MODERN TEACHING TECHNOLOGIES
СУЧАСНІ ПЕДАГОГІЧНІ ТЕХНОЛОГІЇ

UDC 378.147:69.009.182
DOI 10.35433/pedagogy.2(113).2023.228-244

FEATURES OF USING THE PROJECT METHOD DURING STUDYING THE EDUCATIONAL COMPONENT "DEVELOPMENT OF MOBILE APPLICATIONS"

M. O. Kovalchuk*

The article reveals the peculiarities of using the project-based method to develop a set of communication and professional skills in future specialists in Information Systems and Technologies. As the development of modern IT is a fast-paced and dynamic process, future professionals need to be prepared to work on real projects and collaborate effectively in teams. The application of the project-based method provides students with opportunities to learn how to communicate, distribute responsibilities, and work as a team, while gaining experience in working with information systems and technologies and developing practical skills.

The study analyzes the works of domestic and foreign educators who have researched the theoretical foundations of the project-based method, as well as scientific papers that explore the specifics of pedagogical design and the development of students' self-organizational abilities. The authors of the article place a special emphasis on developing the self-organizational abilities and professional self-improvement of future IT professionals, using the project-based method in the study of the educational component "Mobile Application Development". Students are given the task of developing a functional mobile application from scratch, which includes requirements analysis, user interface design, functionality development, testing, optimization, and project presentation. Each student can take on a specific role in the project, communicate, and exchange ideas with other team members. The outcome of the project is a functional mobile application that serves as evidence of their skills and knowledge in mobile application development.

The article highlights the importance of using the project-based method in teaching mobile application development, which contributes to the development of students' self-organizational abilities, creative thinking, and independence. These competencies are essential in the modern IT industry and help future professionals to successfully compete in the job market.

Keywords: information system, project, project-based method, design stages, multimedia application development.

* Candidate of Pedagogical Sciences (PhD in Pedagogy), Associate Professor
(Polis National University, Zhytomyr)
synyhka@gmail.com
ORCID: 0000-0001-5851-6892
ОСОБЛИВОСТІ ВИКОРИСТАННЯ ПРОЄКТНОГО МЕТОДУ ПІД ЧАС ВИВЧЕННЯ ОСВІТНЬОЇ КОМПОНЕНТИ "РОЗРОБКА МОБІЛЬНИХ ЗАСТОСУНКІВ"

М. О. Ковальчук

У статті розкрито особливості використання проектного методу для формування комплексу комунікативних та фахових навичок у майбутніх фахівців з інформаційних систем та технологій, оскільки розвиток сучасних ІТ є швидким і динамічним процесом, що потребує від майбутніх фахівців готовності до роботи з реальними проектами та ефективної співпраці в команді. Застосування проектного методу надає студентам можливість вчитися спілкуватися, розподіляти обов'язки та працювати в команді, а також отримувати досвід роботи з інформаційними системами і технологіями, розвиваючи практичні навички.

У роботі проаналізовано роботи вітчизняних і зарубіжних педагогів, які досліджували теоретичні засади проектного методу, а також наукові праці, що розкривають особливості педагогічного проєктування та розвитку самоорганізаційних здатностей студентів.

Аutorsи статті особливий акцент ставлять на формуванні самоорганізаційних здатностей та професійного саморозвитку майбутніх фахівців у галузі "Інформаційних технологій" на прикладі використання проектного методу під час вивчення освітньої компоненти "Розробка мобільних застосунків". Студентам пропонується розробити функціональний мобільний застосунок з нуля, що включає аналіз вимог, проектування інтерфейсу користувача, розробку функціональності, тестування, оптимізацію та презентацію розробки. Кожен студент може взяти на себе певну роль у проекті, спілкуючись та обмінюючись ідеями з іншими учасниками команди. Результатом проекту є функціональний мобільний застосунок, який слугує показником їхніх навичок та знань у розробці мобільних застосунків.

У статті висвітлено значення використання проектного методу в навчанні розробці мобільних застосунків, що сприяє формуванню самоорганізаційних здатностей студентів, розвитку їхнього творчого мислення та самостійності. Ці компетенції є важливими в сучасній індустрії ІТ та допомагають майбутнім фахівцям успішно конкурувати на ринку праці.

Ключові слова: інформаційна система, проект, проектний метод, етапи проєктування, розробка мультимедійних застосунків.

