the learners are determined according to that content and goal.

In the second paragraph titled ***"1.2. Theoretical foundations for building a teaching system based on the integrated use of information technologies"*** it is emphasized that the use of information technologies in the teaching process is essential in modern times for improving the quality of education, facilitating the learning process, and effectively enhancing students' knowledge. Below, detailed information is provided about the current state of this topic and the theoretical foundations for its development.

At the first level, the core consists of problems related to the theoretical foundations of teaching: psychological issues that influence teaching and learning management methods, the psychological theory of teaching and the theory of interaction within its functioning. At the

[8] Mahmudzadə R., Sadıqov, İsayeva İ.N. "İnformatika 9" Dərslik. "Yaznəşr" 2014.

second level of teaching programs, issues related to the scientific foundations of teaching through information technologies are addressed, meaning the implementation of methods for teaching activities and the functional operation of this system. This includes both ideal (e.g., knowledge) and material (e.g., software) resources. Teaching technologies act as a link between the theory of teaching and its practical realization, projecting the teaching theory onto the operational plane of student and teacher activities. It is crucial to identify the role of the computer in the teaching process, the role of the teacher, and the interaction of students with the computer. The design of educational programs within teaching information technologies is an essential matter. The theoretical problems of teaching constitute the scientific foundation of educational information technologies, which in turn form the methodological basis for designing the teaching system.

In the third paragraph titled ***"Possibilities of integrated use of information technologies in teaching"*** it is emphasized that the integrated use of information technologies allows modern education to become more interactive, accessible, and effective. This approach enriches the learning process for students, enhances their knowledge and skills, and helps them overcome challenges they may face in the modern world. For these possibilities to be realized, it is essential for teachers and educational institutions to be open to new methodologies and to use these technologies efficiently.

In the fourth paragraph of the first chapter, titled ***"Designing the informatics course for higher education: From concepts to applications***" the emphasis is placed on designing the informatics course for higher education to meet modern requirements by transitioning from concepts to practical applications. This approach aims to develop students' knowledge and skills while also preparing them for the future work environment. The design of the informatics course should be enriched with new teaching methods and the use of innovative tools, creating an environment that encourages active student participation.

We believe that the most interesting courses in terms of considering the development of computer technologies are "Algorithmization and programming languages" and "Fundamentals of appli-

cation programs and multimedia technologies". These courses are precisely the subject of our research.

In the fifth paragraph titled ***"Methodological systems used in teaching informatics"*** it is substantiated that the methodological systems used in teaching informatics offer various approaches to meet modern educational requirements and effectively enhance students' knowledge. The combined use of these methods helps develop students' active participation, analytical thinking skills, and practical abilities. The future improvement of these systems and the integration of new technologies will make the teaching of informatics even more efficient.

Of course, this idea cannot be definitively refuted or endorsed. This leads to the conclusion that the methodological structure of the teaching system should be built on a base of complex factors. At this point, the main factors determining the structure of the educational field must be considered. At the same time, the structure of human activity in this area should not be overlooked. Most importantly, the activity approach should be taken into account at all stages of building the methodological system: when determining the goal of teaching, selecting the content, choosing the form of material presentation, defining the system of teaching tasks and organizing the monitoring of teaching outcomes. Taking these considerations into account, let us examine the methodological system for learning informatics.

The methodological system of teaching is defined by V.V.Krayevski as a complete system of pedagogical activity. Subsequently, this system is specified in the design of that activity.

The second chapter of the dissertation is titled **"Methodology of interconnected teaching of programs in the informatics course at pedagogical faculties of higher education institutions".** The first paragraph of the chapter is dedicated to ***"Development of the informatics curriculum".*** The development of the informatics curriculum aims to enhance the role of informatics in the modern education system and ensure that students learn information technologies effectively. Below, the main stages, principles, and components of the curriculum development process are presented.

- Analysis of previous curricula, resources and teaching methods.

• Determination of students' knowledge level, learning styles, and needs.

Defining the overall objective of the curriculum means, for instance, developing students' analytical thinking skills.

The development of the informatics curriculum requires systematic and strategic approaches to meet the demands of the modern education system and ensure that students effectively learn information technologies. This process is aimed at enhancing students' knowledge and skills, preparing them for the modern work environment, and developing their analytical thinking abilities. For the curriculum to be effective, it is essential that it is regularly updated and adapted to the requirements.

