ACTUAL PROBLEMS OF MODERN SCIENCE, EDUCATION AND TRAINING

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CONTENTS

UDC: 159.955:366.636

PEDAGOGICAL ASPECTS OF DEVELOPING STUDENTS' CRITICAL THINKING COMPETENCE IN HIGHER EDUCATION

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Annotatsiya. Maqolada O'zbekiston Respublikasida amalga oshirilayotgan ta'lim islohotlari doirasida talabalarning tanqidiy fikrlash kompetensiyasini rivojlantirish bilan bog'liq masalalar tahlil qilinadi. Milliy me'yoriy-huquqiy hujjatlar, oliy ta'lim muassasalarida joriy etilayotgan kompetensiyaviy yondashuv hamda raqamli ta'lim muhiti imkoniyatlariga tayanib, maqolada tanqidiy fikrlashni shakllantirishning pedagogik mexanizmlari yoritib berilgan.

Kalit so'zlar: *tanqidiy fikrlash, kompetensiyaviy yondashuv, oliy ta'lim, raqamli ta'lim, O'zbekiston ta'lim tizimi, pedagogik texnologiyalar.*

Аннотация. В статье анализируются вопросы развития компетенции критического мышления у студентов в контексте образовательных реформ, реализуемых в Республике Узбекистан. С опорой на национальные нормативно-правовые документы, компетентностный подход, внедряемый в высших учебных заведениях, а также возможности цифровой образовательной среды рассматриваются педагогические механизмы формирования критического мышления.

Ключевые слова: *критическое мышление, компетентностный подход, высшее образование, цифровое образование, система образования Узбекистана, педагогические технологии.*

Abstract. The article analyzes issues related to the development of students' critical thinking competence within the framework of educational reforms being implemented in the Republic of Uzbekistan. Drawing on national regulatory and legal documents, the competence-based approach introduced in higher education institutions, as well as the opportunities provided by the digital learning environment, the paper highlights the pedagogical mechanisms for fostering critical thinking.

Keywords: *critical thinking, competence-based approach, higher education, digital education, Uzbekistan's education system, pedagogical technologies.*

Introduction

In recent years, the Republic of Uzbekistan has identified the radical reform of the education system and bringing it up to international standards as one of its priority tasks. Based on the principle "New Uzbekistan – an enlightened society," developing learners' independent and critical thinking, a conscious attitude toward information, and digital competences has become an important strategic objective [1]. In particular, forming students' critical thinking competence in higher education institutions is

regarded as a key factor in ensuring the intellectual potential necessary for the country's social development [2].

Literature Review

The Decrees and Resolutions of the President of the Republic of Uzbekistan in the field of education emphasize the implementation of the competence-based approach, the renewal of educational content, and the wide introduction of digital technologies [2-4].

Specifically, in the higher education system, the following directions have been identified as priorities: revising curricula and syllabi on the basis of competences; orienting students toward thinking through problem situations; and using interactive methods that develop critical and creative thinking [5].

Within the framework of these reforms, critical thinking is viewed not merely as a theoretical concept, but as an essential competence that is manifested in students' real-life and professional activities [6-8].

Under the conditions of Uzbekistan's higher education system, critical thinking competence is formed on the basis of the following structural components: a cognitive (knowledge) component, which involves analyzing and systematizing interdisciplinary knowledge; an analytical component, which entails critically evaluating information and comparing evidence and conclusions; a reflective component, which includes substantiating one's ideas and reconsidering them when necessary; and an axiological component, which implies thinking grounded in national and universal values [5-9]. These components are closely interconnected and ensure students' intellectual and moral development.

Research Methodology

This qualitative study analyzed national education policies, theoretical literature, and pedagogical practices to investigate critical thinking development in Uzbekistan's higher education. Document review identified strategic priorities for competence-based learning. Literature examination focused on cognitive, analytical, reflective, and axiological components of critical thinking, including Central Asian scholarly traditions. Pedagogical observation in universities examined problem-based learning, debates, case studies, and digital integration. The methodology enabled systematic investigation of how critical thinking competence is conceptualized in policy, structured theoretically, and implemented practically within Uzbekistan's educational reforms.

Analysis and Results

In higher education institutions of Uzbekistan, the development of critical thinking is being implemented through the following pedagogical mechanisms: organizing classes on the basis of problem-based learning; analyzing real-life situations through case studies and project-based tasks; encouraging independent expression of ideas through debates and discussions; and developing an information-handling culture through digital platforms. These approaches enhance not only students' level of knowledge but also their culture of thinking [5-7]. In Uzbekistan's education system,

the process of forming critical thinking competence is carried out through the integration of national mentality, spiritual heritage, and modern pedagogical requirements. The culture of thinking promoted in the works of great scholars-Abu Nasr Farabi, Alisher Navoi, and Abu Rayhan Beruni-continues to serve as an important source for enriching educational content today [10-12].

At the same time, critical thinking and innovative thinking in higher education do not negate each other; rather, they are interrelated competences that ensure different stages of a unified intellectual activity. Innovative thinking is manifested in a student's ability to perceive a problem in a new way, move beyond stereotypical solutions, and generate alternative ideas. Critical thinking, in turn, epistemically organizes these ideas by examining their soundness, reliance on evidence, logical coherence, practical feasibility, and potential consequences. Thus, innovative thinking governs the phase of "creating a new solution," whereas critical thinking governs the phase of "verifying and refining the created solution." As a result, an idea does not remain at the level of imagination; instead, it gains the scientific and analytical foundation necessary to become a real outcome [5-9].

In the higher education process, innovative thinking is often activated through the mechanism of divergent thinking: a student proposes many options for one problem, recognizes unconventional approaches, and tends to accept risk. However, divergent thinking alone does not guarantee an intellectual result, because the number of options does not necessarily indicate their correctness or effectiveness. At this point, critical thinking enters as a tool of convergent analysis: the proposed ideas are selected on the basis of evidence and criteria; their reliance on sources, logical connections, resource requirements, and consequences are assessed. In this way, innovative thinking expands the "field of possibilities," while critical thinking enables an "evidence-based choice" within that field.

When these two competences function together, intellectual potential in higher education develops steadily through the "idea–evidence–testing–improvement" cycle. First, a problematic situation is posed and the student reinterprets the problem: identifies its root causes, defines its boundaries, and explains why existing solutions are insufficient. At this stage, innovative thinking generates new ideas, discovers unexpected connections between different options, and proposes alternative pathways. At the next stage, critical thinking subjects the idea to a "stress test" by asking questions such as: "What is this solution based on?", "What evidence supports it?", "Is there counter-evidence or an alternative explanation?", and "Under what conditions might it fail?" These questions reveal the weak points of the idea. Then the idea is transformed into a prototype or practical solution and tested; the test results are analyzed through reflection, and the idea is improved. Consequently, innovation is formed not simply as "novelty," but as "a functioning, evidence-based novelty."

In the context of higher education institutions, this integration should also be clearly reflected in teaching methods. For example, in project-based learning, a student develops an idea and presents it; however, while the presentation itself demonstrates innovative thinking, the question-and-answer session and expert evaluation activate critical thinking: the quality of argumentation, logical coherence, practical feasibility,

and risk analysis are required. The same applies to case studies and problem-based learning: proposing a solution relies on innovative thinking, whereas justifying the solution and evaluating its consequences are carried out through critical thinking. In academic discussions and debates, innovative thinking is manifested through identifying alternative positions and constructing original arguments, while critical thinking verifies the logical strength and evidential basis of those arguments.

Therefore, the strategy for ensuring intellectual potential in higher education requires developing critical and innovative thinking not in parallel, but in an integrated manner. If innovative thinking remains without critical scrutiny, there may be many ideas but of low quality; if critical thinking is applied without innovative thinking, a student may analyze existing knowledge but become weak in creating new solutions. Thus, these competences are complementary: innovative thinking provides a "new direction" for intellectual growth, while critical thinking "adjusts" that direction on the basis of scientific criteria and turns it into a result. In higher education institutions, precisely this harmony is one of the most important pedagogical foundations for ensuring students' intellectual potential.

Conclusion

In conclusion, forming students' critical thinking competence in Uzbekistan's education system is one of the key factors for improving the quality of education, training competitive specialists, and building an enlightened society. To organize this process effectively, it is necessary to consistently implement the competence-based approach, widely introduce digital and interactive methods, and develop a culture of thinking grounded in national values.

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UDC 159.9: 176.01

ON THE PSYCHOLOGICAL TRAINING OF HANDBALL REFEREES

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Annotatsiya. Gandbol hakamlarining psixologik tayyorgarligi o‘yinni adolatli, xolis va keskin vaziyatlarda xotirjam boshqarishlari uchun juda muhim omildir. Ko‘p yillar davomida gandbol qoidalaridagi o‘zgarishlar va musobaqalarni o‘tkazish tizimi ushbu sport turining rivojlanishini boshqarish vositasi bo‘lib kelgan. Musobaqalarni boshqaradigan hakamlar ishtirokchilardan alohida joylashtirilishi lozim. Hakam bo‘lish faqat qoidalarni bilish emas, balki psixologik barqarorlikni ham talab qiladi. Har qanday kasbiy faoliyatning tizimni shakllantiruvchi xususiyati uning muvaffaqiyatidir. Irodaviy sifatlarning tadqiqi shuni ko‘rsatdiki, barcha gandbol hakamlari jiddiylik va umumlashtirish nuqtai nazaridan maqsadga yo‘naltirilganlikning yuqori darajasi, shuningdek jasorat va qat’iyat bilan tavsiflanadi.

Kalit so‘zlar: *gandbol hakami, o‘yin qoidalari, kasbiy faoliyat, adolatlilik, to‘g‘rilik, insonparvarlik, sport takomillashuvi.*

Аннотация. Психологическая подготовка гандбольных судей является важным аспектом, позволяющим им справедливо, объективно и спокойно управлять игрой в напряжённых ситуациях. На протяжении многих лет изменения правил гандбола и системы проведения соревнований служили средством управления развитием этого вида спорта. Судьи, обслуживающие соревнования, должны быть размещены отдельно от участников. Быть судьёй значит, не только знать правила, но и обладать психологической устойчивостью. Системообразующей характеристикой любой профессиональной деятельности является её успешность. Исследование волевых качеств показало, что все гандбольные судьи характеризуются высоким уровнем целеустремлённости, как по серьёзности, так и по обобщённости, а также смелостью и решительностью.

Ключевые слова: *гандбольный судья, правила игры, профессиональная деятельность, справедливость, корректность, гуманизм, спортивное совершенствование.*

Abstract. The psychological preparation of handball referees is a very important aspect that enables them to manage the game fairly, objectively, and calmly in tense situations. For many years, changes in the rules of handball and in competition systems have served as a means of managing the development of this sport. Referees who officiate competitions must be positioned separately from the participants. Being a referee does not only mean knowing the rules; it also requires psychological resilience. The

system-forming characteristic of any professional activity is its success. The study of volitional qualities has shown that all handball referees are characterized by a high level of purposefulness, both in seriousness and in generalization, as well as by courage and determination.

Keywords: *handball referee, game rules, professional activity, fairness, correctness, humanism, sports improvement.*

Introduction

In the contemporary sports world, the role of handball referees is more difficult and responsible than ever before. Two referees with equal authority are assigned to each match. The referees are assisted by the secretary and the timekeeper in conducting the game. From the moment players and officials arrive at the competition venue until they leave the sports facility, referees must monitor their behavior.

Before the game, referees must check the condition of the playing court, the goals, and the balls. They select the ball to be used in the match. In addition, referees verify whether the players' uniforms comply with the rules, check the match protocol and players' equipment, inspect the equipment in the substitution area for substitute players, determine whether the number of players and officials in the substitution area complies with the accepted limits, and also confirm the presence and surname of each team's official representative.

The pre-match draw is conducted by one of the referees in the presence of the other referee and the official representative of each team, or another team official or player (for example, the team captain) authorized by the official representative. As a rule, the match should be officiated by the same referees throughout. They must ensure compliance with the rules of the game and impose penalties for any violations. If one of the referees is unable to continue officiating, the other referee continues the match alone. Any irregularities that do not comply with the rules must be corrected.

However, the main attention of researchers dealing with the scientific support of refereeing activities has been focused on theoretical and physical preparation, while its psychological aspect has remained practically unexplored. In sports games, refereeing is considered a responsible professional duty. A referee is a person who manages, evaluates, and makes judgments [1].

Literature Review

The manifestation characteristics and interrelations of intelligence indicators in handball referees, as well as the features of temperament and volitional qualities, have been examined. The indicators of success in handball refereeing have been identified. The nature of the influence of intellectual characteristics on refereeing performance and its individual components has been determined. Referees' attitudes toward their professional activity have been analyzed. The character of the relationship between personality traits and refereeing performance has also been established. Furthermore, the specificity of psychological characteristics, performance success, and attitudes toward activity has been identified among referees with high and low levels of professional competence.

The aim of the study is to substantiate the content of the psychological preparation of highly qualified handball referees and to develop methodological recommendations, taking into account their individual psychological characteristics. During the process of psychological preparation, general and specific volitional-psychological qualities are formed in each athlete and in the team. These include a stable interest in sport, disciplined adherence to the training regimen, a sense of duty toward the coach and the team, responsibility for fulfilling the training plan and competition results, as well as diligence and neatness.

The increasing popularity of handball in our republic has led to a growing demand for referees capable of regularly organizing and conducting competitions for all age groups. Therefore, the training of coaches and referees is carried out in a number of physical education collectives. The preparation of coaching and refereeing personnel should directly reflect the needs of physical education and sports organizations. In this regard, seminar plans should be developed, approved by the sports club of the respective organization, and then conducted in accordance with the approved schedule. Seminars should be held for 24, 36, or 40 hours, which may cover a period of four to five days, one week, or even longer. The involvement of professional specialists in these seminars would ensure a higher level of training for future public coaches and referees [1].

In the training of coaching and refereeing personnel, it is advisable to select the most proactive, hardworking, and advanced athletes. After the full implementation of the seminar program, participants should take both theoretical and practical examinations. Based on the examination results, they should be awarded the title of coach or referee. This must be confirmed by an official document granting the individual the right to work as a coach or referee. In addition to theoretical sessions covering all aspects of coach and referee training, the seminars should also develop the practical skills and abilities necessary for professional activity.

Table 1. Sample Training Curriculum for Handball Referees.

№	General Theoretical Section	Time
1.	Physical education and sport in Azerbaijan	2 hour
2.	VMH complex	1 hour
3.	Unified sports classification	1 hour
4.	The role of the referee in athletes' education	1 hour
Specialized Theoretical and Practical Section		
5.	Handball (a brief history of the development of techniques and tactics)	2 hour
6.	Handball game rules and refereeing methodology	14 hour
7.	Organization and conduct of competitions	2 hour
8.	Organization of handball team activities	1 hour
9.	Medical supervision and sanitary-hygienic requirements in handball competitions	2 hour
10.	Practical refereeing in handball (not fewer than five matches)	10 hour
TOTAL:		**36 hour**

Practical training may be carried out during friendly matches and, in some cases, during scheduled team games, with mandatory supervision of the refereeing process.

The success of referee training seminars depends on the methods and techniques applied during instruction.

The coach-referee fosters communication skills in athletes, goodwill toward teammates, respect for both teammates and the coach, high standards toward oneself and others, self-criticism, sports honor, and self-discipline. During the preparation process and in competitions, such qualities as purposefulness, independence in training, persistence in mastering skills, courage and endurance, determination and initiative, as well as firmness and resilience, are developed. In the course of psychological preparation, emotional stability is formed under various training, every day, and competitive conditions.

When preparing athletes psychologically for competition, the coach explains to them the goals and objectives of participation in the competition, the conditions and content of pre-competition preparation, the significance of being highly prepared for performance, the regulation of training intensity and preparation methods to improve the players' psychological state, the modeling of the conditions of the main competitive season, as well as the content and importance of self-control. The coach also provides information on self-control techniques, self-regulation, and their systematic practice.

Experience shows that the idea of the purposefulness and concentration of training loads can be improved over a long competitive period on the basis of foundational and specialized team training. At the same time, in various models of periodization, players demonstrate high performance indicators and manage to maintain them over several years [2].

Main Directions of Psychological Preparation:

a) Stress resistance - the ability to remain calm in tense game situations; maintaining emotional stability under pressure from spectators and players; controlling nerves during conflicts and remaining impartial in decision-making.

b) Attention and concentration - constantly monitoring the course of the game; detecting even minor rule violations in a timely and accurate manner; maintaining long-term focus (especially in extended or high-pressure matches).

c) Decision-making skills - making quick and accurate decisions; acting without hesitation in complex situations; maintaining confidence after making a decision and standing by it.

d) Communication skills - establishing effective communication with players and fellow referees; speaking calmly and clearly with players in tense moments; demonstrating authority through body language and tone of voice.

e) Motivation and self-regulation - recovering quickly after unsuccessful decisions; maintaining a high level of internal motivation; and being capable of self-criticism and open to development.

The study of intelligence showed that a high level of its development is characteristic of all handball referees (Table 2). Referees also possess a strong general awareness and concentration. The intellectual indicators of referees are characterized by low variability in their expression.

Professional referees are distinguished by a high level of general awareness, concentration of attention, the ability to generalize, establish connections between

concepts, and identify logical patterns. Among referees with a high level of professionalism, the lowest coefficients of variation were observed in the overall intelligence indicator as well as in the ability to detect logical patterns.

Table 2. Results of the study of intelligence among referees of different qualification levels.

Indicators of Intelligence	Group A		Group B		t	P≤
	X±S	V	X±S	V		
Level of Awareness	15,9±0,30	10,4	14,3±0,33	12,8	3,41	0,001
Ability to Generalize	15,0±0,37	13,4	12,0±0,34	15,5	5,86	0,001
Concentration of Attention	14,8±0,30	11,2	14,5±0,39	14,9	0,60	-
Connection-Making Ability	14,7±0,30	11,2	11,9±0,42	19,2	5,44	0,001
Pattern Recognition Ability	14,5±0,24	9,0	11,9±0,36	16,7	5,91	0,001
Overall Intelligence Score	74,9±0,69	5,0	64,6±1,60	13,6	5,80	0,001

The study of intelligence among referees with a low level of professionalism shows that they are characterized by a high level of general awareness and concentration, as well as a moderate level of ability to generalize, establish logical connections between concepts, and identify patterns. Referees whose professional development has stagnated are distinguished by low variability in the manifestation of intelligence and in its individual characteristics, particularly in attention concentration and general awareness.

It has been established that highly qualified referees are distinguished by significantly higher levels of awareness, as well as by their ability to generalize, establish logical connections, and identify regularities ($p<0.001$). The listed intellectual indicators determine the professional level of referees. A comparative analysis of the coefficients of variation shows that they are lower among referees with a high level of professionalism, which indicates the presence of a unified tendency in their manifestations [3].

When discussing the characteristics of sensorimotor processes in athletes, it should be noted that complex reactions are an essential component of handball players' specific skills. The outcome of game activity is closely related to indicators of sensorimotor reactions, such as passing the ball, penalty throws, gaining possession under the goal area, and shots from various distances. For players, the most predictive reactions are choice reactions, probabilistic anticipation reactions, anticipation of future events, and a sense of timing. The speed of thinking processes is one of the important foundations of tactical thinking in handball. The speed of thinking processes is manifested in the following situations:

- when it is necessary to immediately assess all the characteristics of a game situation;
- when it is necessary to recognize the possible changes in a situation;
- when decision-making takes a long time under emotionally tense conditions.

Thus, all psychological manifestations that depend on the effectiveness of sports activity are subject to psychological influence. The long-term experience of handball coaches and referees shows that during the training process, they have to work with athletes from the age of 10 up to 35 and even older. As a rule, the older the handball player becomes, the higher their level of mastery. Handball training usually begins at

the age of 14. High-level performance in handball is typically observed between the ages of 20–25 for women and 23–26 for men. Players of national teams, however, should not have more than 10 years of sports experience. To reach the highest level in sport, a handball player should master all technical and tactical aspects of the game by the age of 16–18. It is precisely during this period that the fundamental skills are developed.

Professional referees are characterized by a high level of purposefulness in terms of seriousness and generalization, courage and determination, independence and initiative, endurance, and self-control, as well as a high level of perseverance. In our republic, the training of coaching and refereeing personnel is carried out in a number of physical education collectives. The preparation of coaches and referees should directly reflect the needs of physical education and sports organizations. In this regard, seminar plans should be developed, approved by the sports club of the respective organization, and then conducted in accordance with the approved schedule. The total number of connections and the degree of their closeness make it possible to conclude that referees with a high level of professionalism demonstrate a higher level of integration of personality traits.

Practical training may be conducted during friendly matches and, in some cases, during scheduled team games, with the mandatory organization of supervised refereeing practice. The success of psychological preparation seminars for referees depends on the methods and techniques applied during instruction.