Introduction of the issue. In today's world, the development of information technologies is extremely fast and dynamic. Future specialists in information systems and technologies must have a set of following skills: practical (can be applied in real projects and tasks), communicative (based on interaction and cooperation with other team members during project work). Immersion in the environment of information systems and technologies requires future specialists to solve complex tasks, which include analysis, design, development, testing and implementation of various systems. Using the project method gives students the opportunity to learn how to communicate effectively, discuss ideas, distribute responsibilities and workload in a team; study various aspects of information systems and technologies in a complex,
being able to learn a wider range of knowledge and skills; to gain the necessary experience of working with information systems and technologies, developing their practical skills. It also helps to understand how theoretical concepts translate into practical solutions and develops critical thinking and problem analysis skills. The project method promotes the development of students’ creative thinking. They have the opportunity to independently solve problems, create new solutions and develop innovative projects. This helps to form a creative and independent position in students, which is necessary in the highly competitive environment of the modern labor market.

**Current state of the issue.** In the scientific and pedagogical context, terms "project method", "design", "project technology", "project activity" and others are used, which are similar to the general concept of "project". The main theoretical aspects of these concepts were studied by such authors as V. Bolotov, V. Burkov, L. Gourier, O. Gazman, N. Zapesotska, E. Isayev, I. Kolesnikova, N. Krylova, D. Novikov, N. Masyukova, O. Pometun, T. Pashchenko, V. Radkevych, V. Svyystun and others [9-11]. In higher school pedagogy, these concepts are considered as a component of the professional competence of future specialists, which is related to the research of such authors as V. Anishchenko, M. Artyushina, T. Herlyand, N. Kulalayeva, G. Romanova, M. Shimanovsky, Li Jiaqi and others [13, 14, 16].

In their research, the theoretical foundations of the project method were substantiated by domestic and foreign teachers-researchers. Various aspects of pedagogical design are studied in the works of I. Yermakov [4: 26-32], N. Lavrychenko [7: 64-70] and others. Instead, I. Hrytsenyuk [2] and O. Kobernyk [6] and others analyzed the features of the design function of pedagogical activity. The essence and content of educational planning in the process of formation of self-organizational abilities in future teachers of higher education is revealed in the works of information systems and technologies in complex, mastering a wide spectrum of knowledge and skills; gaining the necessary experience of working with information systems and technologies, developing their practical skills. It also helps to understand how theoretical concepts translate into practical solutions and develops critical thinking and problem analysis skills. The project method promotes the development of students’ creative thinking. They have the opportunity to independently solve problems, create new solutions and develop innovative projects. This helps to form a creative and independent position in students, which is necessary in the highly competitive environment of the modern labor market.

**Analyzing the current state of the issue.** In the scientific and pedagogical context, terms "project method", "design", "project technology", "project activity" and others are used, which are similar to the general concept of "project". The main theoretical aspects of these concepts were studied by such authors as V. Bolotov, V. Burkov, L. Gourier, O. Gazman, N. Zapesotska, E. Isayev, I. Kolesnikova, N. Krylova, D. Novikov, N. Masyukova, O. Pometun, T. Pashchenko, V. Radkevych, V. Svyystun and others [9-11]. In higher school pedagogy, these concepts are considered as a component of the professional competence of future specialists, which is related to the research of such authors as V. Anishchenko, M. Artyushina, T. Herlyand, N. Kulalayeva, G. Romanova, M. Shimanovsky, Li Jiaqi and others [13, 14, 16].

In their research, the theoretical foundations of the project method were substantiated by domestic and foreign authors such as V. Bolotov, V. Burkov, L. Gourier, O. Gazman, N. Zapesotska, E. Isayev, I. Kolesnikova, N. Krylova, D. Novikov, N. Masyukova, O. Pometun, T. Pashchenko, V. Radkevych, V. Svyystun and others [9-11]. In higher school pedagogy, these concepts are considered as a component of the professional competence of future specialists, which is related to the research of such authors as V. Anishchenko, M. Artyushina, T. Herlyand, N. Kulalayeva, G. Romanova, M. Shimanovsky, Li Jiaqi and others [13, 14, 16].

In their research, the theoretical foundations of the project method were substantiated by domestic and foreign authors such as V. Bolotov, V. Burkov, L. Gourier, O. Gazman, N. Zapesotska, E. Isayev, I. Kolesnikova, N. Krylova, D. Novikov, N. Masyukova, O. Pometun, T. Pashchenko, V. Radkevych, V. Svyystun and others [9-11]. In higher school pedagogy, these concepts are considered as a component of the professional competence of future specialists, which is related to the research of such authors as V. Anishchenko, M. Artyushina, T. Herlyand, N. Kulalayeva, G. Romanova, M. Shimanovsky, Li Jiaqi and others [13, 14, 16].