In the second paragraph titled ***"Characteristics of application programs used in the informatics course at pedagogical faculties of higher education institutions"*** it is emphasized that the informatics course at the pedagogical faculties of higher education institutions utilizes various application programs to ensure that students learn and use information technologies effectively.

It is known that application programs are taught as a separate subject at the pedagogical faculties of higher education institutions. Since this subject is taught over one semester, its content includes the main characteristics of the most commonly used programs.

The application programs used in the informatics course at the pedagogical faculties of universities aim to ensure that students effectively learn modern information technologies. These programs help develop students' analytical thinking, problem-solving, and creative skills. The choice of application programs plays an important role in preparing students for their future professional activities and enhances the quality of the teaching process.

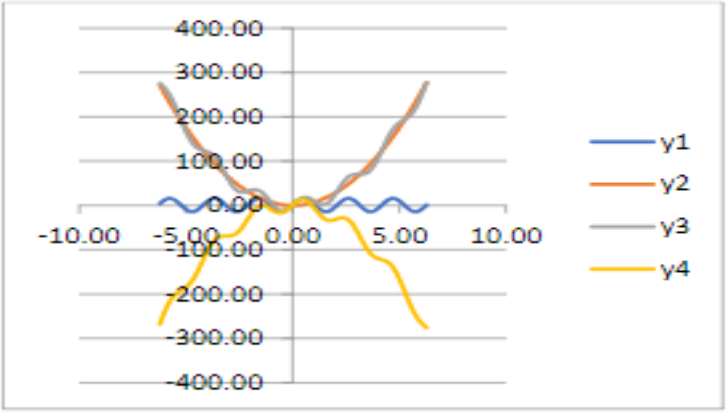
In the fourth paragraph titled ***"Methodology for interconnected teaching of Excel and Matlab"*** it is noted that Excel and MATLAB are two powerful tools widely used for data analysis, computation, and visualization. The joint teaching of these two programs offers students extensive opportunities for data management, analysis, and interpretation. When explaining the topics of informatics, applying its methods and tools to solve problems in other subjects is very impor-

tant. At the same time, teaching other subjects in connection with informatics is also crucial. Learning, applying and solving the theoretical foundations of other subjects using the capabilities of informatics allows for better results. Informatics possesses new information technology tools that enable faster calculations and more efficient problem-solving. The organization of interactive lessons using information technologies increases students' interest and participation in the subjects. Interdisciplinary integration creates conditions for enhancing the effectiveness of lessons[9].

From a methodological standpoint, the selection of informatics methods for teaching topics in the "Mathematics" subject is very important. In the selected topic for the experiment, "Graphs of functions" two different information technologies were used during the teaching process.

It should be noted that the values of these functions can be defined within the same coordinate system. This is more convenient for analyzing and comparing these functions. The graphs of the functions y1, y2, y3 and y4 shown are plotted within the same coordinate system.

The second task involves the graphs of the given functions plotted within the same coordinate system in MS Excel.



[9] Adıgözəlov A.S., Y.R.Talıbov [və b.] Fasiləsiz təhsil şəraitində məktəb riyaziyyat kursunun tətbiqi funksiyasının fənlərarası əlaqə əsasında reallaşdırılması: / Pedaqogika üzrə elmlər doktoru dis./ Bakı, 1992. 386 s; Ağayev Ə.Ə. Pedaqogika. Bakı: Aqiloğlu, 2006. 183 s.

As seen, the application of graphing technology in MS Excel ensures that the visual results obtained are more precise and comprehensible. When using the MATLAB environment to complete the given tasks, it is essential for students to be familiar with its capabilities. The teacher explains the sequence of commands for plotting graphs, allowing students to develop both their knowledge and skills related to the topic.