Normative levels of the expression of success indicators have been calculated for referees with different levels of proficiency. It has been determined that highly qualified referees are distinguished by a significantly higher degree of the following success indicators: objectivity, authority, principled conduct, and the timely and consistent execution of actions [4].

The interrelationship of success indicators—objectivity, confidence, and the overall evaluation of refereeing activity—has been established, which demonstrates their high importance in the process of high-level performance.

As a result of identifying the relationship between personality traits and the success of refereeing activity, it has been found that each indicator of refereeing success is connected with the referees' personality characteristics.

In the process of handball players' sports development, psychological preparation is inseparably linked with the athlete's physical (athletic), technical, and tactical training. The higher the player's qualification level, the more psychological preparation can be distinguished as a relatively independent component of the overall training system. At the same time, the athlete's psychological preparation and its methods should be selected in accordance with psychological principles, while the entire training process should be maximally psychologically oriented.

At the stage of sports development, the following directions can be identified in the psychological preparation of a handball player:

1. Formation of the athlete's moral and volitional personality traits.
2. Development of proper motivation and perseverance in handball training.
3. Creation of a positive socio-psychological climate and a cohesive sports team.

4. Development of psychological processes necessary for the game: attention, working memory, operational thinking, specialized sensations, perception, and reaction speed.

5. Development of volitional qualities and the formation of stress resistance.

Psychological processes related to the provision of techniques, information processing, and decision-making play a key role in the implementation of tactical activity in handball players. These processes are based on perception, the analysis of situations, the mental resolution of game situations, and the execution of corresponding motor actions.

The professionally significant qualities that determine the overall success of referees' performance include the following: volitional qualities—determination and courage, independence and initiative; temperament characteristics; the level of subjective reaction; and intellectual traits, particularly concentration of attention.

An analysis of the relationship between personality indicators and performance success in the group of highly qualified referees revealed a complex of symptoms that combine volitional qualities: courage and determination, independence and initiative (seriousness); indicators of success such as objectivity, confidence, and authority; and an intellectual trait—the ability to establish logical connections between concepts.

Referees monitor the behavior of players from the moment they arrive at the competition venue until they leave the area.

The established relationships indicate the specificity of the psychological conditioning of referees' performance depending on their level of professionalism. Similar relationships were also identified in the group of highly qualified referees; therefore, this type of referee possesses a certain professional potential.

In handball, all competition and training systems are currently associated with the athlete's need to overcome significant physical and emotional loads. In this regard, the formation of proper and stable motivation for players' participation in handball training is of great importance, as it helps maintain interest in the training process over a long period and creates the basis for improved sporting results [1].

In the process of competition and sports training, physical abilities, psychological preparation, and the technical-tactical arsenal of a handball player are implemented in a comprehensive manner. As a purposeful organizational process, game preparation can be achieved only through the proper interaction of all components of an athlete's training. The main means of game preparation is a specially organized instructional game. Under the supervision of the coach during two-sided practice matches, it can be brought as close as possible to real competition conditions by modeling competitive activity through the use of various methodological approaches.

1. Physical preparation - modern referees must be in physical condition comparable to that of professional athletes. They must keep up with the pace of the game and remain constantly in motion.

2. Additional training and certifications - referees must complete special courses and examinations organized by the European and International Handball Federations in order to obtain international qualifications.

3. Fairness and transparency - codes of conduct, ethical standards, and anti-corruption measures are regularly strengthened.

4. Increase in the number of female referees - female referees now officiate not only women's competitions but also international tournaments among men.

Thus, it can be concluded that the psychological conditioning of referees' performance is stronger among those with a high level of professionalism. If referees assess the actions of an offender as extreme unsportsmanlike conduct, the penalty should be determined accordingly. In cases of rule violations listed in sections a and b, the court referees must submit a written report to the relevant authorized bodies after the match. The content of the report should enable the authority to determine the appropriate level of punishment for the offender.

Research Methodology

In the course of conducting the confirmatory study, various forms of the survey method were employed. To examine the personality characteristics of the referees, diagnostic tools assessing temperament, intelligence, and volitional qualities were utilized. Professional performance success and attitudes toward professional activity were investigated using specially designed questionnaires that had been piloted in a preliminary study.

Analysis and Results

1. The personality of handball referees is characterized by a number of distinctive features. Specialists in this profile are distinguished by a high level of volitional qualities, including determination, courage, and decisiveness; intellectual traits such as general awareness and concentration of attention; and temperamental characteristics reflected in the subjective speed of reaction.

2. Indicators of successful officiating in handball include the absence of significant errors, objectivity, confidence, principled behavior, consistency, authority, and timeliness of decisions and actions. Tolerance is not considered an indicator of refereeing success, as it does not correlate with other measures of successful officiating. The interrelations among specific indicators have been established, and a generalized and expert-based evaluation of referees' success has been constructed.

3. The success of handball referees' professional activity is determined by their attitude toward their work. Overall success is associated with job satisfaction. Personal components of attitude are linked to indicators of success, such as satisfaction derived from confidence and consistency in performance.

4. Referees' attitudes toward their professional activity are to a certain extent determined by their psychological characteristics. The need to perform refereeing duties depends on the referees' level of material and emotional motivation.

Conclusion

1. The personality of handball referees is characterized by a number of specific traits. Specialists in this field are distinguished by a high level of volitional qualities—determination, courage, and decisiveness; intellectual traits—general awareness and

concentration of attention; and temperament characteristics, particularly the speed of subjective reaction.

2. Low variability in the manifestation of personality traits indicates a clearer and more consistent tendency in their expression among highly qualified referees. Handball referees are characterized by a high level of indicators reflecting their attitude toward professional activity as a necessary and practically realized endeavor, as well as by a moderate level of job satisfaction.

Depending on the level of professionalism of handball referees, the specificity of the personal determinants underlying their attitudes toward professional activity should be enhanced. The general attitude toward activity depends on the referees' subject-ergonic qualities characteristic of professional performance. However, its specific indicators are determined by individual characteristics of temperament, intellectual capacity, and the volitional sphere.

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UDC: 159.9, 176.01

THE STUDY OF THE DEVELOPMENT OF MOTOR ABILITIES IN ATHLETES ENGAGED IN VOLLEYBALL

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Annotatsiya. Maqolada voleybolchilarning harakat sifatlari rivojlanishining fiziologik asoslari ko‘rib chiqiladi hamda ularning zahira imkoniyatlarining ilmiy-nazariy asoslari tasvirlanadi. Maqolada harakat sifatlarining turlari va ularning funksional xususiyatlari tavsiflangan. Voleybol – yuqori dinamika, aniq texnik ijro va tezkor qaror qabul qilishga asoslangan jamoaviy sport turidir. Sportchilarning jismoniy sifatlari bilan bir qatorda, bu o‘yinda harakat qobiliyatlari ham muhim o‘rin tutadi. Harakat qobiliyatlari sportchiga texnik elementlarni mukammal bajarish va o‘yin vaziyatlariga moslashuvchan tarzda moslashish imkonini beradi.
Voleybolchilarning harakat sifatlarini rivojlantirishni o‘rganish ularning sport formasiga erishishida muhim manba hisoblanadi, chunki u mushak kuchi, tezlik, chidamlilik, chaqqonlik, egiluvchanlik va manevr qobiliyati kabi sifatlarni rivojlantiradi. Ushbu soha, avvalo, ularning faol o‘yin faoliyatini ta’minlaydi.

Kalit so‘zlar: *voleybol bilan shug‘ullanuvchi sportchilar, mushak kuchi, tezlik, quvvat, chidamlilik, chaqqonlik, egiluvchanlik, jismoniy sifatlar.*

Аннотация. В статье рассматриваются физиологические основы развития двигательных качеств волейболистов и описываются научно-теоретические основы их резервных возможностей. В статье охарактеризованы виды двигательных качеств и их эксплуатационные качества. Волейбол – командный вид спорта, основанный на высокой динамике, точном техническом исполнении и быстром принятии решений. Помимо физических качеств спортсменов, в этой игре важную роль играют двигательные способности. Двигательные способности позволяют спортсмену в совершенстве выполнять технические элементы и гибко адаптироваться к игровой ситуации.
Изучение развития двигательных качеств волейболистов является важным источником ресурсов для достижения ими спортивной формы, поскольку развивает такие двигательные качества, как мышечная сила, скорость, выносливость, ловкость, гибкость и маневренность. Изучаемая область, прежде всего, обеспечивает им активную игровую деятельность.

Ключевые слова: *спортсмены, увлеченные волейболом, мышечной силой, скоростью, мощью, выносливостью, ловкостью и гибкостью, физическими качествами.*

Abstract. This article examines the physiological foundations of motor development in athletes engaged in volleyball, describing the scientific and theoretical basis of their reserve capacities. The study analyzes the types of motor qualities and their corresponding performance characteristics. Volleyball is a team sport distinguished by high dynamics, precise technical execution, and rapid decision-making. In this game, alongside physical fitness, motor abilities play a crucial role. These abilities enable athletes not only to perform technical elements with precision but also to adapt swiftly to situational changes during the course of play. The study of the development of motor qualities in athletes engaged in volleyball represents a significant resource for achieving optimal athletic performance. This is because such training fosters the enhancement of motor qualities, including muscular strength, speed, endurance, agility, flexibility, and coordination. The examined domain primarily ensures the athletes' active participation in the game process.

Keywords: *volleyball athletes, muscle strength, speed, power, endurance, agility, and flexibility, physical fitness.*

Introduction

In modern sports, types of movement and their quality of execution are closely interconnected. This is especially evident among athletes engaged in team sports, where the mastery of various movement types directly influences the quality characteristics of performance. The diverse movements employed in the training process are specifically directed toward the enhancement and refinement of physical qualities.

Physical qualities represent the morphological, physiological, biochemical, and psychological foundation necessary for the improvement of movement. Motor skills, which reflect the refinement of physical qualities, characterize the technical preparation of movement functions. Key physical qualities include muscular strength, speed, endurance, agility, and flexibility. The degree of development and enhancement of these physical qualities depends on genetic factors. Within the training process, certain physical qualities, such as agility and overall endurance, are more variable, whereas speed and flexibility are less influenced.

Literature Review

An analysis of the literature and professional experience in elite volleyball indicates that a number of provisions considered essential within the contemporary methodology of basic and advanced technical and tactical training exist; however, in our view, these aspects have not been developed in sufficient depth.

Physiological and psychological research demonstrates that physical exercises enhance volleyball players' working capacity, strengthen their health, and positively influence their physical development. As a result, volleyball players strive to engage in these movements consistently and to perform them accurately and correctly. This, in turn, contributes to improved cardiac function, the gradual acceleration of metabolic

processes, the enhancement of work-related qualities, and the development of relevant sensory and functional capacities.

High coordination is required to accurately receive, pass, and execute attacking strikes with the ball. Coordination training includes various ball manipulations, simultaneous exercises with two balls, and tasks performed while maintaining balance.

Strength, on the other hand, is at a moderate level. The genetic influence on physical qualities is more pronounced at younger ages, typically between 16 and 24 years. The foundation for the individual development of physical qualities is primarily associated with reflex mechanisms. The development of physical qualities is reinforced through biochemical, structural, and functional changes in the body induced by the training process, mobilizing the athlete's reserve capacities [3].

Muscle strength develops through muscle hypertrophy (ATP, creatine phosphate, glycogen), while endurance improves with the growth of motor unit activation (MOT). Speed development, on the other hand, is associated with the characteristics of the central nervous system, the stability of the movement center (balance), and its arousal.

Muscle strength is the ability to resist external forces or sustain muscle tension. In the isometric mode, muscles perform static work, generating static force. In the isotonic mode, muscles perform dynamic work, generating dynamic force. Strength is characterized by the degree of muscle tension and can be expressed as absolute or relative muscle strength [5].

Absolute strength represents the physiological ratio of a muscle's maximal force relative to its antagonist muscles. It is measured in newtons or kilograms per square centimeter (N/cm^2 or kg/cm^2).

Relative strength is the anatomical ratio of a muscle's force to that of its antagonist muscles. In sports practice, it is most simply assessed as the ratio of an athlete's muscle strength to their body weight. Relative muscle strength is realized through speed–strength movements, with external loads ranging from 40–70% of maximal isometric force.

Explosive strength manifests as rapid muscle action under relatively high force and is reflected in the displacement of one's own body weight. Explosive strength is determined by speed–strength capabilities. It is not measured by magnitude alone but by duration, typically quantified as gradient force [4].

Factors affecting muscle strength development include the composition of muscle fibers, biochemical reactions within the muscle, neural regulation, and the degree of manifestation of volitional qualities. Muscle composition refers to the proportion of slow- and fast-twitch fibers, which are not equal in number. Muscles containing a higher proportion of activated slow-twitch, fatigue-resistant fibers exhibit greater endurance and are capable of sustained work [4].

Biochemical reactions occur in muscles under the influence of physical strength training, leading to myofibrillar hypertrophy within the muscle fibers. This hypertrophy increases both the volume and number of myofibrils (muscle fiber folding) and enhances the density and organization of muscle fibers. Androgenic hormones play a crucial role in this process, as they stimulate protein synthesis related to fiber folding—levels of these hormones in men are approximately ten times higher than in

women. The regulation of muscle tension by the nervous system can be assessed by the high number of active motor units (MUs). Measurement of human muscle strength depends on the muscle's ability to resist maximal loads and achieve full contraction. This represents maximal voluntary force (MVF) and corresponds to the concept of absolute muscle strength. The magnitude of MVF is closely associated with maximal force (MF), and the difference between MF and MVF is referred to as muscle force deficit. These indicators, reflecting both general and specific reserves, are crucial for developing movement qualities—strength, speed, and endurance—in all types of sports. Consequently, the energy reserves of muscles increase [1].

Physiological Basis of Speed Development: A large portion of physical movements used in sports games contributes maximally to the development of speed. The maximum outcome of muscle activity is achieved when speed is well developed. Physiologically, speed is defined as the human ability to respond to an external stimulus in the shortest possible time. Some specialists describe the speed component of physical performance in two forms:

Complex and Simple Forms of Speed: Speed can be categorized into complex and simple forms. The complex form of speed includes not only the rapid execution of movements but also mental operations performed within a short period. The elementary (simple) form of speed is manifested as the speed of a single action or movement, specifically the duration of the movement reaction and the maximal tempo of that action. The overall speed of a movement (e.g., jumping, throwing) largely depends on the recruitment of fast-twitch muscle fibers and the anaerobic response. The energy for movement is generated by ATP and phosphocreatine decomposition in anaerobic conditions. The movement reaction time (MRT) is most evident in sprinting and is often referred to as the "latent period" of speed. For complex stimuli (requiring choice), the latent period is 1.5–2 times longer than for simple stimuli (no choice). Genetics play a significant role in this process. The maximal tempo of movements, such as sprinting, depends on two factors: the level of speed development and the maximal speed itself. Speed development is most frequently trained in short-distance activities (10–15 m), common in many sports due to frequent directional changes. Notably, increasing speed and achieving maximal speed are not directly correlated. Speed is measured using a training-test, for example, by counting the number of movements performed in 10 seconds: adults typically perform 50–60 movements, sprints 60–80, and sometimes up to 120.

Physiological factors influencing speed development include: the balance of the nervous system, functional mobility, skeletal muscle properties, energy supply, and the ratio of fast- and slow-twitch muscle fibers [5].

In team sports such as volleyball, regular training improves balance and neuromuscular coordination, enhancing the adaptive capacity of the nervous system. Therefore, specific training methods are applied, such as upright running, resisted running, and other specialized exercises.

Physiological Basis of Endurance Development:

Endurance is the ability of the human body to resist increasing fatigue or declining performance. Endurance is the ability to complete a given task within a certain time

frame. The unit of measurement for endurance is determined by internal physiological changes in the body and the rate of recovery.

There are two types of endurance: general and specific. General endurance involves the participation of multiple muscle groups in the work process and a high level of aerobic capacity. The relative and absolute levels of maximal oxygen uptake (VO_{2max}) serve as indicators of general endurance, reflecting the body's ability to meet oxygen demands over prolonged periods. Specific endurance refers to the athlete's ability to cope with precise physical load requirements specific to their sport. Factors influencing the rate of endurance development include the level of oxygen utilization, the physical capacity of the body, and the efficiency of its use.

Physiological Basis for the Development of Agility and Quickness. Quickness is a set of complex skills closely related to an individual's movement habits. The more stable movement habits a person possesses, the greater their ability to perform complex coordinated movements. Acquiring complex movement habits quickly depends on the efficiency of the movement control mechanism: the better the mechanism, the faster new movement elements can be learned. Quickness also involves the ability to transition efficiently from one movement to another and adapt to changing situations. The physiological basis of quickness development is determined by the motor activity and dynamics of the nervous system, as well as the balance between excitation and inhibition processes. In volleyball training, quickness is developed through non-standard physical movements specific to the sport. Agility is the degree of coordinated motor control of different body parts. The measure of agility can be represented by the amplitude of movements. This amplitude depends on anatomical characteristics of the joints, elasticity of tissues, surrounding structures, and the functional condition of the musculoskeletal and nervous systems.

Agility is activated by muscle warming and becomes passive in cold conditions. In a resting state, agility is delayed and fatigues easily. Its level is lower in the morning and reaches a maximum in the afternoon. Pre-start warm-up initiates activation: blood circulation in muscles increases, temperature rises, and ligament elasticity improves. Agility has active and passive forms:

- active agility is characterized by the amplitude of movement;
- passive (inactive) agility is executed under the influence of an external force.

Agility is generally higher in females, as their muscle-ligament apparatus allows them to perform complex movements more efficiently compared to males. Thus, the development of motor abilities in athletes practicing sports games enhances their physical capabilities, training level, and genetic potential, leading to the following conclusions:

The activity of athletes' oxygen-transporting organs and systems (respiratory, cardiovascular, and blood systems) should be maintained at a level meeting modern requirements through the application of appropriate training methods and tools during the training process.

1. With a specialized program and planned training, the respiratory system should increase its capacity by approximately 50–55% (up to 5–9 L), while the cardiovascular system enhances cardiac activity through an increase in

stroke volume. As a result, overall blood circulation rises by an average of 20%, leading to changes in the total volume of erythrocytes and hemoglobin, which reduces the accumulation of lactic acid.

2. Due to increased physical qualities in muscle activity (80–90%), slow-twitch muscle fibers gain a predominance in aerobic energy supply, enhancing endurance and efficiency.

The study provides a theoretical, scientific–methodological, and practical analysis of the development of motor abilities in athletes engaged in volleyball, demonstrating the mechanisms through which they can achieve higher performance outcomes. The findings of the article can be utilized by every specialist working with volleyball athletes to help them achieve maximum results. The application of modern tools and methods allows for the enhancement of these performance outcomes.

Research Methodology

This study employed a mixed-methods approach combining literature analysis, questionnaire survey, pedagogical observation with medical monitoring, and semi-structured interviews with physicians at the Youth Sports School (UGIM) to investigate injury types and motor ability development in youth volleyball players. The research identified five key motor abilities essential for volleyball performance: speed developed through interval runs and reaction drills; strength through squats, plyometrics, presses, and pull-ups; agility through cone and ladder drills; endurance through aerobic and anaerobic conditioning; and coordination as an integrated capacity. Training methods examined included plyometric exercises for explosive power, functional strength training for whole-body engagement, technical-tactical game situations for practical application, reaction drills for rapid response, circuit and interval training for combined physical capacities, integrated technical-physical drills for skill conditioning, and stretching protocols for injury prevention. This methodology enabled a systematic investigation of the relationship between motor ability development and injury patterns among youth volleyball athletes.

Analysis and Results

Physiological and psychological research indicates that motor abilities enhance volleyball players' working capacity, strengthen their health, and positively influence their physical development.

1. Volleyball players consistently engage in these movements and strive to perform them accurately and correctly. This also contributes positively to the improvement of cardiac function, the gradual acceleration of metabolism, the enhancement of qualities related to the work process, as well as the development of relevant sensory and functional capacities.

2. The development of volitional qualities alongside motor abilities is considered an urgent task within athlete–coach activities. The cultivation of these qualities is formed in the process of overcoming difficulties and obstacles on the basis of improving intellectual, emotional, and executive components.

3. In volleyball players, the formation of motor abilities, physical education, and personality development in sport constitutes a unified process that builds psychological

capacity, shapes individual style, and creates conditions for productive and efficient human performance.

Conclusion

For volleyball players to achieve high performance, it is essential to develop their motor abilities comprehensively. Strength, speed, agility, endurance, and coordination are closely interconnected and form the foundation of an athlete's technical–tactical preparation. The regular development of these qualities through training enhances both individual performance and the overall level of team play. A balanced approach to cultivating these abilities during the training process positively impacts both individual and team performance in volleyball.