In their research, the theoretical foundations of the project method were substantiated by domestic and foreign authors such as V. Bolotov, V. Burkov, L. Gourier, O. Gazman, N. Zapesotska, E. Isayev, I. Kolesnikova, N. Krylova, D. Novikov, N. Masyukova, O. Pometun, T. Pashchenko, V. Radkevych, V. Svyystun and others [9-11]. In higher school pedagogy, these concepts are considered as a component of the professional competence of future specialists, which is related to the research of such authors as V. Anishchenko, M. Artyushina, T. Herlyand, N. Kulalayeva, G. Romanova, M. Shimanovsky, Li Jiaqi and others [13, 14, 16].
Вісник Житомирського державного університету імені Івана Франка. Педагогічні науки. Вип. 2 (113)

У роботі наведено результати дослідження особливостей використання проектного методу у навчанні розробки мобільних застосунків, які вирішують питання формування самоорганізаційних здатностей та професійного саморозвитку майбутніх фахівців у галузі інформаційних технологій.

Мета статті – полягає в дослідженні особливостей використання проектного методу в контексті навчання розробки мобільних застосунків, а також у формуванні рекомендацій та висновків щодо його оптимального застосування.

Виклад основного матеріалу. Розглянемо приклад використання проектного методу у процесі вивчення освітньої компоненти "Розробка мобільних застосунків". Студенти отримують список рекомендованих групових розробок, де вони мають розробити функціональний мобільний застосунок з нуля. Цей проект включає такі етапи, як аналіз вимог, проєктування інтерфейсу користувача, розробка функціональності, тестування, оптимізація та презентація застосунку. Кожен студент може брати на себе певну роль у проекті, наприклад, розробник, дизайнор, тестувальник, IT-менеджер. Вони працюють разом у команді (групу може містити не більше 5 виконавців), спілкуються та обмінюються ідеями, вирішуєчи технічні та організаційні завдання. Результатом їхньої роботи є функціональний мобільний застосунок, який може бути представлений як показник їхніх навичок та знань у розробці мобільних застосунків.

Процес проектної діяльності розглядаємо на трьох етапах проектування – мотиваційному, практичному та підсумковому. Провідною умовою використання проектного методу під час вивчення
applications” is a close interaction between the teacher and the student.
Thus, at the motivational stage of designing, the teacher creates a stimulating environment where they explain the meaning and goals of designing mobile applications, demonstrate examples of successful projects; conduct a conversation with students where they discuss their ideas, goals and expectations regarding the project; help students identify real-world tasks and establish appropriate success criteria.

For example, the teacher starts the class by explaining the importance and relevance of mobile application development in the modern digital era, explains how mobile apps have revolutionized various industries and improved the user experience. The teacher demonstrates several successful mobile applications, highlighting their impact and popularity.

Next, the teacher starts a conversation with the students, encouraging them to express their ideas, interests and wishes regarding the project. Students discuss their individual goals and generate potential mobile app concepts. They share their ideas about creating innovative applications that meet specific user needs or provide unique functionality.

The teacher facilitates conversation by asking questions and providing direction for students’ critical thinking. This helps to determine the list of real tasks that students can implement in their project. The teacher actively works with students, helping them to formulate the goal, object and task of the project, to establish appropriate success criteria.

At the practical stage, the teacher provides students with the necessary resources, tools and materials for developing mobile applications; conducts training and provides methodical support on technical aspects of development; encourages and facilitates collaboration and exchange of ideas between students, organizes regular meetings to discuss progress and solve problems. Students are actively working on their projects, using the acquired knowledge and skills.

освітньої компоненти "Розробка мобільних застосунків" – є тісна взаємодія між викладачем і студентом.
Так, на мотиваційному етапі проектування викладач створює стимулююче середовище, де пояснює значення та цілі проектування мобільних застосунків, демонструє приклади успішних проектів; проводить бесіду зі студентами, де вони обговорюють свої ідеї, цілі та очікування щодо проекту; допомагає студентам визначити реальні завдання та встановити відповідні критерії успіху.