MATLAB's capabilities. To achieve similar results for the second task, the following sequence of commands can be used in the MATLAB environment:

```
Clc
Clear
x=-pi*2:pi/50:2*pi
y1=15*sin (3*x)+1
y2=(sin(x.^2)).^2+7*x.^2
y3=y1+y2
y4=y1-y2
subplot (2,3,1)
plot (x,y1)

title "y1"
subplot(2,3,2)
plot(x,y2)
title"y2"
subplot(2,3,4)
plot(x,y3)
title "y3"
subplot(2,3,5)

plot(x,y4)
title "y4"
subplot(1,3,3)
plot(x,y1,x,y2,x,y1+y2,x,y1-y2)
title 'y1, y2, y3, y4'
```

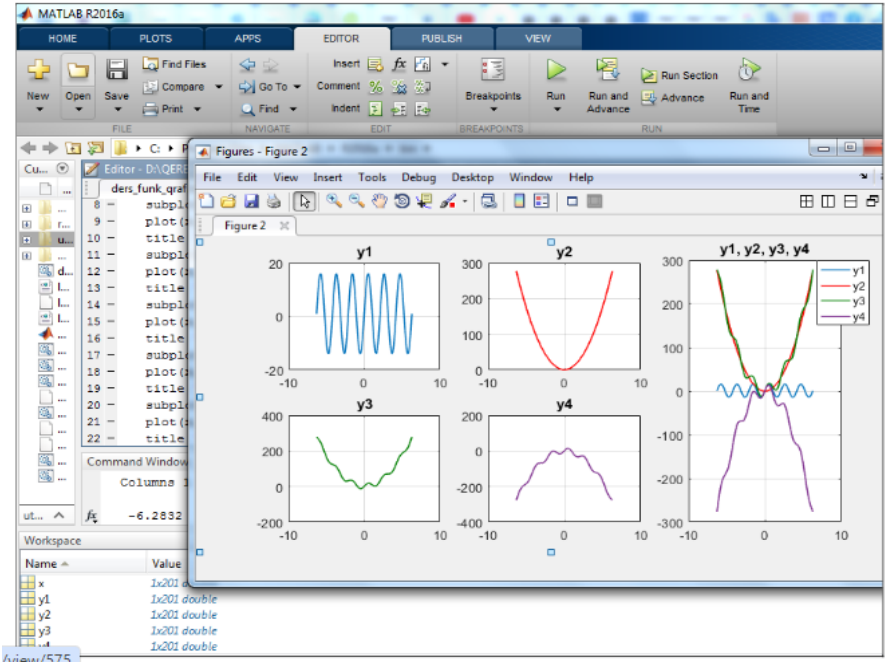


Figure 2.3.1. Graphs of the functions given in the second task plotted in MATLAB

When plotting graphs in the MATLAB environment, various functions can be graphed, programs and graphs can be saved in specific files by making necessary changes to the sequence of commands created. It should be noted that there are extensive opportunities for exploring these environments. Continuous experiments conducted using various methods and tools of informatics to present topics and relevant calculations to students in a structured manner can be analyzed in detail.

In the MS Excel environment, students better grasp the sequence of processes and obtain visual results more quickly. The knowledge and skills acquired in the MS Excel environment create a foundation for their successful use in solving various mathematical problems.

Table 2.3.1

MATLAB vs. Excel: Comparative learning

Feature	MATLAB	Excel
Main use	Advanced mathematical computations and programming	Data analysis, visualization, and basic calculations
Interface	Command line and script-based; requires coding	Graphical interface; user-friendly with cells and menus
Data processing	Built-in functions for efficient processing of large data sets	For small to medium data sets; with pivot tables and data filters
Mathematical functions	Extensive built-in mathematical and statistical functions	Basic arithmetic, statistical, and financial functions
Programming	Supports complex programming (loops, conditions, functions)	Limited programming (automation with VBA, but less flexibility)
Automation	Automating tasks with scripts and simulations	Macros automate repetitive tasks, but with less flexibility
Learning curve	Steeper learning curve due to the requirement of coding	Easier due to an intuitive interface and features
Integration	Integration with other programming languages and tools	Integration with other Microsoft Office tools and some databases
Application areas	Engineering, scientific research, algorithm development	Business, finance, education, and general data analysis

Both MATLAB and Excel are powerful tools, but they serve different purposes and audiences. MATLAB is ideal for advanced mathematical computations and programming tasks, while Excel is

better suited for data organization, basic analysis and visualization. Learning both tools allows for leveraging their strengths in teaching.

In the fourth paragraph titled ***"Methodology for teaching the MS PowerPoint application program in connection with previous application programs"*** it is substantiated that this program, included in the office suite, is used for creating and presenting slides. This program plays a significant role in ensuring visual aid. It allows users to prepare and display information such as images, tables, videos, text, etc., in the form of slides. Although the loading of this program is similar to that of other office programs, its workspace differs from others. For example, while in MS Excel the title bar of the first worksheet is named "Book1", in MS PowerPoint the name of the working sheet is marked as "Presentation1". Like other office programs, users can replace this default template name with any desired name when saving. The program's upper right section includes buttons for minimizing, maximizing and help functions. In the workspace, the title bar is centered at the top, with a ribbon and ribbon headers located below it.