The rapid execution of movements promotes quick thinking and ensures precise control over motor performance. Therefore, motor abilities in volleyball players should be developed consciously rather than mechanically. All these motor abilities develop and manifest in interrelation. The development of individual qualities is possible only under appropriate conditions; therefore, it is essential to ensure the timely and proper cultivation of physical qualities.

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UDC: 378.091.12; 004.9; 811.111

DEVELOPING DIGITAL COMPETENCE AMONG ENGLISH LANGUAGE TEACHERS THROUGH DIGITAL PLATFORMS

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Annotatsiya. Ta’limning tezkor raqamli transformatsiyasi ingliz tili o‘qituvchilariga qo‘yiladigan kasbiy talablarni sezilarli darajada o‘zgartirdi. Ushbu tadqiqotning maqsadi — ingliz tili o‘qituvchilarining raqamli kompetensiyasini raqamli platformalar orqali rivojlantirish bo‘yicha zamonaviy yondashuvlarni tahlil qilish va texnologiyalarni til o‘qitish jarayoniga integratsiya qilishning samarali strategiyalarini aniqlashdan iborat. Tadqiqot zamonaviy ilmiy adabiyotlar, xalqaro doiralar va so‘nggi empirik tadqiqotlar tahliliga asoslangan. Natijalar shuni ko‘rsatadiki, tizimli malaka oshirish dasturlari, institutsional qo‘llab-quvvatlash va raqamli platformalardan foydalanish o‘qituvchilarning raqamli kompetensiyasini rivojlantirishda muhim rol o‘ynaydi. Tadqiqot xulosasiga ko‘ra, raqamli texnologiyalarni tizimli integratsiya qilish ta’lim sifati, o‘quvchilar faolligi va til ta’limining umumiy samaradorligini oshirishga xizmat qiladi.

Kalit so‘zlar: *raqamli kompetensiya, ingliz tili o‘qituvchilari, raqamli platformalar, malaka oshirish, ta’lim texnologiyalari.*

Аннотация. Стремительная цифровая трансформация образования существенно изменила профессиональные требования к преподавателям английского языка. Цель данного исследования — проанализировать современные подходы к развитию цифровой компетентности преподавателей английского языка с использованием цифровых платформ и определить эффективные стратегии интеграции технологий в процесс обучения. Исследование основано на анализе современной научной литературы, международных рамок и актуальных эмпирических работ. Результаты показывают, что структурированные программы повышения квалификации, институциональная поддержка и использование цифровых платформ играют ключевую роль в развитии цифровой компетентности преподавателей. Сделан вывод о том, что системная интеграция цифровых технологий способствует повышению качества обучения, вовлечённости обучающихся и общей эффективности языкового образования.

Ключевые слова: *цифровая компетентность, преподаватели английского языка, цифровые платформы, повышение квалификации, образовательные технологии.*

Abstract. The rapid digital transformation of education has significantly changed the professional requirements for English language teachers. The purpose of this study is to examine current approaches to developing digital competence among English language teachers through digital platforms and to identify effective strategies for integrating technology into language teaching. The research is based on analysis of contemporary scholarly literature, international frameworks, and recent empirical studies. The findings demonstrate that structured professional development programs, institutional support, and the use of digital platforms play a crucial role in enhancing teachers' digital competence. The study concludes that systematic integration of digital technologies contributes to improving teaching quality, learner engagement, and the overall effectiveness of language education.

Keywords: *digital competence, English language teachers, digital platforms, teacher training, educational technology.*

Introduction

The digitalization of education has become one of the defining features of contemporary pedagogical practice. Technological innovations, online learning environments, and digital platforms are transforming teaching methods and learning processes across educational systems. In this context, English language teachers are required to develop not only linguistic and methodological expertise but also a high level of digital competence.

Digital competence refers to the ability to use digital technologies effectively for teaching, learning, and professional development. It includes technical skills, pedagogical knowledge, and the integration of digital tools into classroom practice. International frameworks emphasize that digital competence is a key component of teacher professionalism and educational quality [1–3].

In language education, digital platforms support communication, collaboration, and learner autonomy. However, their effective use depends on teachers' readiness and institutional support. Therefore, the development of digital competence among English language teachers has become a priority in teacher education.

The aim of this study is to analyze current approaches to developing digital competence among English language teachers through digital platforms and to identify effective strategies for integrating technology into teaching practice.

Literature Review

Digital competence has been widely studied in educational research as a multidimensional construct that combines technological, pedagogical, and methodological components. The main components of teachers' digital competence and their theoretical foundations are presented in Table 1. As shown in Table 1, digital competence is a multidimensional construct that integrates technological skills with pedagogical and methodological knowledge required for effective language teaching in digital environments. The European framework DigCompEdu defines digital competence as a set of skills required for teachers to integrate digital technologies into teaching and professional development [1].

Table 1. Components of teachers' digital competence.

Component	Description	Source	Example in English teaching
Technical skills	Ability to use digital tools and platforms	DigCompEdu [1]	Using Moodle, Google Classroom
Pedagogical integration	Using technology in lesson design	TPACK [4]	Kahoot, Quizlet activities
Digital communication	Online interaction with students	UNESCO ICT-CFT [3]	Feedback in LMS, chats
Content creation	Developing digital materials	OECD [2]	Presentations, video lessons
Digital assessment	Online evaluation tools	Chen et al. [7]	Google Forms tests
Professional development	Continuous digital training	Farrell [10]	Webinars, courses

International organizations such as UNESCO and OECD highlight the importance of developing teachers' digital competence through structured training programs and continuous professional development [2, 3]. According to these frameworks, teachers must be able to use digital tools to support student engagement, collaborative learning, and assessment.

Researchers emphasize that digital competence is closely related to the concept of technological pedagogical content knowledge (TPACK), which integrates subject knowledge, pedagogy, and technology [4]. Effective teaching in digital environments requires teachers to combine these elements in a coherent way.

Recent studies indicate that digital platforms play an important role in language education. They provide opportunities for communication, interactive learning, and access to authentic materials. Kohnke and Moorhouse note that digital tools and artificial intelligence are increasingly used in language teaching to enhance student engagement and learning outcomes [5].

At the same time, several challenges remain. Teachers often face difficulties related to limited access to technology, insufficient training, and lack of institutional support. Studies show that without systematic professional development and infrastructure, the integration of digital technologies may remain ineffective [6, 7].

Thus, the development of digital competence among English language teachers requires a comprehensive approach that includes training, institutional support, and methodological guidance.

Research Methodology

This study employs a qualitative theoretical research design aimed at analyzing the development of digital competence among English language teachers through digital platforms. The methodology is based on the analysis of contemporary scholarly literature, international frameworks, and policy documents related to digital competence in education.

The study draws on publications produced between 2017 and 2025, reflecting current trends in digital transformation and teacher professional development. Key conceptual foundations include the DigCompEdu framework and UNESCO ICT-CFT,

which define digital competence as a combination of technological, pedagogical, and methodological skills required for effective teaching in digital environments [1, 3].

The research focuses on English language teachers and examines how digital platforms influence teaching practices, professional development, and student engagement.

The analysis aims to identify effective strategies for developing digital competence and to determine factors that facilitate or hinder the integration of digital technologies into language teaching. By synthesizing findings from international studies and policy documents, the research provides a structured overview of current approaches to digital competence development and outlines directions for further investigation.

Several analytical methods were applied in the study, including theoretical analysis, comparative analysis, content analysis, and synthesis. These methods allowed for systematic examination of digital competence frameworks, research findings, and methodological approaches.

The reliability of the study is ensured through the use of peer-reviewed publications and internationally recognized frameworks. Although the research is theoretical and does not include empirical data collection, it offers a comprehensive overview of current research and identifies key directions for improving teachers' digital competence.

Analysis and Results

The analysis of recent research indicates that the development of digital competence among English language teachers is influenced by several interrelated factors at individual and institutional levels. These factors become visible not only at the theoretical level but also in everyday teaching practice.

1. Structured professional development

One of the most influential factors is the availability of structured training programs for teachers. When professional development courses are based on frameworks such as DigCompEdu, teachers receive clear guidance on how to use digital tools in real classroom situations. For example, training sessions often include practical workshops where teachers learn how to design online quizzes in Google Forms, organize discussions in Padlet, or create vocabulary practice activities in Quizlet. Such training helps teachers move from simply knowing about digital tools to using them confidently in lessons [1, 6].

Teachers who regularly attend webinars, short courses, or institutional workshops are more likely to experiment with new platforms and adapt their teaching strategies. For instance, a teacher who has learned how to use Zoom breakout rooms during training may later apply this tool for speaking activities or group discussions in an online class. Research indicates that regular training increases teachers' confidence and reduces anxiety related to technology use.

2. Institutional support

Teachers are more likely to use digital tools when their institutions provide the necessary infrastructure and support. This includes stable internet access, available devices, and access to digital platforms such as learning management systems. For

example, when a university provides a shared platform like Moodle or Google Classroom and offers technical support, teachers can upload materials, assign tasks, and give feedback more efficiently.

Institutional policies also matter. When schools and universities encourage innovation, provide training opportunities, and recognize teachers' efforts to integrate technology, teachers are more motivated to develop their digital skills. Conversely, when teachers must rely on their own devices and receive little institutional support, the integration of digital tools becomes more difficult and less consistent [2].

3. Role of digital platforms

Digital platforms themselves play a key role in shaping teachers' digital competence. In practice, platforms such as Zoom, Google Classroom, Microsoft Teams, and various language-learning applications become part of everyday teaching routines. For example, teachers may use Google Classroom to distribute assignments, Zoom for online speaking practice, and Kahoot to review vocabulary in an interactive way.

These platforms also allow teachers to monitor student progress more easily. Through online quizzes, discussion boards, and shared documents, teachers can provide immediate feedback and track participation. Students benefit as well: they can access materials outside the classroom, watch recorded explanations, and practice language skills at their own pace. As a result, digital platforms support more flexible and student-centered learning environments [5, 7].

4. Challenges

Despite these advantages, teachers often encounter practical difficulties when integrating digital technologies. Some teachers lack sufficient training and feel unsure about how to use certain tools effectively. Others work in contexts where internet access is unstable or digital resources are limited. For example, a teacher may plan an online activity but face technical problems that interrupt the lesson.

Another challenge is the persistence of traditional teaching habits. Teachers who are accustomed to textbook-based instruction may hesitate to redesign their lessons using digital tools. Overcoming these challenges requires not only technical training but also methodological support and encouragement from institutions.

Addressing these issues involves continuous professional development, access to reliable infrastructure, and a supportive teaching environment. When teachers receive practical training and institutional support, they are more likely to integrate digital tools into their lessons in meaningful ways.

The findings show that the development of digital competence among English language teachers is a gradual process shaped by teaching experience, institutional support, and access to digital platforms. Teachers who regularly use digital tools become more confident and integrate technology more naturally into their lessons. These findings correspond with research emphasizing that digital competence develops through continuous practice rather than isolated training [6,7].

Institutional conditions remain critical. When universities provide stable digital infrastructure and methodological support, teachers are more likely to use technology consistently. Collaboration among teachers and participation in professional

development activities also contribute to competence development. Therefore, the development of digital competence should be viewed as a continuous and collaborative process involving teachers, institutions, and policymakers.

Conclusion

The study confirms that the development of digital competence among English language teachers is essential for effective teaching in digital learning environments. Digital platforms support interactive learning, feedback, and student engagement, but their effective use requires systematic professional development and institutional support.

Teachers need opportunities to experiment with digital tools and gradually integrate them into their practice. Educational institutions play a key role by providing infrastructure, training, and methodological guidance. Strengthening teachers' digital competence contributes to improving language education and preparing both teachers and learners for the demands of digital society. The systematic development of teachers' digital competence should therefore be considered a strategic priority in modern education systems.

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UDC: 37, 631, 004.92

THE IMPORTANCE OF AUTOMATED DESIGN SYSTEMS IN THE DESIGN OF MODERN AUTOMOBILES AND TRACTORS

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Annotatsiya. Ushbu maqolada zamonaviy avtomobil va traktorlarni loyihalash jarayonida avtomatlashtirilgan loyihalash tizimlarining (ALT) o‘rni, ahamiyati va dolzarbligi ilmiy jihatdan tahlil qilingan. CAD, CAE va CAM texnologiyalarining konstruktsiya sifatini oshirish, ishlab chiqarish samaradorligini ta’minlash hamda muhandis-konstruktorlarning kasbiy kompetensiyalarini shakllantirishdagi roli yoritilgan. Shuningdek, O‘zbekiston Respublikasida mashinasozlik va qishloq xo‘jaligi texnikasini rivojlantirish jarayonida ALT fanining dolzarbligi asoslab berilgan.

Kalit so‘zlar: *Avtomatlashtirilgan loyihalash tizimlari, CAD, CAE, CAM, avtomobil, traktor, modellashtirish, raqamli texnologiyalar.*

Аннотация. В данной статье представлен научный анализ роли, важности и актуальности автоматизированных систем проектирования (АСП) в процессе проектирования современных автомобилей и тракторов. Особое внимание уделяется роли технологий CAD, CAE и CAM в повышении качества проектирования, обеспечении эффективности производства и развитии профессиональных компетенций инженерных конструкторов. Кроме того, обоснована актуальность дисциплины АСТ в развитии машиностроения и сельскохозяйственной техники в Республике Узбекистан.

Ключевые слова: *автоматизированные системы проектирования, CAD, CAE, CAM, автомобиль, трактор, моделирование, цифровые технологии.*

Abstract. This article scientifically analyzes the role, importance, and relevance of Automated Design Systems (ADS) in the design process of

modern automobiles and tractors. The role of CAD, CAE, and CAM technologies in improving design quality, ensuring manufacturing efficiency, and shaping the professional competencies of engineering designers is highlighted. Additionally, the relevance of the field of ALT in the development of machinery and agricultural machinery in the Republic of Uzbekistan is justified.

Keywords: *automated design systems, CAD, CAE, CAM, automobile, tractor, modeling, digital technologies.*

Introduction.

In the design process of modern cars and tractors, the science of automated design systems is considered one of the most important and complex scientific and technical fields in the mechanical engineering sector. This discipline enables the modelling of technical objects in a digital environment, the scientific analysis of their structural, functional, and operational characteristics, and the development of optimal design and technological solutions. Today, the acceleration of globalization processes, the digitalization of industrial sectors, and the growing severity of environmental problems demand the introduction of innovative and systematic approaches to the design of transport and agricultural machinery.

In the automotive and tractor manufacturing sectors, the creation of high-quality, safe, energy-efficient and environmentally compliant machinery largely depends on how sophisticated and modern the design process is, and how it is organized using information technologies. From this perspective, studying automated design systems, implementing them in practice and training qualified design engineers is one of today's most pressing tasks. This issue is also intrinsically linked to the wide-ranging reforms being carried out in the Republic of Uzbekistan. In particular, the President of the Republic of Uzbekistan's “Digital Uzbekistan – 2030” strategy, the digitization of industrial sectors, the widespread introduction of modern information and communication technologies into production processes, and the training of personnel with digital competencies in engineering have been identified as priority tasks. Furthermore, the President's decrees and decisions have placed special emphasis on modernizing the automotive and agricultural machinery industries, localizing production, and expanding the manufacture of competitive products [1-9].

Therefore, to develop the science of automated design systems, its integration with education and production, and its widespread application in the design of modern cars and tractors are emerging as important factors in the sustainable development of the republic’s industry.

Literature Review

Current pressing issues in the development of the science of automated design systems. Automated Design Systems (ADS) are a suite of modern engineering tools that provide for the computer-based creation, analysis, and manufacturing preparation of automotive and tractor parts, components, and entire structures. These systems operate on the basis of the integration of CAD (Computer-Aided Design), CAE (Computer-Aided Engineering), and CAM (Computer-Aided Manufacturing)

technologies and have become an integral part of the design process in modern mechanical engineering.

CAD systems enable the creation of geometric and parametric models of structures, serving to accurately represent the shape, dimensions, and structural connections of components. CAE systems, on the other hand, allow the reliability and safety of structures to be scientifically assessed by conducting strength, dynamic, vibration, and thermal analyses based on the created models. Meanwhile, with the aid of CAM systems, the process of preparing the designed parts for manufacture is automated, ensuring technological accuracy and manufacturing efficiency [1-4].

Research Methodology

At the same time, a number of pressing issues exist in the development of automated design systems, covering scientific, technical, and organizational aspects.

The first problem is the gap between theoretical knowledge and practical skills. In many educational institutions, the teaching of ALT focuses primarily on theoretical concepts, and practical modelling work closely aligned with real industrial projects has not been sufficiently developed. For example, students learn to draw simple parts in a CAD system, but they do not acquire the skills to perform complex load, deformation, or fatigue analyses using CAE.

The second problem is related to the lack of modern software and technical infrastructure. In developed countries, software tools such as SolidWorks, CATIA, Siemens NX, and ANSYS, which are widely used in automotive and tractor manufacturing, are not available in all educational institutions or their full capabilities are not utilized. As a result, graduates face difficulties adapting to the real-world design environment used in industrial enterprises [8].

The third problem is the weak integration of the ALT subject with production. Due to the scarcity of projects carried out in collaboration with manufacturers of automotive and agricultural machinery, students are unable to compare the results of virtual modelling with real production processes. For example, the technological processes developed using CAM systems are not tested on actual machine tools.

The fourth problem is that the content of science does not fully align with rapidly evolving technologies. Although approaches such as artificial intelligence, digital twins, cloud computing, and big data–based design are developing rapidly today, these areas have not been adequately covered in the ALT curriculum.

The fifth problem is the issue of staff competence, which is explained by the lack of pedagogical engineers with in-depth knowledge of automated design systems and industrial experience. This situation adversely affects the delivery of the subject content in line with the demands of modern manufacturing.

The effective resolution of the aforementioned problems necessitates the implementation of a systematic approach based on the integration of education, science, and production in the development of the science of automated design systems [1-6].

Analysis and Results

Analyses conducted to show that the effective development of the science of automated design systems in the educational process requires the implementation of a project-oriented teaching methodology organized based on real technical assignments from industrial enterprises. This approach enables students to participate in the full digital cycle of designing automotive and tractor components, fostering the ability to apply CAD, CAE, and CAM technologies in an integrated manner.

The research results confirmed the importance of expanding practical laboratory sessions for CAD/CAE/CAM systems and introducing teaching methods based on a modular and competency-based approach using modern software products. In particular, the comprehensive analysis of strength, dynamic, and thermal processes using CAE systems, as well as applying the processes of preparing designs for manufacturing based on CAM technologies to the curriculum significantly develops students' engineering thinking [9].

Additionally, the development of a teaching methodology for automated design systems based on digital modeling, virtual testing, and optimization helps to increase the scientific basis of design decisions. As a result, in the automotive and tractor manufacturing industries, it produces industrial-level professionals who are competitive, innovative thinkers, and proficient in digital technologies.

Table 1. Methods used in the development of the science of automated design systems and their results.

Method	Scientific-practical result	Competencies to be developed
Project-Based Learning	Students carry out the complete design cycle of automotive and tractor components based on real industrial technical assignments.	Engineering decision-making, systems thinking, and design responsibility
Parametric 3D modeling based on CAD	The geometric accuracy of structures and their optimization based on variable parameters is ensured.	Digital modeling, design flexibility
Virtual testing and analysis based on CAE	Strength, dynamics, and thermal processes are analyzed without a physical prototype.	Engineering analysis, safety, and reliability assessment
CAM-based manufacturing preparation	Design is adapted to the technological process, and manufacturing accuracy is increased.	Technological thinking, integration with production
Modular and competency-based approach	Theoretical knowledge is organically linked with practical skills.	Professional competencies, independent learning
Digital modeling and optimization	The structure's mass, strength, and efficiency are optimized.	Innovative thinking, engineering optimization
Virtual laboratories and simulation	Complex technical processes are studied in a safe and cost-effective environment.	Digital literacy, empirical analysis
Integration of education, science, and production	Graduates fully meet industry demands.	Competitiveness, professional adaptability

Conclusion

Based on the analyses conducted, it was determined that the set of methods used to develop the science of automated design systems serves to enhance the effectiveness of engineering education in line with modern industrial requirements. These approaches ensure a harmony of theoretical knowledge and practical skills in students by integrating the full digital cycle (CAD–CAE–CAM) of automotive and tractor component design into the learning process. As a result, the professional competencies required to prepare design engineers who are proficient in digital technologies, innovative thinkers, and competitive at an industrial level are developed.

At the same time, in order to further improve the science of automated design systems, it is considered appropriate to implement the following scientific and practical recommendations:

- to widely introduce project assignments into the educational process, developed based on real production orders from automotive and tractor manufacturing enterprises;
- to establish specialized digital laboratories equipped with modern CAD/CAE/CAM software;
- developing interdisciplinary integrated learning modules focused on digital modeling, virtual testing, and optimization;
- enhancing the practical competencies of instructors by establishing their professional development at industrial enterprises;
- Phased introduction of digital engineering, “Digital Twin,” and artificial intelligence elements in the teaching of automated design systems.