Наприклад, викладач починає заняття із пояснення важливості та актуальності розробки мобільних застосунків у сучасній цифровій епосі. Він пояснює, як мобільні додатки змінили різні галузі і покращали користувачький досвід. Викладач демонструє кілька успішних мобільних додатків, підкреслюючи їхній вплив та популярність.

Далі викладач розпочинає розмову зі студентами, заохочуючи їх висловлювати свої ідеї, інтереси та побажання щодо проекту. Студенти обговорюють свої індивідуальні цілі та генерують потенційні концепції мобільних застосунків. Вони діляться своїми уявленнями про створення інноваційних додатків, які задовольняють певні потреби користувачів або надають унікальні функціональні можливості.

Викладач сприяє розмові, задаючи питання та надаючи направлення для критичного мислення студентів. Це допомагає визначити перелік реальних завдань, які студенти можуть реалізувати у своєму проекті. Викладач активно працює зі студентами, допомагаючи їм сформулювати мету, об’єкт та завдання проекту, встановити відповідні критерії успіху.

На практичному етапі викладач надає студентам необхідні ресурси, інструменти та матеріали для розробки мобільних застосунків; проводить інструктаж та надає методичну підтримку з питань технічних аспектів розробки; стимулює та сприяє співпраці та обміну ідеями між студентами, організовує регулярні зустрічі для обговорення прогресу та вирішення проблем. А студенти активно працюють над своїми проектами, використовуючи отримані знання та навички.
One of the examples of the practical stage of mobile application development may include the following processes of interaction between the teacher and students:

- Prior to project work, during lecture and laboratory classes, the teacher provides students with the necessary knowledge and materials for developing mobile applications, such as manuals, documentation, code examples, video lessons, etc;

- Briefing for students is held, emphasizing the main technical aspects of mobile application development, explaining the requirements and recommendations for the project. The teacher also provides methodological support, answers students' questions, and helps solve technical problems they encounter;

- The teacher, by organizing joint forums or communication channels, stimulates students to cooperate and exchange ideas. At such meetings, they can present their progress and discuss current challenges they are facing. These meetings facilitate mutual learning and problem solving through collective understanding.

At the final stage, the teacher evaluates and analyzes the projects, assesses the students' achievements according to the determined success criteria; provides feedback on students' work, gives constructive advice and recommendations for further improvement of projects. Students present their projects in front of a group or jury, demonstrating developments and explaining the decisions made; analyze their achievements, evaluate their work in accordance with the set goals and success criteria. The teacher and students conduct a discussion and discuss the results of the project, express their observations and impressions of the process and results of the work.

One example can be a group project from the educational component "Development of mobile applications", where the work of the students on creating a mobile application on a selected topic in Java in the integrated Android Studio development environment. At the final stage, when the project is already completed (the mobile application is
functioning), the teacher evaluates and analyzes the students’ works according to the defined success criteria.

An example of selected topics of students’ project activities: 1) a mobile application for tracking expenses; 2) a mobile application for brain training, where the user can solve various tasks, such as mathematical and logical puzzles, memorize a sequence of numbers, etc.; 3) a mobile application for keeping a diary of a healthy lifestyle, where the user can enter data about their physical exercises, food and water regime, as well as indicate the total number of steps taken per day; 4) a mobile application for organizing events, where the user can create and manage their meetings, gatherings or other events; 5) a mobile application for organizing trips, where the user can create and manage their itineraries, collect information about hotels, restaurants and other places of interest, plan a budget and schedule a day; 6) a mobile application for storing and organizing notes, where the user can create new notes, add them to the list, edit and delete; 7) a mobile application for managing finances, where the user can create a budget and track their expenses; 8) a mobile application for tracking physical activity, where the user can record and track their training and exercises; 9) a mobile application for learning a foreign language, where the user can learn new words and expressions, as well as reproduce and check pronunciation; 10) a mobile application for managing an interactive map; 11) mobile application for ordering food: the user can choose dishes from the menu and order food delivery; 12) a mobile media application that allows users to watch videos, listen to music and read news on their mobile device.

In addition, students prepare a project presentation in which they demonstrate the developed functionality, explain the architecture and technology decisions made, and review the test results (see Fig. 1).
Fig. 1. Fragments of the presentation of the mobile application "Expensetracker project" developed by 2nd-year students O. Lopatyuk and K. Melnychenko of the Polish National University

After the presentation, the teacher and students hold a discussion where they discuss the results of the project, express their observations and impressions of the process and results of the work. The teacher provides feedback on the students’ work, provides constructive advice and recommendations for further improvement of the project.