The fifth paragraph of the second chapter of the dissertation is dedicated to ***"Characteristics of teaching the MS Access application program".*** At the beginning of the lesson, students are provided with general information about the MS Access program. It is noted that MS Access is a Database Management System (DBMS) and is of a relational (table-based) type. In the 2019 version of this program, file extensions are displayed as accdb. Access is a program that allows for dynamic data exchange. It enables importing data from other programs, such as Excel, and working with them. In the Access program, there are certain objects and concepts that require individual explanation. You will see that these characteristics are also present in the programs we previously learned. Some concepts are specific to this program only.

The final paragraph of the second chapter is dedicated to ***"Pedagogical experiment and its results".*** A pedagogical experiment was conducted to test the validity of the hypothesis put forward in the research work, focusing on the use of interconnected teaching methods in the teaching process of the informatics course at the pe-

dagogical faculties of higher education institutions that train primary school teacher specialists. The experiment was carried out in stages to determine its impact on improving the efficiency of teaching and fostering creative thinking qualities in students.

The experimental research, covering the years 2016-2020, consisted of three stages: the determining stage covering 2016-2017, the instructive stage covering 2017-2019 and the verification stage covering 2019-2020. The experimental research was conducted within the Pedagogical Faculty of Azerbaijan State Pedagogical University, based on the Informatics course for the specialty of Primary School Teaching.

In the first stage of the experiment, the research aimed to conduct interviews with primary school teachers working in Baku's secondary schools, analyze the Informatics course program for pedagogical higher education institutions and carry out surveys to determine the knowledge and skill levels of first-year students in pedagogical universities regarding the Informatics course. The theoretical and methodological foundations were identified for solving the problem, the working hypothesis of the research was formulated and expressed, and meetings, surveys, discussions, and lesson observations were conducted to identify the difficulties faced by students and teachers in studying the Informatics course.

During observations and interviews with teachers, it was determined that innovative and interconnected teaching methods and technologies, as well as non-standard and creative exercises, are not sufficiently used in a systematic and integrated manner in lessons. Teachers attribute this to the weak knowledge of application programs among educators, which results in the majority of students not learning such topics logically, systematically and in an interconnected way.

The survey conducted with teachers at higher pedagogical institutions included the following questions:

1) What are the possibilities for using innovative and interconnected teaching methods and new teaching technologies in the teaching of the Informatics course? Do you use these methods? In the teaching of which application programs?

2) What methodological literature and resources from available sources do you use in teaching the Informatics course?

3) How is student engagement observed when using innovative and interconnected teaching methods and new teaching technologies?

4) What difficulties do you face in teaching the Informatics course?

Interviews and surveys conducted with teachers at higher pedagogical institutions revealed that most teachers correctly understand the essence of innovative and interconnected teaching methods and emphasize the necessity of using them, including new teaching technologies, in the teaching process. However, the methods applied by many teachers during the teaching process do not satisfy students. In many cases, this does not allow students to retain the knowledge they acquire in a systematic way.

At this stage of the research, the level of knowledge formation was determined using the comparative analysis method of cognitive activity mentioned in pedagogy.

Accordingly, three levels of knowledge formation were identified in the research: descriptive, applied and creative.

The assessment presented to determine the students' level of preparation in the Informatics course requires the following skills:

1) Knowing the functions of the ribbon groups in MS Excel 2010

2) Ability to work with standard functions in MS Excel 2010

3) Knowing the functions of the ribbon headers in MS PowerPoint 2010

4) Ability to prepare a presentation in MS PowerPoint 2010

5) Knowing the functions of the ribbon headers in MS Access 2010

6) Ability to create a table and input data into it in MS Access 2010

As a result of the completion of the assessment, the average score for the initial knowledge and skill levels of 136 students involved in the experiment was as follows:

1) Knowing the functions of the ribbon groups in MS Excel 2010 and the ability to work with the program's standard functions – 0.74;

2) Knowing the functions of the ribbon headers in MS PowerPoint 2010 and the ability to prepare a presentation in the program – 0.72;

3) Knowing the functions of the ribbon headers in MS Access 2010 and the ability to create a table and input data into it in the program – 0.51.