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UDC: 378, 147, 004, 811

EFFECTIVENESS OF ONLINE TECHNOLOGIES IN DEVELOPING FOREIGN LANGUAGE WRITING SKILLS OF NON-SPECIALIST STUDENTS (on the example of art terms)

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Annotatsiya. Ushbu maqolada hozirgi fan-texnika taraqqiyoti davrida dunyo, xususan, mamlakatimizda xorijiy tillarni o‘rganishning tobora ortib borayotgan ahamiyati, chet tillarini o‘rganishdagi alohida yonlashuvlar hamda maxsus yo‘naltirilgan metodlar va ularning nazariy asoslari, bu borada olib borilgan ilmiy tadqiqotlar, fransuz tilini xorijiy til sifatida o‘rganayotgan talabalarda san’atga oid terminlar leksikasini turli interfaol metodlar va onlayn texnologiyalar asosida shakllantirish hamda yozma nutq ko‘nikmalarini rivojlantirishning ustuvor yo‘nalishlari xususida so‘z boradi.

Kalit so‘zlar: *chet tili, fransuz tili, yozma kompetensiya, pedagogik xarita, dars ishlanmasi, interaktiv metodlar, onlayn pedagogik texnologiyalar, onlayn diagrammalar, Coogle.it, WordArt.com, Framapad.com.*

Аннотация. В данной статье рассматривается растущее значение изучения иностранных языков в контексте современного научно-технического развития как в мире в целом, так и в нашей стране в частности. Анализируются конкретные подходы и специализированные методики преподавания иностранных языков, их теоретические основы, а также научные исследования, проводимые в этой области. Особое внимание уделяется формированию искусствоведческой терминологии у студентов, изучающих французский язык как иностранный, посредством различных интерактивных методов и онлайн-технологий, а также приоритетным направлениям развития навыков письменной речи.

Ключевые слова: *иностранный язык, французский язык, письменная компетенция, педагогическая карта, план урока, интерактивные методы, онлайн-педагогические технологии, онлайн-схемы, Coogle.it, WordArt.com, Framapad.com.*

Abstract. This article discusses the growing importance of learning foreign languages in the context of modern scientific and technological development worldwide and, in particular, in our country. It examines specific approaches and specialized methods of foreign language teaching, their theoretical foundations, as well as the scientific research conducted in this field. Special attention is given to the formation of art-related terminology among students

learning French as a foreign language through various interactive methods and online technologies, as well as to the priority directions for developing writing skills.

Keywords: *foreign language, French language, writing competence, pedagogical map, lesson plan, interactive methods, online pedagogical technologies, online diagrams, Coogle.it, WordArt.com, Framapad.com.*

Introduction

Modern world science and education are undergoing a process of globalization day by day. The most preferable approach in this regard is the perfect study of foreign languages, and this requirement requires each country to reform its education system and introduce the consistent study of foreign languages in order to keep pace with the world. For this reason, currently, foreign languages such as French, English, German, Italian, Korean, Chinese, Spanish, Hindi and Arabic are being taught in schools of our republic from the primary grades, and the focus on learning French, in particular, is increasing every year [1, 2]. It should be emphasized that the perfect study of foreign languages requires a special approach, the use of specially focused methods and technologies.

Literature Review

From this point of view, it is worth saying that to date, world and Uzbek scholars who have been engaged in the methodology of teaching foreign languages have provided complete information on the system of exercises used in teaching foreign language skills [3, 5, 20].

The issues of teaching a foreign language, in particular, the methodology of teaching foreign languages, are discussed by local scholars J.J. Jalolov, O.H. Khashimov, I.Yakubov, L.T. Akhmedova, O.V. Kon, A.T. Iriskulov, M.Dzhusupov, T.K. Sattorov, I.M. Tukhtasinov, D.U. Khashimova, S.A. Ziyaeva, G.T. Makhkamova, Sh.S. Ashurov, S. Saidaliyev, F.M. Specialists who conducted scientific research, as well as A.A. Isakova, P.J. Nazarov conducted scientific research on the formation of foreign language lexis and teaching methodology [1, 3-6, 9, 11, 13, 14, 16, 18, 19, 22, 24, 26, 28-30, 35].

There are also a number of studies related to the methodology of teaching foreign languages to students of non-philological universities and issues of interdisciplinary relations, including the works of G.N. Irmukhammedova, F.B. Saidova, I.V. Panfyorova, N.K. Kushiyeva, D.M. Israilova, B.R. Samatova, and U.K. Nasyrov, which have studied these issues from a scientific and theoretical perspective [7, 8, 10, 12, 23, 25, 27].

Language is of great importance for the cognitive process, as it is a psychological, communicative, functional, and cultural phenomenon, because it is a factor leading from ignorance to knowledge. Communicating in a foreign language, mastering it means forming skills in four main types of speech activity. In this, the skills of listening, speaking, reading, and writing are developed in an interconnected manner.

It should be noted that the teaching of foreign languages is carried out through the effective use of interactive methods, role-playing games, and information and communication technologies in the educational process. For this reason, the role of interactive methods and technologies in this regard is incomparable, and it is appropriate to list the following as the theoretical foundations of these concepts:

✓ *Method* – derived from the *Greek word* "method"(method of research, way), it refers to a way of research or knowledge, a theory, or a teaching:

a) A method of knowing and researching natural and social phenomena;
b) method, style – means [15].

✓ *A teaching method* can be defined as a specific, systematic way of organizing the joint activities of the learner and the teacher, aimed at a specific goal. A teaching method is a specific, systematic way of organizing the joint activities of the learner and the teacher, aimed at a specific goal.

✓ *Technology* - as a term derived from the Greek words "technōs" (techne) - skill, art and "logo"(logos) - science, understanding, teaching:

a) A set of methods (techniques) used in a particular field of production to process or reprocess raw materials, materials, and semi-finished products, changing their state, properties, and shape.
b) The science of methods and ways of processing raw materials and materials using appropriate production tools [15].

Pedagogical technology is a systematic method of creating and applying all processes of teaching and learning, which sets the task of optimizing forms of education, taking into account technical resources, people, and their interaction [2]. *Pedagogical technology* is a foreign pedagogical direction aimed at increasing the effectiveness of the educational process and ensuring that learners achieve planned results.

Educational technology, in its literal sense (in English "an educational technology"), can be called a science (or teaching) that provides information on the organization of the educational (teaching) process at a high level of skill and art.

It should be noted that in learning French as a foreign language, interactive methods such as, "Blitz-Demande" (Quick questions), "Squelette de poisson" "Fishbone", "Chutomots", "Claster" (Cluster), "La taxonomie de BLOOM" (Bloom's Taxonomy), "La technologie "Comment?" (The technology "How?"), "La technologie "Pourquoi?" (The technology "Why?"), "Le diagramme de "VENN" (The "Venn Diagram"), "La technologie "PINBORD" (The "Pinboard" technology), "Schéma T" (T-Chart), "Sinkveyn" (Sinkwein), "L'analyse "FFOM" (SWOT Analysis), "Test d'esprit" (Mind Test), "Test de correspondence" (Matching Test), "Test avec réponse" (Test with Answers), "Test sans réponse" (Test without Answers), "Test suivi" (Follow-up Test), "Test SAVEZ-VOUS?" ("Do You Know?" Test), "Test DE CHOISIR L'INTRUS" ("Choose the Intruder" Test), "Technologie "Six chapeaux" (The "Six Thinking Hats" technology), "Brainstorming", "Work in small groups", "Circular conversation", "Role play", "Discussion", "Problem situation", "Project", "Boomerang", "Aquarium", "Crossword", "Bingo" play an important role [31]. In addition, the role of online technologies and platforms such as Coggle, WordArt,

LearningApps, Wordwall, Kahoot, and Framapad is invaluable in the process of teaching and learning foreign languages.

Analysis and Results

The following are effective methods for teaching non-specialist students to write on the topic "L'ART. LE CINÉMA. LE THÉÂTRE" (Art. Cinema. Theater) in French using interactive methods and online technologies.

Thème: L'ART. LE CINÉMA. LE THÉÂTRE

Fiche pédagogique

Thème	**L'art. Le cinéma. Le théâtre**
Professeur	**G.S.Khojieva**
Durée: 1.20 min.	**Quantité des étudiants** : 12
Forme de cours	Cours pratique
Objectifs de la leçon: → ***Objectifs communicatifs/ pragmatiques*** • Parler sur **L'art. Le cinéma. Le théâtre.** • Retrouver des mots manqués • Comprendre le locuteur • Exprimer ses opinions → ***Objectifs linguistiques*** • Revoir les significations des types de l'art • Enrichir son lexique par des termes de l'art → **Lexical** → **Grammatical**	• Pénétrer dans la structure profonde de la compétence langagières à l'aide des activités communicatifs contextualisés; • Apprendre à interagir dans différentes situations; • Apprendre à saisir le sens global et détaillés des documents; • Le développement de la compétence de l'écrire sur des sujets varies. • Enrichir la compétence de la production écrite sur le sujet, interaction et l'utiliser dans le discours. • Enrichir le vocabulaire et la compétance d'écrire pour accéder au sens. • Savoir utiliser les termes de l'art dans la P.É.
Objectifs pédagogiques: • Apprendre aux étudiants l'utilisation du vocabulaire dans le discours • Apprendre donner la caractéristique socio-culturelle aux termes de l'art	**Résultats acquis de la technologie pédagogique:** • Utiliser librement des faits sur **L'art. Le cinéma. Le théâtre.** • Savoir donner la caractéristique lexicale et grammaticale des mots. • Connaître des types de l'art. • Savoir donner son opinion et refaire ses activités en apprenant les méthodes interactives et les technologies en ligne. • Savoir travailler en groupe – coopérer, négocier, interagir. • Développer leur compétence communicative.
Méthodes pédagogiques	Travail individuel; Travail en binôme, Travail en groupe; Le diagramme de VENN; Les technologies interactives en ligne Coogle.it, WordArt.com, Framapad.org
Formes d'apprentissage	Individuelle, travail en binôme et en groupes, toute la classe
Types d'évaluation	Diagnostique; formative; participation; la révision de devoir;

It is advisable for language teachers to first provide a pedagogical map and plan of the lesson in order to correctly determine its purpose.

Plan de la leçon		
Étapes et heure	**Professeur**	**Étudiant**
1. Introduction (20 minutes)	1. COMMENCEMENT 1.1. Le professeur fait actif des étudiants et donne des questions pour attirer leurs attentions et pour les diriger au thème nouveau. 1.2. Le professeur analyse les connaissances des étudiants en eux donnant des questions.	1.1. L' étudiant réponde aux questions du professeur.
2. Partie essentielle (50 minutes)	2.1.1. Le professeur explique le thème "**L'art. Le cinéma. Le théâtre**" en le présentant. 2.1.2. Le professeur s'interresse avec les connaissances des étudiants sur le thème et il travaille sur la lexique du thème nouveau à l'aide du diagramme Coogle.it. 2.1.3. En utilisant des méthodes interactives et des technologies en ligne pendant la leçon il profonde leurs connaissances. Il propose de composer de nuage des mots à l'aide de la technologie en ligne WordArt.com sur les termes de l'art. 2.1.4. Il demande d'écrire des mots nouvaux sur la plateforme d'édition de texte Framapad.org.	2.1. L'étudiant répète les mots nouvaux. 2.2. L'étudiant réponde aux questions du professeur et il note les mots nouvaux. 2.3. L'étudiant compose de nuage des mots à l'aide de la technologie en ligne WordArt.com en utilisants des termes de l'art. 2.4. L'étudiant écrit des mots nouvaux sur la plateforme d'édition de texte Framapad.org 2.4.1. Il écoute. 2.4.2. Il donne ses propres exemples.
3. Conclusion (10 minutes)	Il donne le devoir à la maison: 3.1.1. Travailler sur le thème **L'art. Le cinéma. Le théâtre.** 3.1.2 Faire le diagramme de VENN à l'aide des termes de l'art. 3.2. Le professeur finit la leçon et note des étudiants.	3.1. Il écrit le devoir. 3.2. Il écoute.

L'ART. LE CINÉMA. LE THÉÂTRE.

L'art a toujours tenu une place importante dans la vie de l'homme. C'est l'expression des facultés créatrices des hommes qui donnent naissances aux oeuvres artistiques. L'art regroupe les œuvres humaines destinées à toucher les sens et les émotions du public. Il peut s'agir aussi bien de *peinture* que de *sculpture, vidéo, photo, dessin, littérature, musique, danse*…[36]

Le cinéma est un art qui expose au public un film: une œuvre composée d'images en mouvement accompagnées d'une bande sonore. ... La persistance rétinienne, l'effet phi et les techniques de projection permettent à l'être humain de voir cette série d'images discrètes en un continuum visuel. Le cinéma est un art du spectacle. En français, il est couramment désigné comme le *"septième art"*, d'après l'expression du critique Ricciotto Canudo dans les années 1920 [1]. *L'art cinématographique* se caractérise par le spectacle proposé au public sous la forme d'un film, c'est-à-dire d'un récit (fictionnel ou documentaire), véhiculé par un support (pellicule souple, bande magnétique, contenant numérique) qui est enregistré puis lu par un mécanisme continu ou intermittent qui crée l'illusion d'images en mouvement, ou par un enregistrement et une lecture continus de données informatiques. La communication au public du spectacle enregistré, qui se différencie ainsi du spectacle vivant, se fait à l'origine par l'éclairement à travers le support, le passage de la lumière par un jeu de miroirs ou/et des lentilles optiques, et la projection de ce faisceau lumineux sur un écran transparent (Émile Reynaud, Thomas Edison) ou opaque (Louis Lumière), ou la diffusion du signal numérique sur un écran plasma ou à led. Au sens originel et limitatif, le cinéma est la projection en public d'un film sur un écran (en salle ou en plein-air). Dès Émile Reynaud, en 1892, les créateurs de films comprennent que le spectacle projeté gagne à être accompagné par une musique qui construit l'ambiance du récit, ou souligne chaque action représentée. Très rapidement, ils ajoutent des bruits provoqués par un assistant à l'occasion de chaque projection, et font commenter les actions par un bonimenteur présent lui aussi dans la salle. Depuis son invention, le cinéma est devenu à la fois un art populaire, un divertissement, une industrie et un média. Il peut aussi être utilisé à des fins publicitaires, de propagande, de pédagogie ou de recherche scientifique ou relever d'une pratique artistique personnelle et singulière [36].

Le terme "cinéma" est l'abréviation de cinématographe (du grec κίνημα / kínēma, "mouvement" et γραφή / graphê, "art d'écrire, écriture"), nom donné par Léon Bouly à l'appareil de prise de vues dont il dépose le brevet en 1892. N'ayant plus payé les droits les années suivantes, et son invention tournant court, il en perd la propriété et les frères Lumière lui reprennent cette appellation. Antoine Lumière (le père) aurait préféré que la machine de ses fils soit nommée "Domitor", mais Louis et Auguste préférèrent Cinématographe, mot à leur avis plus dynamique. Cependant, le mot d'Antoine revint en 1985, l'Association internationale pour le développement de la recherche sur le cinéma des premiers temps ayant, avec un peu d'humour, surnommé leur association Domitor. Le mot cinéma est polysémique, il peut désigner l'art filmique, ou les techniques des prises de vue animées et de leur présentation au public, ou encore, par métonymie, la salle dans laquelle les films sont montrés. C'est dans cette dernière acception que le terme est lui-même souvent abrégé en français dans le langage familier, en "ciné" ou "cinoche", la référence à l'écran de projection ayant par ailleurs donné l'expression des cinéphiles, "se faire une toile". Dans le même registre, "se faire son cinéma", "c'est du cinéma" (c'est mensonger ou exagéré), sont des expressions nées du 7e art. À noter que dès 1891, Thomas Edison nomme caméra Kinétographe l'appareil de prise de vues photographiques

animées qu'il a imaginé et que son assistant, William Kennedy Laurie Dickson, met au point, et qui est à l'origine des premiers films du cinéma, dès 1891. Ce terme de *kinétographe* (d'après le grec ancien kinetos et graphein qui signifient respectivement *"mouvement"* et *"écrire")* sert de base d'appellation du cinéma dans plusieurs langues autres que latines. *Kino*, aussi bien en allemand qu'en russe, et dans bien d'autres langues, désigne *le cinéma* [36].

Le théâtre est une forme littéraire bien précise: il est ce que l'on appelle un genre et se distingue des deux autres grands genres, le roman et la poésie. Le terme *"théâtre"* vient du grec *theôria* qui signifie *"action d'examiner"*. Philosophe grec du 4e siècle av. J.-C., *Aristote affirme,* dans sa *Poétique*, que *le théâtre est, pour les spectateurs, "l'imitation d'une action* [...] *faite par des personnages en action et non par le moyen de la narration*" [36].

The lesson begins with a presentation on the above topic.

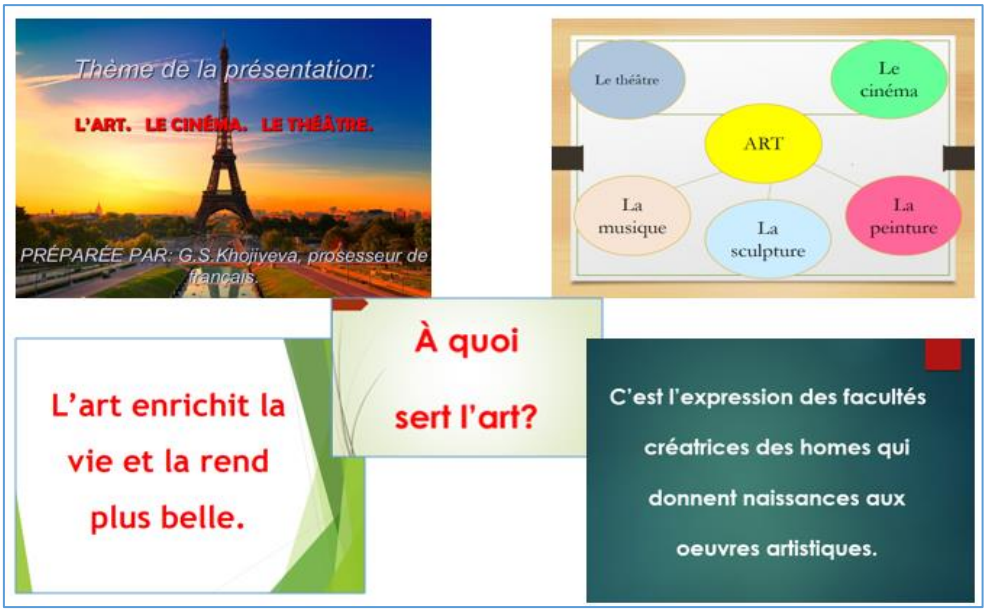

Figure 1.

After that, information about the art and its types based on the *Coogle.it* diagram is presented to the attention of students. The *Coggle.it* diagram, which can be considered an online improved version of the traditional "Klasster" method, is actually an online technology with very wide possibilities. It serves, in particular, to form and develop students' writing and reading skills. When working with "Coggle.it", the user is required to go through and master several stages. Including:

Step 1. Create a diagram, choose a language, and write the main topic - the title.

In this case, the title should reveal the main topic at a high level and clearly show others what the diagram is about. At this stage, the basis of the diagram and several parts are created.

Step 2. Divide the main topic into subtopics and name them.

For example, when creating a diagram on the topic of "Art", it can be divided into "crafts", "music", "painting", "theater", etc.

Step 3. Format the text, color, and line style when placing topics.

At this stage, it is advisable to represent each of them based on lines, shapes, and text format in a separate color in order to highlight the differences between topics and the proportionality in directions.

Step 4. Add images, labels, pictograms, web pages and comments to clearly express ideas.