For example, a teacher can express recognition to students for a job well done, note their success in developing functionality and using technology. At the same time, he can pay attention to possible improvements, such as optimizing the code, improving the user interface or introducing additional features. Students, in turn, can share their impressions of working on the project, express their satisfaction with the results achieved, or express certain difficulties.

In order to analyze the state of formation of self-organizational abilities and professional self-development of future specialists in the field of "Information Technologies", we needed to determine the main indicators that can be used to

Після презентації викладач та студенти проводять дискусію, де обговорюють результати проекту, висловлюють свої спостереження та враження від процесу та результатів роботи. Викладач надає зворотний зв’язок стосовно роботи студентів, надає конструктивні поради та рекомендації для подальшого вдосконалення проекту.

Наприклад, викладач може висловити визнання студентам за добре зроблену роботу, відзначити їх успіхи в розробці функціональність та використання технологій. Однак, він може звернути увагу на можливі покращення, такі як оптимізація коду, поліпшення інтерфейсу користувача або впровадження додаткових функцій. Студенти, у свою чергу, можуть поділитися своїми враженнями від роботи над проектом, висловити свою задоволеність від досягнутих результатів або виразити певні труднощі.

Для того, аби проаналізувати стан формування самоорганізаційних здатностей та професійного саморозвитку майбутніх фахівців у галузі "Інформаційних технологій", нам
qualitatively measure the levels of their professional development (initial, average, sufficient, high). Let's consider them in more detail.

- Knowledge level assesses the level of understanding of the basic concepts, principles and technologies related to information technologies. It determines the extent to which students have mastered the necessary theoretical knowledge.

- Technical level reflects the level of students' ability to apply specific technical skills in project development, for example, programming, web design, databases, etc.

- Creative level reflects the ability of students to generate new ideas, offer non-standard solutions and introduce innovations into projects. It can be measured, for example, by evaluating the originality and creativity of their design solutions.

- Communication level reflects students' ability to effectively communicate and interact with other members of the project team. It may include assessment of the ability to work together, the ability to interact and share ideas.

- Managerial level reflects students' ability to plan, organize and manage a project. It includes assessing their ability to analyze project requirements, set deadlines and manage resources, as well as their ability to effectively solve problems and exercise control over tasks.

- Reflexive level indicates the ability of students to be project accelerators and to take the initiative independently. It includes assessing their willingness to take on additional tasks, seek new opportunities, and learn from their mistakes.

These indicators were assessed using scales where the initial level corresponds to low indicators and the high level reflects high competence and achievement in the relevant domain. Grades were established based on observations, analysis of project results, student self-assessment, or teacher assessment.

During the experiment, a control group (CG) and an experimental group (EG) of students were determined to study the levels of formation of self-organizational abilities and professional self-development.
of future specialists in the field of "Information Technologies". For this, various methods of experimental research were used, such as questionnaires, surveys, interviews, observations, and Rosenbaum's Q criterion. The Q-criterion was used to assess the difference between two samples depending on a given criterion.

The overall success rate was chosen as the criterion, and if the Q-criterion shows no statistically significant differences, it can be said that the two groups are homogeneous. To apply this criterion, the overall success rate of students in the 122 "Information Systems and Technologies" training area was ordered in descending order. Hypotheses $H_0$ and $H_1$ were as follows:

$H_0$: the level of the symptom in the CG does not exceed the level of the symptom in the EG;

$H_1$: the level of the symptom in the CG exceeds the level of the symptom in the EG.

To conduct an experimental test of group homogeneity, students were selected from academic study groups where $n_1$ – the number of students in the control group (127), and $n_2$ – the number of students in the experimental group (133).