The overall coefficient for the formation level of initial knowledge and skills is $S_{initial}$=0,65 (determined as the arithmetic mean of the indicators).

The obtained result indicates that the achieved level of knowledge and skills is satisfactory for learning new material.

A total of 136 students participated in the experiment. According to the level of knowledge formation, they were divided as follows: descriptive level – 46 students (33.9%), applied level – 81 students (59.7%), creative level – 9 students (6.4%).

In the determining stage of the pedagogical experiment, the following conclusions were reached:

- Very few students possess creative qualities of thinking activity. If they do possess them, it is at a very low level and they cannot apply these qualities consciously and independently;

- The ability of students at higher pedagogical institutions to solve non-standard, creative tasks is not high, indicating that they are not sufficiently prepared for their future professional activities;

- It is necessary to improve the quality of teaching the informatics course, which plays an essential role in the formation of professional preparation levels of informatics teachers. One of the solutions to this problem, in our opinion, is the use of innovative and comparative teaching methods, new teaching technologies that develop students' creative and comparative thinking qualities and a systematic approach to engaging students in activities that match their level of preparation in the informatics course.

The results of the determining experiment, as well as the theoretical analysis of psychological-pedagogical literature, led to the identification of the research problem.

The third stage of the research was conducted in 2019-2020. The aim was to test the effectiveness of the methodology presented for the

use of interconnected teaching methods and technologies in the process of teaching the Informatics course during the academic year. The experiment was conducted with students of the Primary School Teaching specialty at the Pedagogical Faculties of SSU, ASPU and GSU. A total of 136 students participated in the experiment. The experiment was carried out by the author of this research and had a natural character, being implemented during practical lessons.

If all the tasks in the assessment are completed fully and correctly, and all solution methods are considered, the assessment is considered fully and correctly completed. If there are deficiencies in the solutions to the tasks and not all solution methods have been considered, the assessment is considered completed correctly but not fully. If there are errors in the solutions to the tasks, the assessment is considered completed incorrectly. These can also be represented using the 10-point grading system mentioned above.

Table 2.6.1
Results of assessments by topics

Quality of work completion	Topic No. 1	Topic No. 2	Topic No. 3	Topic No. 4
Excellent - A	43	38	42	41
Very Good - B	20	23	18	17
Good - C	20	23	18	17
Satisfactory - D	7	9	20	19
Unsatisfactory - F	9	8	10	12

The coefficient of the level of knowledge formation, calculated using the following formula, was used to determine the level of knowledge formation of the students[155 p.27]:

$S_m=(n+n_1)/n_0 \leq 1$

where: n_0 – the maximum number of correct answers to all questions, n – the number of correct and complete answers to all questions, n_1 $(n \cdot 0{,}8)$ – the number of correct but incomplete answers (with a conditional coefficient of 0.8 for the value of correct answers).

Table 2.6.2

Quality of completion of the final assessment

Quality of work completion	Topic No. 1	Topic No. 1	Topic No. 1	Topic No. 1
Excellent - A	42	40	41	42
Very Good - B	26	20	24	20
Good - C	22	20	19	17
Satisfactory - D	30	11	12	14
Unsatisfactory - F	0	4	0	2

The experimental training allowed for significant progress in students' knowledge and skills in the informatics course. The quantitative and qualitative changes observed in the groups involved in the experiment clearly demonstrate this. At the end of the instructive experiment, the level of knowledge formation reached S_{final}=0,81. According to the results of the final verification experiment, the distribution of students based on their levels of knowledge formation was as follows: descriptive level – 33 students (24.2%), applied level – 90 students (66.1%), creative level – 13 students (9.7%). In other words, 4 students advanced from the applied level to the creative level, and 13 students moved from the descriptive level to the applied level.

Thus, the comparative analysis of the level of knowledge formation of students shows that the use of interconnected methods in the teaching process of application programs in informatics purposefully enhances the effectiveness of the teaching process, specifically improving the quality of students' knowledge and skills.