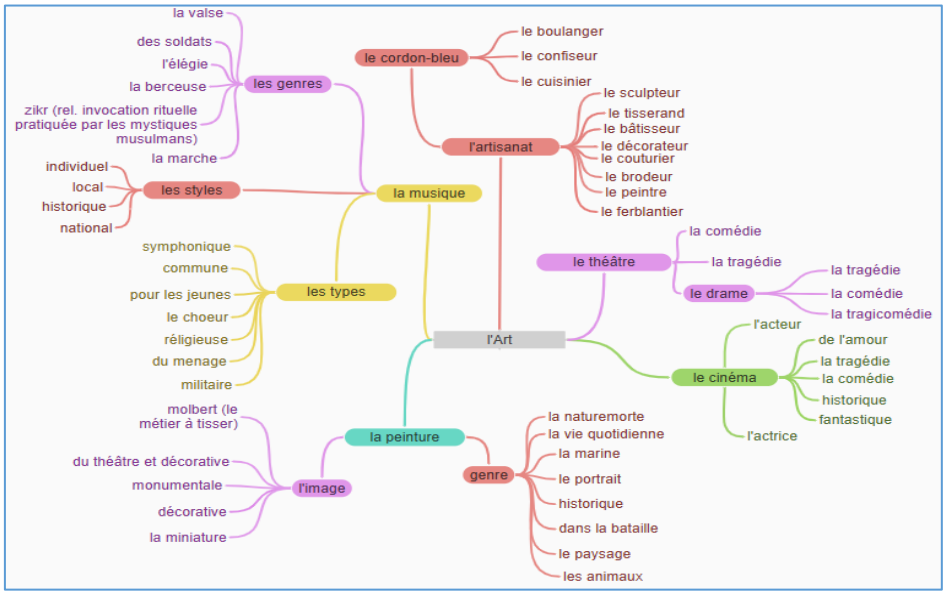

Figure 2. Diagram made by author G.Hojiyeva.
(https://coggle.it/diagram/X9sqwWWKvf4Cljpv/t/l'art)

Coggle-it is also an online mind map tool. It helps organize complex concepts in a graphical way and makes it easier to express ideas visually. Mind maps are used in pedagogy to improve the structural representation of knowledge and cognitive management - this is also confirmed by scientific research, that is, concept maps improve memory and understanding.

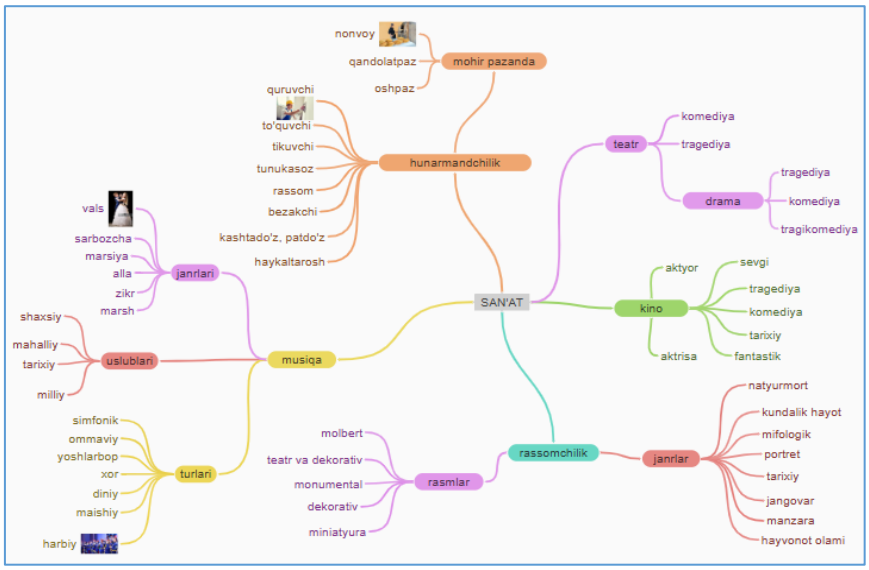

Figure 3. Diagram made by author G.Hojiyeva
(https://coggle.it/diagram/X8sniCM6Pb1WLhzg/t/san'at).

The collaborative nature of this diagram supports real-time work, which serves to effectively implement student-teacher or group work. In short, Coogle helps students

to think structurally, visually formulate problems, and better remember complex concepts - this is an approach that is also well-established in the theory of knowledge (according to scientific research, concept maps improve cognitive structures).

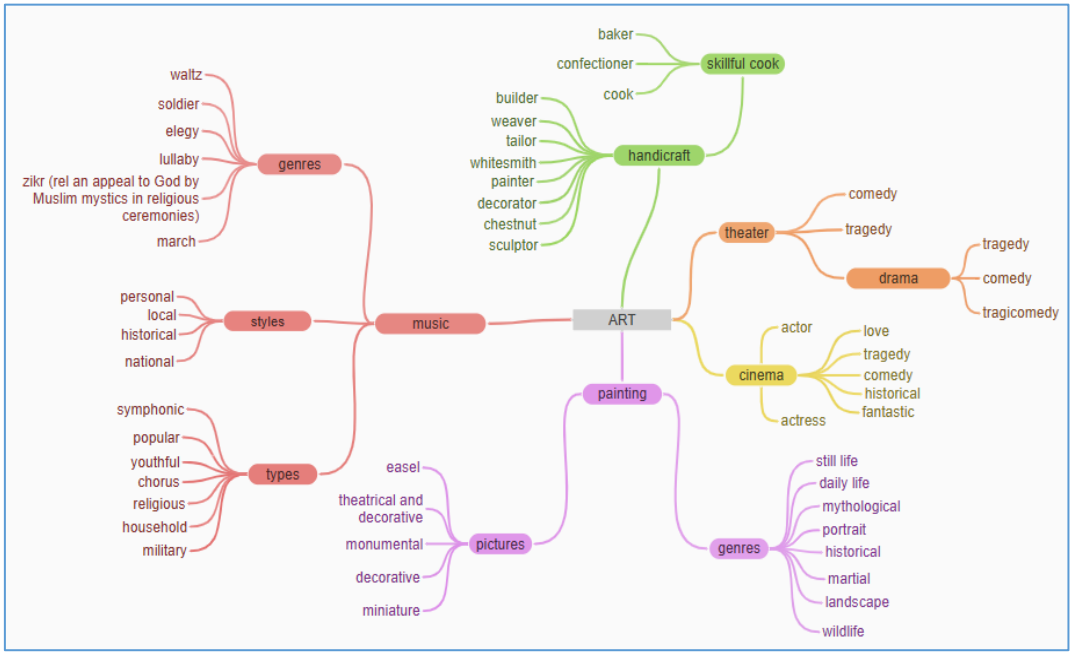

Figure 4. Diagram made by author G.Hojiyeva (https://coggle.it/diagram/YCjF5i31d94GwNn6/t/art).

In short, in the Coggle.it diagram, you can continue, change, and add to the topic as much as you want, and at the same time work on the topic online with students in a group. The goal is to ensure that the topic of the diagram is memorable, interesting, and understandable for the learner.

During this demonstration, students are encouraged to memorize or write down the genres and types of art. Because they will use the terms learned during the lesson as a result of the Coggle.it diagram to create their own developments based on *WordArt.com* - an application that involves creating a visual-graphic “cloud” of the most frequently used words in the text.

WordArt.com is used for text analysis and highlighting key concepts, or more precisely, as a visual strategy for organizing education based on an effective approach to quickly identifying key topics in a large text, analyzing the text, and identifying important concepts.

At the same time, the pedagogical significance of this application is to develop students' analytical and critical thinking skills by presenting text-based information in a visual format, helping them quickly understand the content of the text.
WordArt is based on the ability to create various designs by freely choosing the order of words, shapes, colors, font type, and page (writing) placement. This application not only develops students' creativity, but also serves to improve their writing skills.

Another online platform that can help language learners improve their writing skills is *Framapad*, an open-source text editing platform designed for collaboration and real-time co-authoring of documents. It allows multiple users to write, edit, and comment simultaneously without the need for specialized software. Created by the

French non-profit organization Framasoft, Framapad embodies the idea of digital independence and encourages users to use technologies that are transparent and respectful of their personal data. Its lightweight structure and fast synchronization system make Framapad a worthy alternative to commercial collaboration tools.

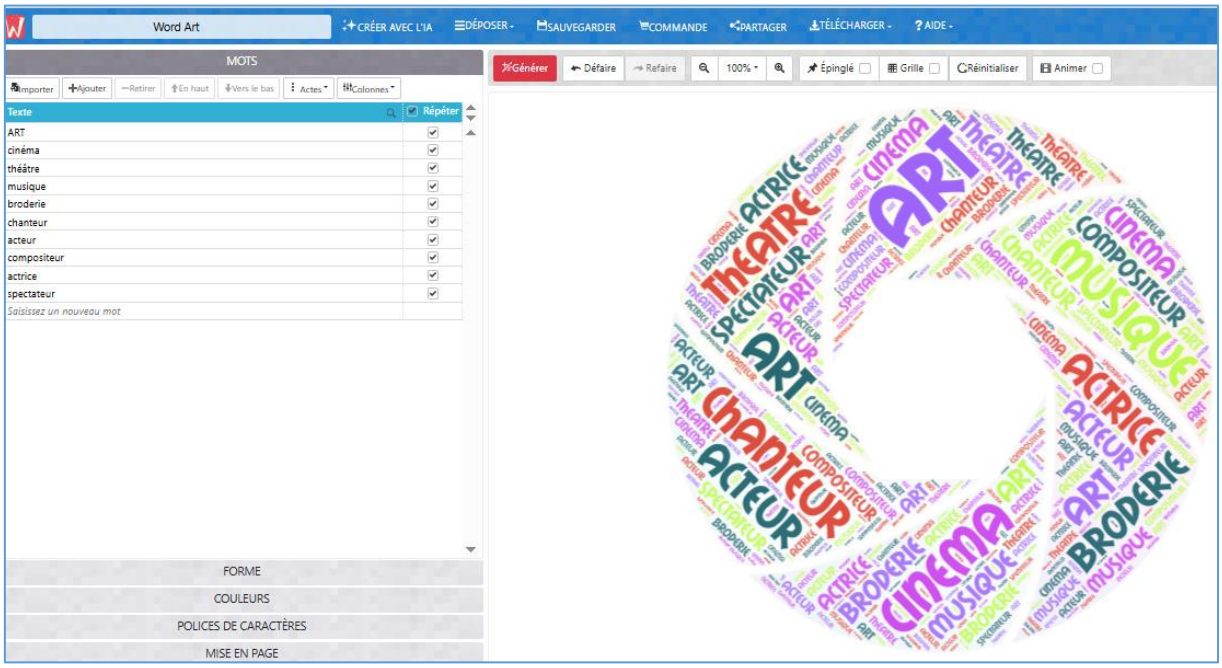

Figure 5. By author G.Hojiyeva.

The popularity of this platform lies in its convenience and versatility. Framapad works directly through a web browser, requiring no installation or registration, allowing users to start writing immediately. It is widely used by teachers, project teams, developers, researchers, and activists who value openness, impartiality, and data protection. Each “pad” is a live workspace, where changes to the text are reflected immediately and effectively organize the exchange of ideas between participants [14].

Framapad can offer more than just collaborative editing. It has customizable features such as time history, color-coded authoring, internal chat, and export in multiple formats. These features make it a complete collaborative environment that is ideal for content creation, documentation, and learning processes.

In terms of pedagogical value, *Framapad* serves to enhance social learning and group activity as a real-time text collaboration. It is also methodologically consistent with the concept of cooperative learning and is positively evaluated in scientific pedagogical work [32-34].

Additional features of Framapad include:

- color-coding text;
- chat;
- download text in pdf or word format;
- password protection (on some servers) [32-34].

It is also worth familiarizing yourself with the names and functions of the symbols listed at the top of the Framapad window (from left to right) [32-34]:

Basic editing functions

- Gras – *Bold font*. Used to write text in bold.
- Italique – *Italic (slanted) font*. Allows you to write text in a slanted style.
- Souligné – *Underlined text*. Underlines text.
- Barré – *Strikethrough text.* Draws a line through text (meaning deleted or canceled).

Working with lists

- *Liste ordonnée* – Numbered list. Present data by serial number.
- *Liste non ordonnée* – Bulleted list. Present data using symbols (•).
- *Indent* – Move in (expand paragraph). Moves text or list item to the right.
- *Désindenter* – Move out. Moves text back to the left.

Editing actions

- *Annuler* – Cancel (Undo). Undoes the last action performed.
- *Rétablir* – Redo. Redoes the undone action.
- *Effacer le surlignage par auteur* – Remove color highlighting by author. Removes the colors of text written by different users.

Additional writing styles

- *Superscript* – Superscript. Write text in lowercase (for example, m^2).
- *Subscript* – Subscript. Write text in lowercase (for example, H_2O).
- *Normal Couleur* – Normal color. Resets or changes the text color to the default.

Comments and statistics

- *Annotate selection* – Add a comment to the selection. Allows you to write a comment or annotation to the selected text.
- *Afficher le nombre de mots* – Show word count. Calculates the total number of words in the text.

Working with files

- *Importer / Exporter des formats de fichiers différents* – Import/export files in different formats. Upload or save text in .doc, .pdf, .txt and other formats.

History and versions

- *Historique dynamique* – Dynamic history. View previous revisions of a document and track changes over time.
- *Enregistrer la révision* – Save a revision version. Save a specific revision status separately.

Settings and management

- *Paramètres* – Settings. Manage language, interface and other technical parameters.
- *Partager et intégré ce bloc-notes* – Share and embed this document. Send it to others via a link or embed it on a site (embed).
- *Retours à l'accueil* – Return to the main page. Return to the main page.
- *Afficher les utilisateurs du bloc-notes* – Show document users. Shows a list of users working on the document.
- *Show Framasoft menu* – Show the Framasoft menu. Allows you to switch to other services of the platform.
- *Chat* – Online chat (correspondence). Real-time correspondence between users.

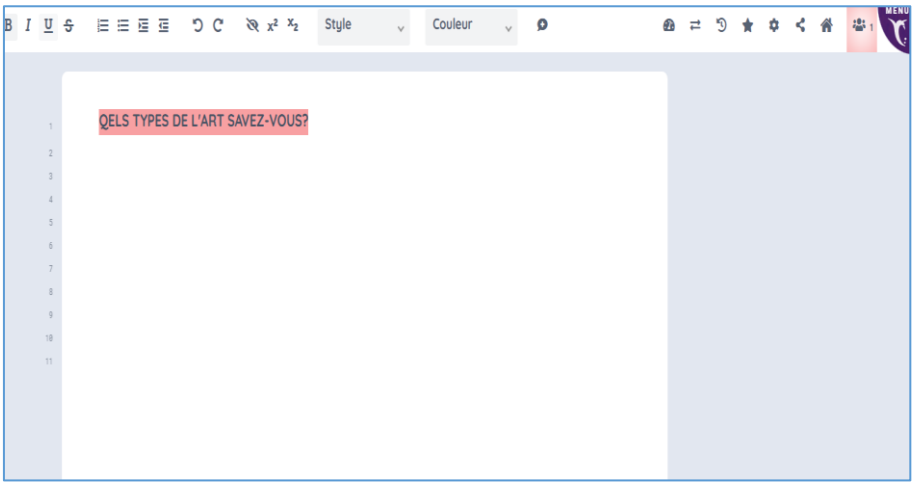

Figure 5. By author G.Hojiyeva.

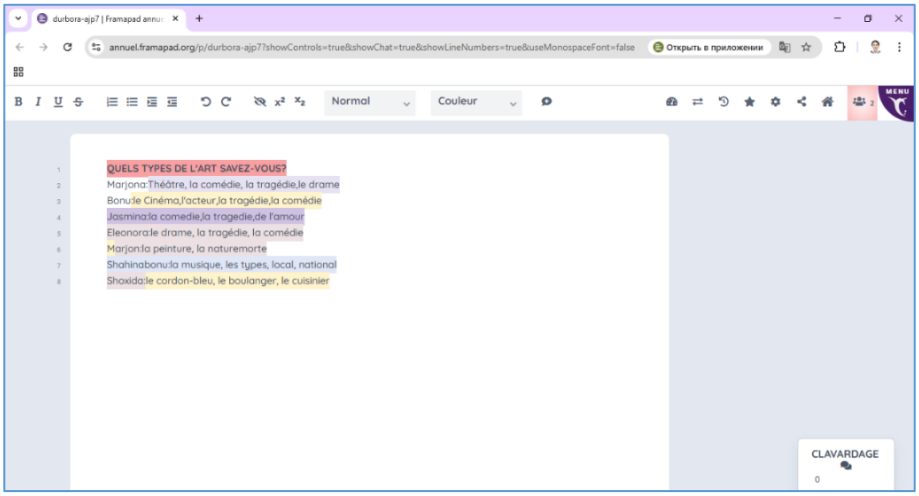

Figure 5. By author G.Hojiyeva (https://annuel.framapad.org/p/durbora-ajp7?showControls=true&showChat=true&showLineNumbers=true&useMonospaceFont=false).

Conclusion

Writing is of great importance in learning a foreign language, and writing refers to the means of learning the language (the use of graphemes and lexical and grammatical units in written form, i.e., writing techniques) and the expression of thoughts in written form. Writing is the expression of written thoughts while observing grammatical and spelling rules. Writing is usually done in two ways: writing down one's own thoughts and expressing in writing what someone else has said (read). In both cases, a written text (discourse) is created. When it comes to writing techniques, graphics (the relationship between sound and letter and the function of the letter to convey meaning), calligraphy (handsomeness), and orthography (spelling) are taken into account. The technique of reading and writing graphics is closely related to comprehension. Spelling is the process of writing words and sentences, and the rules for them.

Writing skills consist of aesthetics, spelling, composition (combining sentences to express an idea in writing), and lexical and grammatical skills of writing.

To write, a language learner needs skills such as planning and organizing a message (cognitive and linguistic skills) and writing the text in handwriting or print (writing skills) or by some other method to put the text on paper.

In the modern era of science and technology, the importance of using not only paper and pencil, but also various interactive methods, online programs such as Coogle.it, WordArt.com, Framapade.com, new pedagogical technologies, and applications in developing writing skills is increasing day by day. These innovations serve not only to improve students' spelling and lexical knowledge, but also their technological creativity competencies.

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UDC: 87.6.47

HISTORICAL ROOTS OF NON-GOVERNMENTAL NON-PROFIT ACTIVITY: GLOBAL EXPERIENCE AND THE EVOLUTION OF SOCIAL INSTITUTIONS IN THE TERRITORY OF UZBEKISTAN

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Annotatsiya. Ushbu maqolada O‘zbekiston hududidagi ijtimoiy institutlar evolyutsiyasi va jahon tajribasi prizmasi orqali nodavlat notijorat faoliyatining tarixiy ildizlari ko‘rib chiqiladi. Tadqiqot nodavlat notijorat tashkilotlarining paydo bo‘lishi o‘rta asrlardagi xayriya institutlari, Yevropadagi diniy-harbiy ordenlar va musulmon olamidagi vaqf tizimi bilan chambarchas bog‘liqligini ko‘rsatadi. Gospitalyerlar, tampliyerlar va Tevton ordeni, shuningdek, Markaziy Osiyoda, xususan O‘zbekistonda vaqf asosida tashkil etilgan madrasa, masjid va kasalxona (dor ush-shifo) kabi muassasalarning gumanitar va ijtimoiy faoliyatining qiyosiy tahlili o‘tkazilgan. Maqolada zamonaviy notijorat tashkilotlarning falsafiy-tarixiy asoslarini tashkil etuvchi nodavlat maqom, notijorat yo‘nalishi, ixtiyoriylik va gumanizm tamoyillarining tarixiy shakllanishi yoritib berilgan.

Kalit so‘zlar: *nodavlat notijorat tashkilotlari, fuqarolik jamiyati, xayriya institutlari, diniy ordenlar, vaqf tizimi, ijtimoiy himoya, tarixiy evolyutsiya.*

Аннотация. В данной статье рассматриваются исторические корни негосударственной некоммерческой деятельности сквозь призму мирового опыта и эволюции социальных институтов на территории Узбекистана. Исследование демонстрирует, что возникновение негосударственных некоммерческих организаций тесно связано со средневековыми благотворительными институтами, религиозно-рыцарскими орденами в Европе и системой вакфа в мусульманском мире. Проведен сравнительный анализ гуманитарной и социальной деятельности госпитальеров, тамплиеров и Тевтонского ордена, а также институтов, основанных на вакфе, таких как медресе, мечети и больницы (дар ал-шифа) в Центральной Азии, в частности в Узбекистане. В статье освещается историческое формирование принципов негосударственного статуса, некоммерческой направленности, добровольности и гуманизма, составляющих философско-исторические основы современных некоммерческих организаций.

Ключевые слова: *негосударственные некоммерческие организации, гражданское общество, благотворительные*

институты, религиозные ордена, система вакфа, социальная защита, историческая эволюция.

Abstract. This article examines the historical roots of non-governmental non-profit activities through the lens of global experience and the evolution of social institutions in the territory of Uzbekistan. The study demonstrates that the emergence of non-governmental non-profit organizations is closely connected with medieval charitable institutions, religious-military orders in Europe, and the waqf system in the Muslim world. A comparative analysis is conducted of the humanitarian and social activities of the Hospitallers, Templars, and the Teutonic Order, as well as waqf-based institutions such as madrasas, mosques, and hospitals (dar al-shifa) in Central Asia, particularly in Uzbekistan. The article highlights the historical formation of the principles of non-governmental status, non-profit orientation, voluntarism, and humanism, which constitute the philosophical and historical foundations of modern non-profit organizations.