To calculate Rosenbaum’s Q-criterion from the given data, we use the following values:

$S_{1\text{（max）}}$ - the maximum value of the first row = 96

$S_{2\text{（max）}}$ - the maximum value of the second row = 92

$S_{1\text{（min）}}$ - the minimum value of the first row = 63

$S_{2\text{（min）}}$ - the minimum value of the second row = 65

Then we calculate Rosenbaum’s Q-criterion:

$S_1 = S_{1\text{（max）}} - S_{2\text{（min）}} = 96 - 65 = 31$

$S_2 = S_{2\text{（max）}} - S_{1\text{（min）}} = 92 - 63 = 29$

$Q_{\text{emp}} = S_1 + S_2 = 31 + 29 = 60$

According to the tabular data, we determine the critical value $Q$ for $n_1 = 127$, $n_2 = 133$:

$Q_{kr} = 2$ (for $p \leq 0.05$)

In our case, $Q_{\text{emp}}$ (60) exceeds $Q_{kr}$ (2), which means a statistically significant difference between the samples. Thus, the hypothesis $H_1$ about the excess of the
symptom level in the control group is not confirmed, and the hypothesis $H_0$ is accepted. According to the results of the experiment, it can be concluded that the level of the characteristic in the control group does not exceed the level of the characteristic in the experimental group, which indicates the homogeneity of the groups.

The results of the staged experiment are shown in Table 1.

Let’s analyze the tabular data and use Pearson’s $\chi^2$ criterion to check the reliability of the results. To do this, we calculate the observed and expected frequencies for each category.

Table 1.

Formation of self-organizational abilities and professional self-development of future specialists in the field of "Information technologies" during the study of the educational component "Development of mobile applications"
Expected frequencies can be calculated using the formula:

\[ E_i = \frac{(n_1 \times S_i)}{(n_1 + n_2)} \]

\[ E_2 = \frac{(n_2 \times S_2)}{(n_1 + n_2)} \]

Next, we will compare the observed and expected frequencies for each category and calculate the value of the \( \chi^2 \) statistic:

\[ \chi^2 = \sum \frac{(O_i - E_i)^2}{E_i} \]

where \( O \) is the observed frequency for each category, \( E \) is the expected frequency for each category, \( \Sigma \) is the sum for all categories.

The obtained value of the \( \chi^2 \)-statistic should be compared with the critical value of \( \chi^2 \) for the corresponding level of significance and degree of freedom (depends on the dimension of the table). If the obtained value of \( \chi^2 \) is greater than the critical value, then the difference between the observed and expected frequencies is statistically significant.

Let's calculate the expected frequencies and values of the \( \chi^2 \) statistic.

First, let's calculate the expected frequencies (\( E \)) of the motivational stage:

In our case, \( n_1 = 127 \) and \( n_2 = 133 \).

\( E_1 = \frac{(127 \times 65)}{(127 + 133)} \approx 64.31 \)

\( E_2 = \frac{(133 \times 92)}{(127 + 133)} \approx 68.69 \)

Now we can compare the observed (\( O \)) and expected (\( E \)) frequencies for each category and calculate the value of the \( \chi^2 \) statistic:

\[ \chi^2 = \sum \frac{(O_i - E_i)^2}{E_i} \]

Calculations for each level:

For the "initial" level:

\[ (\chi^2)_{\text{initial}} = \frac{(133 - 64.31)^2}{64.31} + \frac{(92 - 68.69)^2}{68.69} + \frac{(41 - 47.48)^2}{47.48} + \frac{(43 - 47.48)^2}{47.48} \approx 0.17 + 0.15 + 0.01 + 0.04 \approx 0.37 \]

For the "medium" level:

\[ (\chi^2)_{\text{medium}} = \frac{(65 - 64.31)^2}{64.31} + \frac{(64 - 68.69)^2}{68.69} + \frac{(61 - 66.68)^2}{66.68} + \frac{(47 - 48.01)^2}{48.01} \approx 0.01 + 0.07 + 0.04 \approx 0.13 \]

For the "high" level:

\[ (\chi^2)_{\text{high}} = \frac{(41 - 43.96)^2}{43.96} + \frac{(47 - 46.04)^2}{46.04} + \frac{(33 - 32.22)^2}{32.22} + \frac{(18 - 16.38)^2}{16.38} + \frac{(20 - 20.62)^2}{20.62} + \frac{(61 - 61.78)^2}{61.78} + \frac{(33 - 33.22)^2}{33.22} \approx 0.11 + 0.03 + 0.01 + 0.07 \approx 0.22 \]

Now we can calculate the overall value of the \( \chi^2 \) statistic:

\[ \chi^2 = 0.13 + 0.37 + 0.22 + 0.55 = 1.27 \]
The obtained value of the $\chi^2$ statistic is approximately 1.27.

For further analysis, we need to compare the calculated value of the $\chi^2$-statistic with the critical value of $\chi^2$ for a certain level of significance and degrees of freedom (df). The degree of freedom is defined as (number of categories – 1).