As a result of achieving the set goal in the research work, the following outcomes were obtained:

1. In an era of rapid scientific and technological development, the informatization of society, and the deep penetration of computer technology into all areas of societal life, the state places the training of individuals as an important task for schools. This necessitated the preparation of curricula and syllabi with subject-appropriate content and teaching using new methods at all levels of continuous education, including pedagogical universities. Therefore, fulfilling the tasks arising from the requirements of educational reform conducted

in higher education institutions, including pedagogical universities that train primary school teachers, holds significant importance.

2. The teaching of the informatics course at the pedagogical faculties of universities has created a number of serious problems that need to be addressed. One of these problems is the lack of development of new methods for teaching application programs in the pedagogical specialty of primary school teaching. The analysis of pedagogical literature showed that the experience of teaching the Informatics course with new methods in the universities of our country has not been sufficiently formed, and the country's pedagogues and methodological scientists have touched on the issues of teaching the Informatics course in higher education to some extent and have put forward certain methodological considerations. However, there is no experimental justification for the proposed methods and techniques. The problem of determining effective ways and means of teaching application programs in the Informatics course at pedagogical universities and their impact on the quality of teaching has not been studied.

3. Our research and observations related to the teaching of the Informatics course at pedagogical universities indicate that the inclusion of concepts related to application programs often involves the mechanical use of traditional methodology applied in technical subjects at universities.

4. In the Informatics course content of the Primary School Teaching specialty at pedagogical faculties, the conscious and thorough mastery of application programs is possible through their comparative and interconnected teaching.

5. The conscious and thorough mastery of application programs by future primary school teachers, as well as the creation of visual representations of these programs, can be achieved through their comparative and interconnected teaching with graphic illustrations. The content related to the application of programs such as MS Excel, MS PowerPoint, and MS Access for solving relatively simple tasks should be sequentially, systematically, and coherently considered in the syllabus and included in the program.

6. When sufficient attention is given to explanations related to MS Excel, MS PowerPoint and MS Access and the application of these programs in various situations, it increases students' interest in the lesson, enhances the effectiveness of teaching, and demonstrates the universality of the interconnected method. This also broadens students' scientific worldview and contributes to their overall development as a means of implementing intra-disciplinary integration.

7. It is known that in informatics teaching, any given objective is demonstrated through practical tasks. From this perspective, when the application programs intended to be taught in the content are presented in a comparative manner, it ensures deeper and more conscious mastery of the material. A system of purposefully selected tasks aimed at developing students' cognitive processes also ensures the complete comprehension of the subject.

8. The designed system of exercises has an intensive impact on students' mastery of knowledge and the development of applied skills when the teacher observes the following conditions during the teaching process:

- The teacher must understand the didactic basis of the system of exercises, focusing not only on the acquisition of knowledge but also on the development of the ability to apply it;
- Special attention must be given to students' independent cognitive activity at various stages of the lesson;
- The teacher must coordinate group and individual work forms during the lesson.

9. The pedagogical experiment showed that the comparative and interconnected teaching of application programs for future primary school teachers in pedagogical universities fosters interest in learning and enables deeper mastery of knowledge and skills. It also facilitates the application of knowledge to solve real-life problems and helps cultivate qualities such as activity, independence, purposefulness, and the ability to achieve set goals. Additionally, it creates conditions for independent thinking, reasoning, generalizing, drawing conclusions, and justification.

Thus, the results obtained during the course of the research have both theoretical and practical significance. These results

contribute to enhancing the effectiveness of informatics teaching in the Primary School Teaching specialty of the pedagogical faculty, and the methodology expressed for teaching application programs will ensure the future development of the methodology for teaching informatics in universities.

The results of the research provide the basis for the following recommendations:

1. Effectiveness of the teaching process: It has been found that methods for teaching application programs are more effective when combined with modern approaches (e.g., interactive technologies).
2. Importance of interdisciplinary connections: Linking informatics courses with other subjects (such as mathematics and engineering) enhances students' problem-solving skills.
3. Significance of practical experience: Integrating lab work and real projects makes learning more meaningful by developing students' practical skills.
4. Student motivation and interest: Presenting programs and projects that align with students' interests boosts learning motivation.
5. Increased role of teachers: Familiarity of teachers with modern methodologies improves the quality of the teaching process.
6. Updating assessment systems: Implementing project-based assessment methods allows for a more objective evaluation of students' knowledge and skills.

These results, in line with the purpose of the research, encourage the application of new approaches and methods aimed at advancements in the education system.

The main content of the dissertation has been reflected in the following scientific works:

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