Keywords: *non-governmental non-profit organizations, civil society, charitable institutions, religious orders, waqf system, social protection, historical evolution.*

Introduction

Non-governmental, non-profit activity has emerged as an important and integral institution of civil society worldwide through the course of historical development. The main objectives of this activity are to address social problems in society, ensure social justice, protect human rights, and promote humanitarian values. Historically, non-governmental, non-profit activity emerged in response to society's internal needs in circumstances where state and market mechanisms were insufficient or unable to fully meet social needs [1-3]. The earliest historical roots of non-governmental non-profit activity are directly linked to the charitable foundations, religious brotherhoods, and trade unions that emerged in the Middle Ages. In global practice, particularly in European countries, charitable organizations operating under the auspices of churches fulfilled the role of ensuring social solidarity and harmony in society by providing assistance to orphans, the poor, the sick, and other needy groups. These institutions were relatively independent from state authority and were distinguished by their activities, which were based on the principles of voluntariness, selflessness, and humanitarianism.

Literature Review

In the Muslim world, the institution of waqf developed extensively as an important historical form of non-governmental, non-profit activity. The waqf system served to support the socially vulnerable strata of society by financing mosques, madrasas, hospitals (dar al-shifa), caravanserai, orphanages, and shelters for travelers [3-6]. In Central Asia, particularly in Uzbekistan, educational and charitable institutions operating on the basis of waqf properties played a significant role in ensuring the social stability of society and in the development of science and

enlightenment. In this respect, the waqf institutions operated on the principles of non-statehood, stability, and service to the public interest, and are considered the historical prototype of modern non-governmental, non-profit organizations [7].

This process is also clearly evident in the case of the territory of Uzbekistan. In the regions of Transoxiana and Turkestan, educational and charitable institutions operating on the basis of waqf properties have held an important place in society since the Middle Ages. The famous madrasas, mosques, and hospitals in the cities of Samarkand, Bukhara, Khiva, and Tashkent were primarily funded by waqf endowments, serving to meet the social, spiritual, and educational needs of the population. In particular, the waqf system established alongside centers of learning such as the Ulugh Beg Madrasah, the Mir Arab Madrasah, and the Abdulaziz Khan Madrasah served to ensure social stability and the advancement of science and learning during that period. This situation also demonstrates that the historical roots of non-governmental and non-commercial activity are deep in Uzbekistan. Thus, a comparative analysis of global and Uzbek experience shows that modern non-governmental non-profit organizations did not arise by chance, but are a logical continuation of the charitable, religious, and public institutions that were formed over the course of history. They play a significant historical and philosophical role in establishing the values of social justice, harmony, and humanitarianism in society.

Research Methodology

First, a comprehensive literature review was conducted to identify the primary institutional precursors to modern non-profit organizations, such as religious-military orders (Hospitallers, Templars, Teutonic Order) and the Islamic waqf system. Second, a comparative analysis was performed to identify parallels and divergences in the operational principles, funding mechanisms, and social functions of these institutions. The analysis focused on core principles common to modern non-profits, namely non-governmental status, non-profit orientation, voluntarism, and humanitarian service. Finally, a historical-genetic method was applied to trace the continuity of these principles from their medieval manifestations to their role as foundational elements of contemporary civil society, with a specific focus on the territory of modern-day Uzbekistan.

Analysis and Results

During the Crusades of the Middle Ages, particularly in the 11th to 13th centuries, religious-chivalric orders emerged in Europe. Although these orders were originally established for military-religious purposes, over time, charity, medical assistance, and social protection began to play an important role in their activities. The assistance provided to pilgrims, wounded warriors, the sick, and the needy during the Crusades elevated the humanitarian activities of these orders to an institutional level [5]. In particular, the hospitals, shelters, and aid centers established by the Hospitaller and other chivalric orders served needy individuals, regardless of their religious beliefs. This demonstrates that the principles of voluntariness, selflessness, and humanitarianism were paramount in their activities. Furthermore, these orders established a system for managing charitable funds and financing social services from

property and donations. It is precisely these aspects - relative independence from the state, non-profit status, and service to the social needs of the community - that form the basis for considering them the historical prototypes of modern non-governmental, non-profit organizations. The activities of the religious-chivalric orders hold historical and philosophical significance in medieval Europe as one of the earliest organizational forms of social responsibility and public initiative.

One of the oldest and most prestigious orders established during the Crusades was the Order of Saint John of Jerusalem, founded in the late 11th century in Jerusalem to assist pilgrims, the sick, and the needy. The hospitals and hospices established by this order in Jerusalem, Acre, Rhodes, and later Malta became important centers of medieval medicine. A key aspect of the Hospitallers' work was that they served the needy, regardless of their religious beliefs or nationality. This demonstrates how the principles of humanitarianism transcended religious boundaries, taking on an institutional form as a universal value [6]. The Order of the Temple (Knights of the Temple of Christ and Solomon) was founded in Jerusalem in 1119, initially tasked with protecting pilgrims travelling to the Holy Land [7]. However, over time, the Order developed an extensive economic and financial network across Europe, managing charitable funds and distributing them to those in need. The introduction of a system for safeguarding and transferring financial funds for pilgrims on their journeys is regarded as one of the earliest banking practices in history. This demonstrates that the religious-military orders became important institutions not only in the military but also in the socio-economic sphere.

Another important religious-chivalric organization active during the Crusades was the Teutonic Order (Order of the German Knights), which operated in Eastern European territories. Alongside its military activities, the order established hospitals, shelters, and religious and educational institutions, making the care of the sick and the poor one of its principal duties [1]. The activity of the Teutonic Order demonstrates the intrinsic link between social service and religious duty. These religious-chivalric orders operated relatively independently of state structures, relying on voluntary membership and charitable donations. In their activities, the priority was not profit-making, but rather responding to social needs and realizing humanitarian ideals. For this reason, these orders are considered historically significant in medieval Europe as non-governmental and non-profit social institutions, and are regarded as one of the earliest forms of civil society.

In the Middle Ages, the emergence of charitable and social welfare institutions in Central Asia, particularly in Uzbekistan, was linked to a socio-legal system similar to that of the religious-chivalric orders during the Crusades in Europe and the Muslim world. In the history of cities such as Samarkand, Bukhara, Khiva, and Tashkent, hospitals, madrasas, mosques, and orphanages operating based on waqf properties were an integral part of the social protection system of medieval society [3]. For example, the Ulugbek Madrasa in Samarkand, the Mir Arab Madrasa, the Abdulaziz Khan Madrasa in Bukhara, and the Khoja Ahror complex in Tashkent were financed by waqf funds. These funds were primarily donated by landowners and wealthy individuals as charity, to assist the socially vulnerable strata of society and promote science and

enlightenment. In this respect, the waqf system is analogous to the charitable and humanitarian activities of the religious-knightly orders, such as the Hospitallers and the Templars.

Hospitals, mosques, and madrasas established based on waqf properties not only performed religious and educational functions but also provided social protection. For example, sources record that the hospitals provided free medical care to the sick, and shelters were established for orphans and the poor [2]. Through this system, charitable activity in medieval Uzbek society was established as an independent institution, based on social responsibility and not dependent on state structures. Thus, the activities of waqf properties and charitable foundations in the territory of Uzbekistan served not only to assist the local population but also to ensure the stability of society and to promote the development of knowledge and culture. This situation, when compared with religious-chivalric orders in world history, demonstrates the intrinsic connection between the historical roots of non-governmental, non-profit institutions and the universal principles of voluntarism, humanitarianism, and social protection.

Conclusion

This article has demonstrated that the primary evolutionary roots of modern non-governmental non-profit organizations were formed through medieval charitable foundations, religious brotherhoods, trade guilds, and the waqf systems of the Muslim world. The Hospitallers, Templars, and Teutonic Orders operating under the auspices of churches in Europe, as well as Madrasas, mosques, and hospitals in Central Asia and Uzbekistan, fulfilled functions such as assisting vulnerable sections of society, providing shelter for orphans and the poor, and promoting science and education. Thus, the principles of non-governmental, non-profit, voluntary, and humanitarian character were formed over the course of history, becoming the core principles of modern non-governmental non-profit organizations. The research findings show that non-governmental non-profit institutions play a vital role in fostering the values of social justice, stability, and humanitarianism in society, and studying their historical roots serves to ensure the effective functioning of modern civil society and the non-profit sector.

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UDC: 87.6.48

THE NEW EXPERIENCE OF MODERN VALUES CHANGES IN MODERN UZBEKISTAN

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Annotatsiya. Mazkur maqolada zamonaviy O‘zbekiston taraqqiyoti sharoitida milliy aksiologik qadriyatlarning transformatsiyasi tarixiy-falsafiy nuqtai nazardan tahlil qilinadi. Tadqiqot milliy qadriyatlar tizimining yangilanishi, ularning demokratik jamiyat qurilishiga moslashuvi hamda tarixiy meros asosida zamonaviy ijtimoiy ongni shakllantirishdagi o‘rni ochib berilgan. Natijalar shuni ko‘rsatadiki, milliy aksiologik konsepsiyalarning modernizatsiyasi Yangi O‘zbekiston taraqqiyoti uchun muhim konseptual asosni tashkil etadi.

Kalit so‘zlar: *aksiologiya, milliy qadriyatlar, Yangi O‘zbekiston, transformatsiya, ijtimoiy ong, tarixiy meros, falsafiy tafakkur.*

Аннотация. В данной статье с историко-философской точки зрения анализируется современная трансформация национальных аксиологических перспектив в период становления Нового Узбекистана. В исследовании показано обновление системы национальных ценностей, её согласование с построением демократического общества и роль в формировании современного общественного сознания на основе исторического наследия. Результаты демонстрируют, что модернизация национальных аксиологических перспектив является ключевой концептуальной основой для развития мысли в Новом Узбекистане.

Ключевые слова: *аксиология, национальные ценности, Новый Узбекистан, трансформация, общественное сознание, историческое наследие, философская мысль.*

Abstract. This article analyzes the modern transformation of national axiological perspectives in the development phase of New Uzbekistan from a historical-philosophical point of view. The study reveals the renewal of the system of national values, its alignment with the construction of a democratic society, and its role in shaping modern social consciousness on the basis of historical heritage. The results of the study indicate that the modernization of national axiological perspectives constitutes a key conceptual foundation for the development of thought in New Uzbekistan.

Keywords: *axiology, national values, New Uzbekistan, transformation, social consciousness, historical heritage, philosophical thought.*

Introduction

In the context of globalization, the sustainable development of societies is not only dependent on economic or political factors, but also on the content and direction of the value system. In particular, for countries that are consolidating their independence and moving along the path of democratic progress, it is important to reinterpret national axiological concepts in line with modern conditions. The comprehensive reforms being implemented in Uzbekistan within the framework of the "New Uzbekistan" concept are bringing about fundamental changes in all areas of social life, as well as in the system of social values and norms.

National axiological values are inextricably linked to the historical memory, spiritual ideals, moral standards, and cultural traditions of society, and they manifest themselves as an internal driving force for social progress. For this reason, it is necessary to analyze the modern transformation of national values in the context of the experience of New Uzbekistan not only from a theoretical point of view, but also from a practical and ideological point of view. This is because it serves to ensure the harmony of national and universal values and to shape modern democratic thinking based on historical heritage. Within the framework of this article, it is also important to analyze the mechanisms of modern changes in the national axiological views of New Uzbekistan on the basis of historical and philosophical considerations and to establish their place in the development of social thought.

Literature Review

National spiritual heritage and values directly or indirectly influence the path of development of the people. From this point of view, moving away from national spiritual values is not a path to independent progress, but rather leads to dependence on other states or peoples. Therefore, when analyzing the modern changes in national axiological views**,** it is necessary to focus on the reinterpretation of values in society, because values are the main factor that determines a person's worldview, social behavior, and historical consciousness [1-6]. In the context of modern Uzbekistan, this axiological system is acquiring new meaning based on the harmony between traditional moral values, national heritage, and modern democratic principles. From an axiological point of view, values are not limited to the ethical and moral sphere of social life, but also function as a universal basis that determines the internal content of political, legal, educational, and spiritual relations [6]. Thus, in the experience of New Uzbekistan, the paramount importance of values such as human rights, personal freedom, social justice, and civic responsibility clearly reflects the modern transformation of national axiological concepts**.**

In the context of modern Uzbekistan, the modern transformation of national axiological values, which forms the inner spiritual basis of the development of society, is not a rejection of historical values, but rather through its adaptation to modern democratic principles. This situation confirms that values are not static, but rather a dynamic phenomenon that changes along with social development [4]. In addition, the modern transformation of national axiological values is leading to the emergence of new concepts of identity, historical memory, and social responsibility. The system of values serves to promote the individual as an active subject of social and state development. This is based on the philosophical foundation of the New Uzbekistan

development model, which is based on humanism and civic responsibility. Scientific research on the issue of harmony between national and universal values is entering a new phase. While the relationship between nationalism and globalism has often been interpreted as contradictory and antagonistic, the experience of New Uzbekistan shows that this relationship has been integrated and is developing in the form of a harmonious model. As a result, while preserving the strength of national identity, it is possible to create a stable, socially harmonious system based on openness, democratic principles, and civic responsibility.

In explaining this process, Feruza Inagamova links the transformation of national axiological values to the fundamental and systematic changes in the value systems accepted by society, various social groups, and individuals as a complex phenomenon associated with the fundamental and systematic change of the system of values accepted by them. According to the researcher, the transformation of the value system does not occur suddenly, but rather the formation of new values and the acquisition of new meanings by existing values usually takes several years [6]. From a legal point of view, various social, economic, and cultural factors influence this process. Social progress, globalization, technological advances, social changes, and migration accelerate the transformation of values and their adaptation to contemporary needs. In this regard, young people play a central role in the transformation of national axiological values. Young people are prone to change and, due to their incomplete personal development, are highly susceptible to and imitate unfamiliar cultural and moral elements that differ from those of the rest of society [4]. For this reason, they play a role not only in accepting the transformation of values but also in promoting and disseminating new values. This contributes to the effective formation of a national axiological system in society and its integration with contemporary needs.

According to Hayridinov Abboskhon, from the very beginning of Uzbekistan’s independent development, a comprehensive policy has been pursued to preserve national values, systematically pass them on to the younger generation, and strengthen them in society. In this process, material cultural heritage sites have been re-registered, reconstruction and restoration work has been carried out, and spiritual heritage has been restored as a national treasure. In order to convey their social significance to the wider public, various festivals, competitions, and other cultural and spiritual events have been organized on a regular basis. In the 1980s, the rapid development of mass culture, especially information technologies and social networks, gained momentum and had a negative impact on young people. For this reason, as the author emphasizes, comprehensive programs have been developed to strengthen the ideological immunity of young people in order to counteract such negative socio-axiological trends. In particular, the establishment of the “Temurbek School” has served to shape social and moral values such as patriotism, courage, and bravery in young people. In addition, the “Youth notebook” system employs young people in need of social protection, which is designed to protect them from any negative cultural influences by providing them with preferential loans and developing small businesses. According to Hayridinov Abbosxon's analysis, a systematic policy aimed at preserving national values and adapting them to modern social needs is an important tool for shaping moral stability

among young people and creating axiological immunity to the influence of mass culture [3].

Research Methodology

The subject of this study is the role of national spiritual heritage and values in the development of society, their modern transformation, and the analysis of new axiological systems emerging in the conditions of modern Uzbekistan.

Analysis and Results

The results of the study show that moving away from national spiritual values may hinder independent development, and, on the contrary, may lead to the risk of falling under the influence of other states or peoples. From this point of view, the reinterpretation of values in society plays a central role in understanding the modern transformation of national axiological concepts. In addition, researchers link the modern changes in national axiological views to the acquisition of new meanings of identity, historical memory, and social responsibility in the individual. This system of values serves as an active subject of social and state development, thereby philosophically justifying the humanism and civic responsibility principles of the New Uzbekistan development model. When analyzing each of the sources used, it became clear that the existing studies on the issue of harmony between national and universal values have reached a new stage. While the relationship between nationalism and globalism has often been interpreted as contradictory, the experience of New Uzbekistan has shown that this relationship can be integrated and developed in a harmonious model. In this regard, while preserving the strength of national identity, it is possible to build a stable social system based on openness, democratic principles, and civic responsibility.

The results discussed in the article show that they can be divided into several main categories and directions:

1. The role of national spiritual heritage and values in the development of society has a direct or indirect impact. Moving away from national heritage poses a threat to independent development and exposes the country to the influence of other states or peoples. From this point of view, the main focus in analyzing the modern transformation of national axiological concepts is the reinterpretation of values in society.

2. In the new Uzbekistan, the axiological system is gaining new meaning through the harmony between traditional moral values, national heritage, and modern democratic principles. The results of the study show that values are not only relevant in the ethical and moral sphere of social life, but also function as universal standards in political, legal, educational, and spiritual relations.

3. The modern interpretation and practical impact of the value system have been clarified, showing that values are not only normative ideals, but also real social practices. In particular, the prevalence of values such as human rights, justice, personal freedom, and the rule of law in state policy and social life confirms the practical function of the national axiological system.

4. The reflection of national axiological values in the individual leads to the acquisition of new meanings of identity, historical memory, and social responsibility. This process serves to shape the individual as an active subject of social and state development, resulting in a philosophical foundation for the humanistic and civic principles of the New Uzbekistan development model.

5. Through social and axiological transformation, young people play a role not only in accepting the transformation of values, but also in promoting and implementing new values. For this reason, it is clear that the formation of a national axiological system in society and its integration with contemporary needs are linked to the activities of young people.

6**.** Preserving and promoting national values through a systematic policy of restoring cultural heritage sites, bringing values to the wider public through festivals and competitions. Initiatives such as “Temurbek School” and “Youth notebook” serve to strengthen the social stability of the national axiological system and create axiological immunity among young people.

The results show that the modern transformation of national axiological values in the conditions of New Uzbekistan strengthens the internal spiritual foundation of society, strengthens the connection between values and institutions, and successfully shapes identity and social responsibility among young people.

Conclusion

The modern transformation of national axiological values is evident in the role of national spiritual heritage and values in the development of society in the new Uzbekistan. This transformation is based on the harmony between traditional moral values, national heritage, and modern democratic principles, and it strengthens values not only as normative ideals but also as real social practices. The national axiological values reflected in the individual serve to give new meaning to the concepts of identity, historical memory, and social responsibility. Young people play an active role in this process, not only accepting values but also promoting them and integrating them into society. As a result, the harmony between national and universal values is preserved, and the possibility of establishing a stable, socially harmonious system based on openness, democratic principles, and civic responsibility in society is broadened. At the same time, the modern transformation of national axiological concepts forms the axiological basis of the New Uzbekistan development model, ensuring the dynamic and integrated role of values in various spheres of social life.

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UDC: 94.05.

METRO STATIONS AND THEIR ARCHITECTURAL SOLUTIONS

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Annotatsiya. Metropoliten bekatlari nafaqat shahar transport infratuzilmasining muhim elementi, balki shaharning o‘ziga xosligi, texnologik rivojlanishi va estetik qadriyatlarini aks ettiruvchi muhim me’moriy hamda madaniy makon ham hisoblanadi. Metropoliten bekatlarining me’moriy loyihalanishi funksional samaradorlikni ta’minlash, yo‘lovchilar uchun qulaylik yaratish va vizual jozibadorlikni oshirishda muhim ahamiyat kasb etadi. Ushbu tadqiqot metropoliten bekatlarida qo‘llaniladigan me’moriy yechimlarni tahlil qiladi hamda ularning fazoviy tashkil etilishi, konstruktiv tuzilishi, bezak elementlari va shahar muhiti bilan integratsiyasiga e’tibor qaratadi. Tadqiqotda metropoliten bekatlari me’morchiligining tarixiy rivojlanish bosqichlari ko‘rib chiqilib, ularning loyihalanishida muhandislik, badiiy va madaniy omillarning ta’siri yoritiladi. Shuningdek, yirik metropoliten shaharlardagi metro tizimlarining me’moriy xususiyatlari hamda ularning zamonaviy shahar talablariga moslashuvi alohida tahlil qilinadi. Tadqiqot natijalari metropoliten bekatlari nafaqat transport inshootlari, balki muhandislik innovatsiyalari va me’moriy ijodkorlikni o‘zida mujassam etgan muhim jamoat makonlari ekanligini ko‘rsatadi.