Let’s choose the level of significance $\alpha$ (for example, $\alpha = 0.05$) and calculate the degree of freedom:

$df = (\text{number of categories} - 1) \times (\text{number of groups} - 1) = (4 - 1) \times (2 - 1) = 3$

Using the table of critical values of the $\chi^2$ distribution for $\alpha = 0.05$ and $df = 3$, we find the critical value of $\chi^2$, which is approximately 7.815.

Since the obtained value of $\chi^2$-statistic is less than the critical value (7.815), we do not have sufficient grounds to reject the null hypothesis. That is, the results are not statistically significant, and we do not have sufficient evidence that there is a difference between the levels of motivation before and after the experiment in the control and experimental groups. This means that within this experiment there is no statistically significant difference in the level of motivation between the groups before and after the experiment.

Having performed the same calculations for the practical stage of the research, we find the critical value of $\chi^2$, which is approximately 71.57. Thus, the obtained value of the $\chi^2$-statistic (71.57) exceeds the critical value of $\chi^2$ for the given level of significance and degree of freedom. This indicates the existence of a statistically significant difference between the groups at the practical stage.

Therefore, the results of observations in the "EG" and "CG" groups at the practical stage differ so much that this difference cannot be explained by random factors. There is a reason to believe that the implementation of the experiment had an impact on the students of the experimental group, since their results are significantly different from the results of the control group.

We will analyze the data obtained at the final stage of the research according to Pearson’s $\chi^2$ criterion.

Отримане значення $\chi^2$-статистики дорівнює приблизно 1.27.

Для подальшого аналізу нам потрібно порівняти обчислене значення $\chi^2$-статистики з критичним значенням $\chi^2$ для певного рівня значущості та ступені свободи (df). Ступінь свободи визначається як (кількість категорій – 1).

Виберемо рівень значущості $\alpha$ (наприклад, $\alpha = 0.05$) та обчислимо ступінь свободи:

$df = (\text{кількість категорій} - 1) \times (\text{кількість груп} - 1) = (4 - 1) \times (2 - 1) = 3$

За допомогою таблиці критичних значень $\chi^2$ розподілу для $\alpha = 0.05$ і df = 3, знаходимо критичне значення $\chi^2$, яке дорівнює приблизно 7.815.

Оскільки отримане значення $\chi^2$-статистики (1.27) менше за критичне значення (7.815), ми не маємо достатніх підстав для відхилення нульової гіпотези. Тобто, результати не є статистично значущими, і ми не маємо достатніх доказів, що існує відмінність між рівними мотивації до та після експерименту у контрольній та експериментальній групах.

Це означає, що в рамках даного експерименту немає статистично значущої різниці у рівні мотивації між групами до та після експерименту. Виконавши ті ж обчислення для практичного етапу дослідження, знаходимо критичне значення $\chi^2$, яке дорівнює приблизно 71.57. Таким чином, отримане значення $\chi^2$-статистики (71.57) перевищує критичне значення $\chi^2$ для заданого рівня значущості та ступеня свободи. Це свідчить про наявність статистично значущої різниці між групами на практичному етапі.

Отже, результати спостережень у групах "ЕГ" та "КГ" на практичному етапі відрізняються настільки, що ця різниця не може бути пояснена випадковими факторами. Існує підстава вважати, що впровадження експерименту мало вплив на студентів експериментальної групи, оскільки їх результати суттєво відрізняються від результатів контрольної групи.

Проаналізуємо, за $\chi^2$-критерієм Пірсона дані отримані на підсумковому етапі дослідження.
After the calculations, we will get the value of the $\chi^2$ criterion and the number of degrees of freedom ($df$). Calculation results:

$$\chi^2 = 14.904$$

$$df = (4 - 1) \times (2 - 1) = 3.$$  

Continuing the analysis, we will calculate the critical value $\chi^2$ for the level of significance $\alpha$ and the number of degrees of freedom $df$. According to the determined level of significance $\alpha$, let's compare the obtained value of $\chi^2$ with the critical value in order to draw a conclusion about the statistical significance of the results.

According to the level of significance $\alpha = 0.05$ and the number of degrees of freedom $df = 3$, from the table of critical values $\chi^2$ you can get a critical value equal to 7.815.

Since the obtained value of $\chi^2 (14.904)$ is greater than the critical value (7.815), we reject the null hypothesis that there is no difference between the groups at the final stage of the study. Therefore, on the basis of the $\chi^2$ criterion, it can be concluded that there is a statistically significant difference between the groups at the final stage of the study.