Kalit so‘zlar: *metropoliten bekatlari, yerosti me’morchiligi, shahar transport infratuzilmasi, me’moriy loyihalash, fazoviy tashkil etish, muhandislik yechimlari, shahar muhiti, jamoat makoni.*

Аннотация. Станции метрополитена являются не только элементами городской транспортной инфраструктуры, но и важными архитектурными и культурными пространствами, отражающими идентичность города, уровень его технологического развития и эстетические ценности. Архитектурное проектирование станций метро играет значительную роль в обеспечении функциональной эффективности, комфорта пассажиров и визуальной привлекательности. В данном исследовании анализируются

архитектурные решения, применяемые на станциях метрополитена, с акцентом на их пространственную организацию, конструктивные особенности, декоративные элементы и интеграцию с городской средой. В работе рассматривается историческая эволюция архитектуры станций метро, а также раскрывается влияние инженерных, художественных и культурных факторов на их проектирование. Особое внимание уделяется архитектурным особенностям метрополитенов крупных мегаполисов и их адаптации к современным требованиям городской среды. Результаты исследования показывают, что станции метро выступают не только как транспортные объекты, но и как важные общественные пространства, объединяющие инженерные инновации и архитектурное творчество.

Ключевые слова: *станции метрополитена, подземная архитектура, городская транспортная инфраструктура, архитектурное проектирование, пространственная организация, инженерные решения, городская среда, общественное пространство.*

Abstract. Metro stations are not only elements of urban transport infrastructure but also important architectural and cultural spaces that reflect the identity, technological development, and aesthetic values of a city. The architectural design of metro stations plays a significant role in ensuring functional efficiency, passenger comfort, and visual attractiveness. This study analyzes the architectural solutions applied in metro stations, focusing on their spatial organization, structural design, decorative elements, and integration with the urban environment. The research examines the historical evolution of metro station architecture and highlights the influence of engineering, artistic, and cultural factors on their design. Particular attention is paid to the architectural features of metro systems in major metropolitan cities and their adaptation to modern urban requirements. The findings demonstrate that metro stations serve not only as transportation facilities but also as important public spaces that combine engineering innovation with architectural creativity.

Keywords: *metro stations, underground architecture, urban transport infrastructure, architectural design, spatial organization, engineering solutions, urban environment, public space.*

Introduction

Rapid urbanization and population growth in modern cities have significantly increased the demand for efficient public transportation systems. Among various urban transport systems, metro networks have become one of the most reliable and widely used solutions for managing large passenger flows in metropolitan areas. In this context, metro stations represent key structural and functional elements of underground transport systems. Beyond their technical and operational roles, metro stations also function as architectural landmarks that reflect the cultural and artistic identity of a city.

The architectural design of metro stations involves the integration of engineering solutions, aesthetic principles, and functional requirements. Architects and engineers must consider factors such as passenger circulation, safety, lighting, acoustics, materials, and artistic expression. Over time, metro station architecture has evolved significantly. Early metro systems were designed primarily with functional considerations in mind, whereas modern stations often combine technological innovation with artistic design and cultural symbolism. Consequently, metro stations have increasingly become spaces that contribute to the visual identity and cultural heritage of urban environments. The purpose of this research is to analyze the architectural solutions used in metro stations, examine their functional and aesthetic characteristics, and identify the factors that influence their design and development in modern urban infrastructure.

Literature Review

The architecture of metro stations has been widely studied by researchers in the fields of urban planning, architecture, and transport engineering. Scholars have examined metro stations not only as transportation facilities but also as architectural spaces that influence the urban landscape. Research on underground architecture emphasizes the importance of spatial planning, structural safety, and passenger flow management in the design of metro stations. Studies also highlight the role of lighting systems, ventilation, and material selection in creating comfortable and safe underground environments. Several authors have analyzed the architectural characteristics of metro systems in major cities such as London, Moscow, Paris, and Tokyo. These studies demonstrate that metro station architecture often reflects national traditions, artistic styles, and historical contexts. For example, many metro stations are designed with decorative elements, sculptures, mosaics, and murals that symbolize the cultural heritage of the city. Recent research also focuses on sustainable architecture and the integration of smart technologies into metro station design. Modern metro stations increasingly incorporate energy-efficient lighting, environmentally friendly materials, and advanced passenger information systems. These developments indicate a shift toward more sustainable, technologically advanced, and user-oriented transport infrastructure. Despite extensive research in this field, the architectural solutions of metro stations continue to evolve in response to technological innovation and changing urban needs. Therefore, further analysis of their architectural features remains an important research direction.

Research Methodology

This research is based on a combination of qualitative and analytical research methods. The study employs historical analysis, comparative analysis, and architectural observation to examine the development and architectural characteristics of metro stations. The historical method is used to trace the evolution of metro station architecture from the early stages of underground transport development to contemporary designs. Comparative analysis allows the examination of architectural similarities and differences among metro systems in various cities. In addition, architectural analysis is applied to evaluate spatial organization, structural design,

decorative elements, and functional efficiency of metro stations. The research also utilizes secondary data sources, including academic publications, architectural studies, transport planning reports, and visual materials related to metro station design. These sources provide valuable information for understanding the theoretical and practical aspects of underground architectural solutions. Through these methodological approaches, the study aims to identify the main architectural principles and design trends that shape modern metro stations.

Analysis and Results

The analysis of metro station architecture demonstrates that their design is influenced by several key factors, including engineering requirements, passenger capacity, urban planning considerations, and aesthetic values. One of the primary architectural aspects of metro stations is spatial organization. Efficient passenger circulation is essential for preventing congestion and ensuring safe movement within the station. Therefore, the layout of platforms, corridors, escalators, and entrances must be carefully designed. Structural design is another important factor in underground architecture. Metro stations require strong and durable construction techniques to withstand geological conditions, seismic activity, and heavy passenger loads. Engineers often employ reinforced concrete structures, deep foundation systems, and advanced tunneling technologies to ensure safety and stability. In addition to functional considerations, architectural aesthetics play a crucial role in metro station design. Many metro systems incorporate artistic elements such as sculptures, mosaics, decorative panels, and thematic lighting. These elements enhance the visual environment and create a unique identity for each station. The analysis also shows that modern metro stations increasingly emphasize sustainability and technological innovation. Energy-efficient lighting systems, automated ventilation, digital information displays, and smart security systems are commonly integrated into contemporary station designs. Overall, the results indicate that successful metro station architecture requires a balance between engineering efficiency, functional design, and artistic expression [1].

Metropolitan architecture is an extremely broad and multifaceted concept. It includes the issues of route design, the search for modern planning of stations and vestibules, the creation of the most comfortable conditions for passenger movement with the shortest possible time, the formation of the architectural appearance of underground structures, and the organization of the interior space.

The architectural and artistic appearance of stations is formed in the process of meaningful and responsible creative research. Initially, city-wide competitions are organized to determine the best architectural and artistic solution for stations, in which many specialists participate. The best projects will be selected and will serve as the basis for further detailed development [2].

The architectural composition of metro stations is largely determined by their structural design. The decorative work of underground halls and vestibules reflects the characteristics of certain stages of architectural development. Architectural and artistic solutions are combined with the specific urban environment, theme, and name of the station. Also, the territory where the station is being built - the historically formed part

of the city or new industrial districts - has a great influence on its architectural and artistic appearance.

The architectural appearance of each station is created by maximizing the disclosure of its constructive basis, the rational use of functionally necessary elements, and details in the organization of the internal space. Depending on the type of station, the central hall can have various shapes and appearances. Chandeliers, lamps, and wall lamps (bra) - their various fastening methods and lighting solutions are an integral part of the central hall's decoration and play an important role in the overall architectural composition. Walls are usually faced with marble, granite, and other natural materials; their color is carefully chosen in accordance with the overall theme of the station. The plan shape of columns and pylons at stations varies depending on the depth of their placement. Their form also serves to reveal the figurative solution of the station more deeply.

Bronze reliefs, bas-reliefs, and decorative "*ganch"* carving are of particular importance in the decoration of columns and pylons. Usually, they are covered with marble. Sometimes granite, pressed glass, or other artificial materials are also used. The last (narrow) wall of the station is decorated with panels, mosaics, and bas-relief compositions, which allows for a more complete expression of the station's artistic idea. The platform floors are covered with polished granite slabs [3].

Detailed culture also plays a crucial role in decorating stations. It is this aspect that distinguishes successful architectural solutions and plays a significant role in creating a unified stylistic harmony. Therefore, special attention is paid to furniture, information displays, and other small elements in the station's interior.

The diversity in the architectural plasticity of ceiling and wall surfaces, the shapes of columns and pylons, types of lighting and coating materials, and structural diagrams allows for giving stations a unique, figurative, and expressive appearance. Artificial lighting, ventilation systems, shapes of structures, and color solutions eliminate the feeling of being underground and eliminate unpleasant sensations.

The originality, uniqueness, and memorable appearance of the Tashkent metro stations are recognized not only in our country but also abroad, which is the result of the creative work of architects, artists, engineers, builders, and maintenance personnel.

Sabir Rakhimovich Adilov recounts: Sh. At Rashidov's suggestion, a tender was announced for the stations of the Chilanzar line. We reviewed all the projects submitted to the competition and expressed our recommendations for improving architecture and ensuring national identity. The proposals were accepted by the authors, and shortly after, we organized an exhibition of the Tashkent metro station projects.

Members of the government, heads of the city committee, and the city executive committee participated in the discussion of the competition results. Moscow guests also visited - Minister of Road Transport, Chairman of the State Planning Committee, project engineers, and Director of Mosmetrogiprotans A.S. Lugovtsov. In my speech, I spoke about the ideas and shortcomings of each project. Everyone listened attentively, and only the Muscovites asked questions. At the end of the meeting, A. S. Lugovtsov asked for the floor. He said that several projects could be further improved by the Moscow Institute and then implemented in construction work. He noted that other

projects are not suitable, and Tashkent architects do not have sufficient experience. Addressing me, he said, “As the chief architect of the city, you and your colleagues designed underground marble palaces. Now you need to be able to distinguish transport structures from palaces” [4].

The architecture of the Tashkent metro was first started in 1972 by newly arrived young specialists at the Tashmetroproekt Institute. They graduated from the Faculty of Architecture of the Tashkent Polytechnic Institute. This group included Muzaffarova F., Adilov A., and Mansurov Ya., Tabibov A. In different years, such talented architects as Makhmudov V., Fayzullaev R., Vereshchagina M., Kazimov S., Dubrovnaya L., Kichaev P., Khasanov T. worked at Tashmetroproekt.

Leading design institutes of Moscow have been involved in the design of metro stations in different years (for example, “Metrgiprotans,” architects Popov L., Strelkov A., Kachurinets V.); Tashkent Institutes – “UzNIIP gradostroitelstva” (architects S. Sutyagin, V. Agafonova), “TashNIIEP” (architects Merport I., Akramov M., Aydinova O.), “TashNIIP Genplan” (architects Muratov V., Rakhimov U., Tursunov F., Sadykov T.), “Tashgiprogor” (architects Khurshidov A., Loshkaryov A.) and others [5].

For this work, Akhmarov Ch., Khabibulin O., Lipene I., Mukhamedjanov R., Kayumov A., Sultanmuradov S., as well as folk masters Usmanov M., and I. Shermukhamedov. The best architectural, artistic, and constructive solutions, as well as new volumetric and planning platforms and vestibule solutions, were created under the direct supervision of chief engineers G. Oganesov and A. Zakirov.

New constructive and volumetric-planning solutions, as well as a genuine synthesis of architecture and monumental art, usually served to achieve a very high level of quality. Such examples include the stations of the Tashkent metro – “Alisher Navoi,” “Mustaqillik maydoni,” “Hamid Olimjon,” “Hamza,” “Beruniy,” “Kosmonavtlar,” “Gafur Gulom,” “Tinchlik,” and others. These stations marked the mood, and a magnificent underground ensemble was created in Tashkent, amazing with its vitality, unique images, national diversity, and the beauty of architectural compositions [6]. Here, engineering thinking and the artist's inspiration blended harmoniously. Natural stones - marble and granite - were widely used at the stations, most of which were mined from local deposits. Traditional national decorative styles were also used: painting, *ganch* carving, and especially art ceramics, which are popular in the architectural monuments of Samarkand, Bukhara, and Khiva.

The architects of Tashmetroproekt dedicated their creative energy to the creation of underground palaces in the capital of Tashkent. In different years, F. Muzaffarova, A. Adilov, Ya. Mansurov, A. Tabibov, R. Fayzullaev, V. Makhmudov, S. Kazimov, and other architects were awarded high honors and diplomas by the city, the republic, the Union of Architects of Uzbekistan, and the Ministry of Transport and Construction. At the same time, Ya. Mansurov, A. Tabibov, O. Aydinova, and R. Fayzullaev were awarded the State Prize [7].

According to experts, the station with the most expressive architectural and artistic image is “Independence Square.” This result is achieved through the harmonious combination of all architectural and artistic solution elements, creating an emotionally rich and expressive appearance of the platform.

The solemn and festive atmosphere of the station is created by numerous crystal chandeliers, colorful guirlends placed between three platforms. The station area, filled with a bright stream of light, reminds one of the sunny nature of Uzbekistan. The same theme was continued in the architectural decoration of octagonal columns, with capitals in the form of stalactites, and in the geometric decoration of the ceiling (plaster stamped by I. Dubrovsky). The synthesis of works created by artists and the original station's architecture is so harmonious that it can serve as a model.

In some stations, the "retro" style was used, which allows recreating the atmosphere of the 19th century, taking into account architectural decorations and some elements of the past-century culture. The architectural and artistic image of the "Pushkin" station was created using simple yet expressive means.

The station is distinguished by its firmness and unique elegance. This effect is achieved through a caisson ceiling, precise rows of columns, and original lights mounted on them - candlestick-like lamps in bronze chandeliers. The romantic image created on the platform is complemented by heraldic reliefs on the front walls; they depict allegories of Music and Glory and are surrounded by a bronze profile of A.S. Pushkin. One of the achievements in the search for original architectural and artistic solutions of the Tashkent metro is the station "Hamid Olimjon." The station's memorable appearance was created through eight arches passing from one platform wall to the other. The arches reflect the traditional architectural decorations of Uzbekistan, reworked in a modern interpretation through the pattern, silhouette, and color palette.

According to the artists, a particular achievement is the "Alisher Navoi" station, where a unique national architectural and artistic image has been found. The arched-domed ceiling solution, decorated with ceramics, gives the interiors uniqueness and is reminiscent of medieval architectural monuments. Therefore, the ceramic reliefs dedicated to the works of Alisher Navoi are very logically placed at the station [4].

Conclusion

The study confirms that metro stations represent an important intersection between engineering infrastructure and architectural creativity. Their design involves complex interactions between functional requirements, structural safety, passenger comfort, and aesthetic considerations. The research highlights that modern metro station architecture has evolved from purely functional underground spaces into multifunctional public environments that contribute to the cultural and visual identity of cities. Architectural solutions such as efficient spatial planning, innovative structural systems, and artistic decoration play a key role in improving the overall quality of metro infrastructure. Furthermore, the integration of sustainable technologies and smart systems is becoming an increasingly important trend in metro station design. These innovations enhance operational efficiency, environmental sustainability, and passenger experience. In conclusion, metro stations should be considered not only as elements of transport infrastructure but also as significant architectural spaces that shape the urban environment and reflect the cultural character of modern cities.

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UDC: 37,37.01/.09,378

MECHANISMS FOR ENHANCING STUDENTS’ SCIENTIFIC AND CREATIVE ACTIVITY IN THE HIGHER EDUCATION SYSTEM

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Annotatsiya. Mazkur maqolada oliy ta’lim tizimida talabalarning ilmiy-ijodiy faolligini oshirish mexanizmlari ijtimoiy-falsafiy yondashuv asosida tahlil etiladi. Talabaning bilishga bo‘lgan qiziqishi, mustaqil fikrlashi, ilmiy izlanishlarga erta bosqichdan jalb etilishi hamda ta’lim va ishlab chiqarish integratsiyasi ilmiy-ijodiy faollikni oshirishning muhim omillari sifatida asoslab beriladi. Shuningdek, ilmiy to‘garaklar, grant tizimi, xalqaro tanlov va olimpiadalar orqali raqobat muhitini shakllantirishning ahamiyati yoritiladi. Maqolada milliy ma’rifiy meros va zamonaviy ta’lim paradigmasi uyg‘unligi asosida ziyolilik madaniyatini rivojlantirish, yoshlarning intellektual salohiyatini yuksaltirish masalalari xulosaviy tarzda umumlashtiriladi.

Kalit so‘zlar: *oliy ta’lim, ijodiy faollik, daraja, tarbiya, intellektual salohiyat, ijodkorlik, tafakkur, fikr, shaxs.*

Аннотация. В данной статье механизмы повышения научно-творческой активности студентов в системе высшего образования анализируются на основе социально-философского подхода. Интерес студентов к познанию, самостоятельное мышление, раннее вовлечение в научно-исследовательскую деятельность, а также интеграция образования и производства обосновываются как важные факторы повышения научно-творческой активности. Также раскрывается значение формирования конкурентной среды посредством научных кружков, грантовой системы, международных конкурсов и академических олимпиад. В статье в обобщённом виде рассматриваются вопросы развития интеллектуальной культуры и повышения интеллектуального потенциала молодёжи на основе гармоничного сочетания национального просветительского наследия и современной образовательной парадигмы.

Ключевые слова: *высшее образование, творческая активность, уровень, образование, интеллектуальный потенциал, творчество, мышление, идея, личность.*

Annotation. This article analyzes the mechanisms for increasing students' scientific and creative activity in the higher education system based on a socio-philosophical approach. Students' interest in learning, independent thinking, early involvement in scientific research, and the integration of education with industry are substantiated as key factors in enhancing scientific and creative activity. The importance of creating a competitive environment through scientific clubs, grant systems, international competitions, and academic Olympiads is also highlighted. The article concludes with a generalized discussion on developing intellectual culture and enhancing the intellectual potential of youth through the harmony of national educational heritage and modern educational paradigms.

Keywords: *higher education, creative activity, level, education, intellectual potential, creativity, thinking, idea, personality.*

Introduction

Higher education institutions serve as key social establishments responsible for preparing competent specialists capable of meeting the future needs of society and the state. These institutions develop in accordance with the country's long-term demand for qualified human resources. Their essential functions include bringing together experienced and highly qualified academic and pedagogical personnel, ensuring the integrated implementation of educational, methodological, scientific-research, humanitarian education, and upbringing processes. In addition, higher education institutions foster a cooperative environment between faculty members and students, encouraging inquiry, motivation for learning, scientific creativity, and the acquisition of professional skills through practice-oriented interaction and mutual engagement.

Literature Review

Within this academic environment, students receive education and moral development while gradually forming themselves as independent individuals. Today, this process is carried out through modern pedagogical technologies in response to the rapidly increasing demand for intellectual capacity and professional competence. According to contemporary educational approaches, the primary responsibility for mastering knowledge and professional specialization increasingly lies with the students themselves. Therefore, one of the main directions for enhancing students' social activity is strengthening their interest in learning, alongside the development of personal identity, self-awareness, and a growing sense of responsibility [1, 2]. Students' cognitive engagement manifests itself through active participation in classroom activities, independent learning efforts, curiosity toward innovation and discovery, and the ability to inspire scientific interest among peers and other youth groups. The successful organization of such activities largely depends on professors' and instructors' ability to understand students and effectively encourage their interest in academic disciplines and future professions. Consequently, the systematic and efficient completion of independent study tasks outlined in academic curricula is closely connected with the level of students' social and intellectual activity [3-6].

Research Methodology

This study is based on a comprehensive research approach employing socio-philosophical, systemic, historical, and normative-legal methods of analysis. The research integrates theoretical considerations with practical objectives, combines national educational and cultural heritage with contemporary educational paradigms, and scientifically forecasts future development prospects. Such an approach allows for a holistic examination of the mechanisms that enhance students' scientific and creative activity within the higher education system.

Analysis and Results

Scientific and creative competition among students plays a significant role in strengthening their interest in learning and research activities. This competitive environment becomes particularly evident during classroom activities, meetings of scientific clubs, theoretical and practical academic conferences, as well as various contests and Olympiads organized at different levels and academic fields. These platforms stimulate students' motivation for inquiry and encourage active engagement in research. Although higher education institutions have already implemented a number of effective initiatives in this direction, there remains a need to further incorporate modern approaches, higher standards, and a stronger spirit of creativity into these processes.

Moreover, such competition should extend beyond national boundaries, enabling young scholars to present their scientific potential on international platforms as a reflection of national pride and intellectual achievement. Increasing students' social activity largely depends on their broader involvement in scientific research. Traditionally, students' research engagement has been organized through scientific clubs, where universities have accumulated valuable positive experience. However, current conditions require linking these activities more closely with grant systems,

announcing special research grants specifically for students, developing targeted research programs within institutional partnerships, and supporting student-led research initiatives.

In our view, this process should begin from the very first year of study. From the initial stages of higher education, students should, with the support of their specialized departments, identify their future scientific interests and design an individual research trajectory for their academic years. This early orientation helps establish cooperation with organizations and research institutions. Importantly, a student's voluntary entry into research activities based on personal interest differs fundamentally from formal participation imposed merely for reporting purposes. Scientific and creative activities organized solely to fulfill administrative reporting requirements often fail to produce meaningful or sustainable outcomes.