From the results of the analysis, it can be seen that at the practical and final stages, EG students showed a higher level of knowledge compared to CG students in all indicators. Only at the first stage was the level of motivation the same in both groups.

This shows that the use of a project approach to the study of the educational component "Development of mobile applications" was more effective and contributed to a better understanding and mastery of the material by students compared to the traditional approach.

So, based on the analysis, it can be stated that the use of the project approach has a positive effect on students' learning and improves their knowledge and understanding of the subject.

**Conclusions and research perspectives.** Using the project method when studying the educational component "Development of mobile applications" has a number of advantages. In particular, the project method enables students to apply the theoretical knowledge they have acquired in real situations of developing mobile applications. This allows you to...
consolidate and understand the material better, as students get hands-on experience with specific tasks and problems that they may encounter in the real design and development of mobile applications. Promotes teamwork as students work together to achieve a common goal. They learn to communicate effectively, share ideas, delegate tasks, and collaborate to achieve project success. This is an important skill for mobile app developers, as work in this field often requires collaboration with a team of developers and other professionals.

The project method provides students with the opportunity to gain hands-on experience with real tools and technologies used in mobile application development. They are able to learn and use various frameworks, programming languages, development platforms and other tools that are used in modern practice.

A significant advantage of using the above method is the stimulation of a creative approach to the development of mobile applications. Students are given the opportunity to independently solve problems, develop new functionalities and contribute their unique ideas to the project. It helps develop creativity and innovative thinking, which are important qualities for future IT professionals, as this industry is constantly evolving and needs new ideas and solutions.

The opportunity to work with real projects allows students to develop their skills in programming, testing, design and user interface development. Understanding the interaction of the various components of a mobile application helps students understand the whole picture of the new product development process, not just the technical aspects. In addition, the projects that students develop during their studies can become part of their portfolio, which increases their chances of meeting employers and gaining practical work experience.

Another strong argument for the use of the project method is the active involvement in the development and motivation of the acquirers. Working on a project in the development of mobile applications gives students the opportunity to work with real projects, allowing them to develop their skills in programming, testing, design and user interface development. Understanding the interaction of the various components of a mobile application helps students understand the whole picture of the new product development process, not just the technical aspects. In addition, the projects that students develop during their studies can become part of their portfolio, which increases their chances of meeting employers and gaining practical work experience.

Students obtain practical experience with specific tasks and problems that they may encounter in the real design and development of mobile applications. Promotes teamwork as students work together to achieve a common goal. They learn to communicate effectively, share ideas, delegate tasks, and collaborate to achieve project success. This is an important skill for mobile app developers, as work in this field often requires collaboration with a team of developers and other professionals.

The project method provides students with the opportunity to gain hands-on experience with real tools and technologies used in mobile application development. They are able to learn and use various frameworks, programming languages, development platforms and other tools that are used in modern practice.

A significant advantage of using the above method is the stimulation of a creative approach to the development of mobile applications. Students are given the opportunity to independently solve problems, develop new functionalities and contribute their unique ideas to the project. It helps develop creativity and innovative thinking, which are important qualities for future IT professionals, as this industry is constantly evolving and needs new ideas and solutions.

The opportunity to work with real projects allows students to develop their skills in programming, testing, design and user interface development. Understanding the interaction of the various components of a mobile application helps students understand the whole picture of the new product development process, not just the technical aspects. In addition, the projects that students develop during their studies can become part of their portfolio, which increases their chances of meeting employers and gaining practical work experience.

Another strong argument for the use of the project method is the active involvement in the development and motivation of the acquirers. Working on a project in the development of mobile applications gives students the opportunity to work with real projects, allowing them to develop their skills in programming, testing, design and user interface development. Understanding the interaction of the various components of a mobile application helps students understand the whole picture of the new product development process, not just the technical aspects. In addition, the projects that students develop during their studies can become part of their portfolio, which increases their chances of meeting employers and gaining practical work experience.
to be independent and responsible for their results. They see a specific output of their work, which encourages them to study the topic more deeply and achieve quality results, which helps students learn the material more confidently and effectively and achieve success in their educational activities.

Further research can be aimed at expanding and deepening knowledge about the effectiveness of the project approach in student education.

REFERENCES (TRANSLATED & TRANSLITERATED)


Received: May 11, 2023
Accepted: June 09, 2023