The integration of the education system with industry occupies a crucial place in enhancing students' social activity. Within this integration, profound reforms taking place in education on the one hand, and modernization processes occurring in production sectors on the other, generate mutually reinforcing demands. As a result, these requirements contribute, firstly, to improving the quality and effectiveness of the education system and clarifying its strategic objectives, and secondly, to transforming production environments into spaces where highly qualified specialists with modern intellectual competencies can effectively operate and develop.

The Presidential Decree *"On the State Program for the Implementation of the Action Strategy on Five Priority Areas of Development of the Republic of Uzbekistan for 2017–2021 in the Year of Development of Science, Enlightenment and the Digital Economy"* outlines important objectives within the Concept for the Development of Science until 2030. These include the introduction of a national ranking system aimed at evaluating the effectiveness of scientific and innovative activities of research organizations, strengthening self-governance mechanisms in science, expanding social partnership between the state and scientific institutions, and implementing collaborative projects within this framework. Furthermore, the program sets targets to increase the share of technological innovation expenditures carried out by organizations themselves by 3.5 times by 2025 and by nine times by 2030 in the overall volume of research and development investments.

The new educational paradigm replaces the traditional concept of "education for life" with the model of "lifelong learning." In this regard, the early-twentieth-century idea proposed by R. Sloter regarding the formation of a "culture of inquiry" is particularly noteworthy. He emphasized the need to develop qualitatively new collective capacities aimed at future-oriented thinking and long-term forecasting. Addressing this challenge requires prioritizing the formation of social consciousness grounded in an understanding of the meaning of social history, the essence of cultural processes, their laws, directions, and responsibilities, since without such awareness, it is impossible to fully explain the logic and content of humanity's intellectual culture. It should also be emphasized that intellectuals represent the intellectually and socially active segment of society, where intellectual development and social engagement are closely interconnected. Scientists, researchers, innovators, engineers, and

entrepreneurs distinguish themselves not only through professional competence but also through their adherence to social responsibility and ethical values.

An intellectual is, above all, a thinking individual for whom creative reasoning is inseparable from civic responsibility and moral awareness. As thinking differentiates intellectual and physical labor, it becomes an independent form of activity characterized by its own goals, intentions, and practical manifestations. Intellectual development largely occurs internally and often implicitly. Because it is difficult to organize solely through external means, individuals rely on intellectual capacity as an internal instrument of activity. The processes of thinking typically culminate in cognitive outcomes such as judgments, concepts, or conclusions. These results are usually expressed through language; therefore, without articulating thoughts, it becomes difficult to influence or motivate purposeful activity.

At the present stage of educational and scientific development, carriers of intellectual culture often constitute an elite group. However, this situation is temporary. A socially responsible elite shaped by healthy national ideas and grounded in the synthesis of intellectual and popular culture can serve as a guarantee of stable social development. Achieving intellectual maturity requires not only intelligence and knowledge but also the ability for independent and creative reflection. Through independent thinking, individuals develop a holistic understanding of reality and gain the capacity to recognize qualitative transformations, interconnections, and mutual influences within social and natural processes.

The level of an individual's intellectual maturity is primarily determined by independent thinking, professional activity, and lifestyle. Therefore, intellectual development is connected not only with moral and spiritual qualities but also with living conditions and material well-being. As noted by I.B. Siddiqov, in the new stage of societal development, special attention to enhancing the intellectual culture of individuals and society—particularly youth—has become an objective necessity. A socio-philosophical study of the interaction between societal progress and the intellectual culture of young people, which represents one of the challenges of modernizing market economy relations, contributes to eliminating shortcomings in the preparation of highly qualified specialists capable of applying advanced scientific achievements in practice and developing as intellectually mature individuals.

Conclusion

By improving one's level of intellectual and cultural development, an individual gradually gains a deeper and clearer understanding of the self. In this sense, intellectual maturity is primarily distinguished by a person's ability to achieve self-awareness and conscious self-reflection. Therefore, the ideas expressed by the prominent Jadid enlightener Ismail Gasprali remain highly relevant today. He emphasized that Europe, as an experienced civilization, deserves respect for its historical experience and achievements; however, its practices should not be adopted blindly. Instead, every innovation should be critically evaluated through reason, conscience, and moral responsibility, asking what its true essence is and what consequences it may lead to.

Another leading representative of the Jadid enlightenment movement, Abdulla Avloni, also devoted his efforts to educating young people as honest, capable, resilient,

generous, and patriotic individuals. As an intellectual of his time, he regarded education and upbringing as decisive factors in human and societal destiny. His well-known idea that education represents a matter of "life or death, salvation or decline, happiness or misfortune" highlights the exceptional importance he attributed to the process of upbringing. For Avloni, the development of intellect through knowledge and experience was essential, and cultivating children's ability to think independently was considered a sacred and indispensable task.

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UDC: 81'37, 811.111

THEORETICAL ANALYSIS OF THE VERBALIZATION OF THE EMOTION OF JOY THROUGH THE CONCEPT OF "LAUGHTER"

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Annotatsiya. Maqola quvonch emotsiyasining "kulgi" konsepti orqali verbalizatsiyasini nazariy jihatdan tadqiq etishga bag'ishlangan. Kulgi quvonchning lingvistik ifodasi sifatida uning leksik-semantik, pragmatik va kulturologik jihatlari ko'rib chiqiladi. Kulginining kommunikatsiyadagi funksiyalari, uning semantik ko'pqatlamliligi hamda madaniy-emotsional tajribani shakllantirishdagi roli tahlil qilinadi. Xulosa qilinishicha, "kulgi" konsepti ekspressiv, kommunikativ va ramziy funksiyalarni bajaruvchi murakkab leksik-semantik hamda pragmatik birlik hisoblanadi.

Kalit so'zlar: *kulgi, quvonch, emotsiyalar verbalizatsiyasi, konsept, lingvomadaniyat, pragmatika.*

Аннотация. Статья посвящена теоретическому исследованию вербализации эмоции радости через концепт "смех." Рассматриваются лексико-семантические, прагматические и культурологические аспекты смеха как лингвистического выражения радости. Анализируются функции смеха в коммуникации, его семантическая многослойность и роль в конструировании культурно-эмоционального опыта. Делается вывод о том, что концепт "смех" является комплексной лексико-семантической и прагматической единицей, выполняющей экспрессивные, коммуникативные и символические функции.

Ключевые слова: *смех, радость, вербализация эмоций, концепт, лингвокультура, прагматика.*

Abstract. The article is devoted to a theoretical study of the verbalization of the emotion of joy through the concept of "laughter." The lexical-semantic, pragmatic, and cultural aspects of laughter as a linguistic expression of joy are examined. The functions of laughter in communication, its semantic multilayered nature, and its role in constructing cultural-emotional experience are analyzed. It is concluded that the concept of "laughter" is a complex lexical-semantic and pragmatic unit performing expressive, communicative, and symbolic functions.

Keywords: *laughter, joy, verbalization of emotions, concept, linguoculture, pragmatics.*

Introduction

Emotions occupy a central place in linguistics, cognitive science, and cultural studies. Among them, joy stands out as a basic emotion characterized by universal manifestations and distinctive verbal markers. In language, joy is expressed not only through descriptive constructions ("joyfully," "happily") but also through the specific

concept of “laughter,” which integrates physiological, emotional, and cultural components of experience. In linguistic theory, the concept of “laughter” is viewed as a lexical-semantic and pragmatic unit that includes: an expressive level - imitations of laughter (onomatopoeic interjections such as “ha-ha,” “hee-hee”); a semantic level - lexemes denoting joy or positive evaluation (“funny,” “amusing”); a pragmatic level - functions of social regulation, tension relief, agreement, or irony; a metaphorical level - symbolic uses of laughter to convey deeper meanings (“laughter through tears”).

Literature Review

In modern linguistics and cognitive science, emotions are regarded as a key element of communication, and their verbalization is an important object of analysis within cognitive-linguistic and cultural studies. Joy, as a basic emotion, has received particular attention due to its expression through the concept of laughter, which integrates physiological, emotional, communicative, and cultural components of human experience [1-3]. Early studies of laughter as a manifestation of joy were conducted within the psychology of emotions. Ekman emphasized the universality of joy expressed through physiological reactions of the face and body, including laughter, making it a universal marker of positive emotional states [1]. Provine investigated laughter as a social phenomenon, highlighting its role in regulating interpersonal interaction and creating emotionally congruent communicative environments [2].

Linguistic studies interpret laughter as a lexical-semantic and pragmatic concept. Attardo identifies its multilayered nature, including expressive, evaluative, communicative, and metaphorical levels [4]. The expressive level captures physiological reactions through sound-imitating forms; the evaluative level conveys joy or irony; the communicative level regulates social interaction; and the metaphorical level transmits symbolic meanings of joy, resilience, and cultural identity. From a cultural perspective, Wierzbicka notes that laughter and its verbalization depend on sociocultural context and reflect collective norms and values [5]. Different cultures employ varying forms of expressing laughter: some favor sound imitation, while others prefer descriptive constructions. Campbell considers laughter an instrument of social integration, tension relief, and transmission of cultural values [6, 7]. It serves as a marker of trust, friendliness, emotional involvement, and also as a means of distancing, irony, and social critique. Local studies confirm these conclusions. Kozlov examines emotional verbalization in discourse, highlighting laughter’s expressive, commentary, and symbolic functions [8]. Lykova emphasizes its pragmatic role in interpersonal communication [9]. Murashova analyzes intercultural differences in emotional verbalization [10, 11]. Thus, the concept of laughter is a multidimensional phenomenon integrating cognitive, lexical-semantic, pragmatic, and cultural aspects.

Research Methodology

The methodological framework includes lexical-semantic and pragmatic analysis, content analysis of literature, comparative analysis, and an axiological approach aimed at identifying the value and symbolic dimensions of laughter as an expression of joy. The methodology is conceptual and based on modern linguocognitive theories.

Analysis and Results

The concept of laughter represents a complex lexical-semantic unit integrating several semantic dimensions reflecting different aspects of joy verbalization. At the expressive level, laughter manifests as a physiological reaction reflected through interjections such as “ha-ha” or “hee-hee”, conveying intensity and emotional tone. The evaluative dimension gives laughter additional meaning, allowing it to signal joy, amusement, irony, or mild criticism. Its communicative function regulates social interaction by coordinating emotional states and strengthening interpersonal relationships. The metaphorical function allows laughter to symbolize liberation, resilience, and harmony. Pragmatically, laughter supports social integration, emotional regulation, and communicative harmony. It also enables ironic distancing and serves as a mechanism for alleviating discomfort. Culturally, laughter reflects collective norms and values, functioning as an indicator of cultural identity. Thus, laughter integrates physiological, lexical-semantic, pragmatic, and cultural dimensions of experience.

Conclusion

The concept of laughter is a multidimensional linguocultural unit including expressive, semantic, pragmatic, and symbolic levels. The analysis shows that: laughter expresses joy but also performs social and metaphorical functions; the verbalization of joy through laughter is dynamic and context-dependent; theoretical models of laughter are essential for further studies in emotional verbalization and intercultural communication. Future research may focus on cross-linguistic comparisons, digital communication, and the impact of media on emotional expression.

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UDC: 5, 54, 549.5

SYNTHESIS OF SYNERGISTICALLY ACTING INTUMESCENT FLAME-RETARDANT AND ANTISEPTIC AGENTS BASED ON ZINC BORATE AND INVESTIGATION OF THEIR PHYSICOCHEMICAL PROPERTIES

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Annotatsiya. Ushbu ishda to‘qimachilik materiallarini yong‘indan himoyalash maqsadida rux oksidi borat kislota, fosfat kislota va mochevina asosida yangi sinergik ta’sirga ega bo‘lgan ZnB-1 markali intumessent antipiren-antiseptik sintez qilindi. Sintez jarayonining optimal harorat va vaqt parametrlari aniqlanib, reaksiya unumi 92 % ga yetkazildi. Olingan mahsulotning kimyoviy tuzilmasi IQ-FTIR, termik barqarorligi TGA/DTA usullari yordamida o‘rganildi. Natijalar fosfor–bor–azot–ruxli kompleks tuzilma shakllanganini, kovalent P–O–C bog‘lar hosil bo‘lganini hamda antipirenning yuqori termik barqarorlik va yuvishga chidamlilikka ega ekanligini tasdiqladi. ZnO nanozarralarining kiritilishi sinergetik effekt ko‘rsatib, mineral bar’yer hosil bo‘lishiga va ko‘mir qoldig‘i miqdorining ortishiga olib keldi. Olingan antipiren paxta va paxta–poliester matolar uchun istiqbolli yong‘inga qarshi himoya materiali sifatida tavsiya etiladi.

Kalit so‘zlar: *intumessent antipiren, rux borat, ZnO nanozarralari, fosfor-azot tizimi, FTIR, TGA, to‘qimachilik materiallari.*

Аннотация. В данной работе с целью огнезащиты текстильных материалов был синтезирован новый синергетически действующий интумессентный антипирен-антисептик марки ZnB-1 на основе оксида цинка, борной кислоты, фосфорной кислоты и мочевины. Определены оптимальные температурные и временные параметры синтеза, при которых выход реакции достиг 92 %. Химическая структура полученного продукта исследована методом ИК-Фурье-спектроскопии, а термическая стабильность — методами термогравиметрического и дифференциально-термического анализа (TGA/DTA). Полученные результаты подтверждают формирование

фосфорно–борно–азотно–цинковой комплексной структуры, образование ковалентных связей P–O–C, а также высокую термическую стабильность и стойкость антипирена к стирке. Введение наночастиц ZnO проявляет синергетический эффект, способствуя формированию минерального барьерного слоя и увеличению выхода углеродистого остатка. Синтезированный антипирен рекомендован в качестве перспективного огнезащитного материала для хлопчатобумажных и хлопкополиэфирных текстильных тканей.

Ключевые слова: *интумессентный антипирен, борат цинка, наночастицы ZnO, фосфорно-азотная система, FTIR, TGA, текстильные материалы.*

Abstract. In this study, a new synergistically acting intumescent flame-retardant and antiseptic agent labeled ZnB-1 was synthesized based on zinc oxide, boric acid, phosphoric acid, and urea in order to provide fire protection for textile materials. The optimal temperature and reaction time parameters were determined, and the reaction yield was increased up to 92%. The chemical structure of the obtained product was investigated using FTIR spectroscopy, while its thermal stability was evaluated by TGA/DTA methods. The results confirmed the formation of a phosphorus–boron–nitrogen–zinc complex structure, the presence of covalent P–O–C bonds, and the high thermal stability and washing resistance of the flame retardant. The incorporation of ZnO nanoparticles exhibited a pronounced synergistic effect, contributing to the formation of a mineral barrier and an increased char residue yield. The synthesized flame retardant is recommended as a promising fire-protective material for cotton and cotton–polyester fabrics.

Keywords: *intumescent flame-retardant agent, zinc borate-based additive, ZnO nanostructures, phosphorus–nitrogen synergistic system, Fourier-transform infrared spectroscopy (FTIR), thermogravimetric analysis (TGA), textile fabrics.*

Introduction

Currently, foaming phosphorus–nitrogen intumescent flame-retardant systems are widely used for the fire protection of textile materials. In such systems, ammonium polyphosphate (APP) is commonly employed as an acid source, pentaerythritol or starch serves as a carbon source, and melamine or urea is used as a blowing agent and nitrogen source. These components interact synergistically and, under thermal exposure, form a protective char layer that slows down the combustion process [1–4].

Literature Review

However, one of the main drawbacks of conventional intumescent systems is their poor washing durability when applied to textile substrates. Therefore, in recent years, special attention has been given to enhancing the synergistic effect and improving thermal stability by incorporating borate compounds and metal oxides, particularly zinc oxide (ZnO), into flame-retardant formulations [5–8]. Borate compounds are

distinguished by their ability to form a glass-like protective layer at elevated temperatures, while ZnO nanoparticles exhibit catalytic activity that accelerates the formation of a mineral barrier. Moreover, the chemical (covalent) bonding of flame-retardant components with the hydroxyl (–OH) groups of cellulose fibers significantly increases washing resistance [9–27]. In the present study, a novel synergistic intumescent flame-retardant and antiseptic agent labeled ZnB-1 was synthesized based on phosphoric acid, boric acid, urea, and ZnO nanoparticles. Its physicochemical and thermal properties were investigated in detail.

Research Methodology

Composition of the Flame-Retardant. The synthesized ZnB-1 flame-retardant consists of the following components:

- Orthophosphoric acid (H_3PO_4, 85%) — 53%;
- Boric acid (H_3BO_3) — 15%;
- Urea — 26%;
- Zinc oxide nanoparticles (ZnO, 20–50 nm) — 6%.

This composition is designed to form a phosphorus–boron–nitrogen–zinc complex system, providing a synergistic effect that enhances the intumescent mechanism.

Synthesis of ZnB-1 Intumescent Flame-Retardant. Initially, ZnO nanoparticles were dispersed in an aqueous medium using ultrasonication in the presence of a stabilizer to ensure uniform distribution. In a reaction flask, 7 g of boric acid (H_3BO_3) was added, and 3 g of ZnO nanoparticles were gradually incorporated. The mixture was heated at 110 °C for 1 hour under magnetic stirring. Subsequently, 12 g of urea and 25 g of orthophosphoric acid (H_3PO_4, 85%) were added to the resulting mass, and the reaction was continued at 150 °C for 1 hour. As a result, a white, viscous, and water-soluble flame-retardant (ZnB-1) was obtained. This procedure yields a synergistic phosphorus–boron–nitrogen–zinc complex, which enhances the intumescent mechanism and provides improved flame-retardant performance.

Optimization of Reaction Yield.

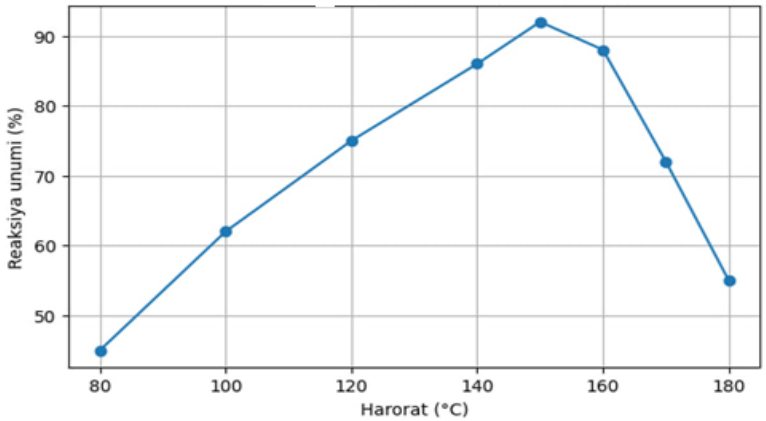

Figure 1. Dependence of the reaction yield of ZnB-1 on temperature.

The figure shows the effect of temperature on the reaction yield. The study revealed that a temperature of 150 °C is optimal for the reaction, resulting in a maximum yield of 92%.

Figure 2 shows the dependence of the reaction yield on time. The optimal reaction time was found to be 120 minutes, under which conditions the reaction yield reached 92%.

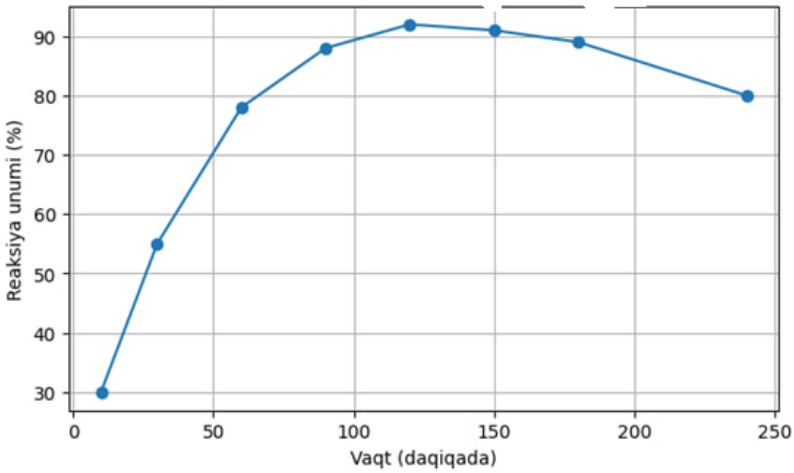

Figure 2. Dependence of the reaction yield on reaction time.

Analysis and Results

Characterization by IQ-FTIR. The infrared spectrum of the textile material treated with ZnB-1 was recorded in the 4000–500 cm^{-1} range, illustrating the presence of characteristic functional groups associated with the phosphorus–boron–nitrogen–zinc (P–B–N–Zn) complex.

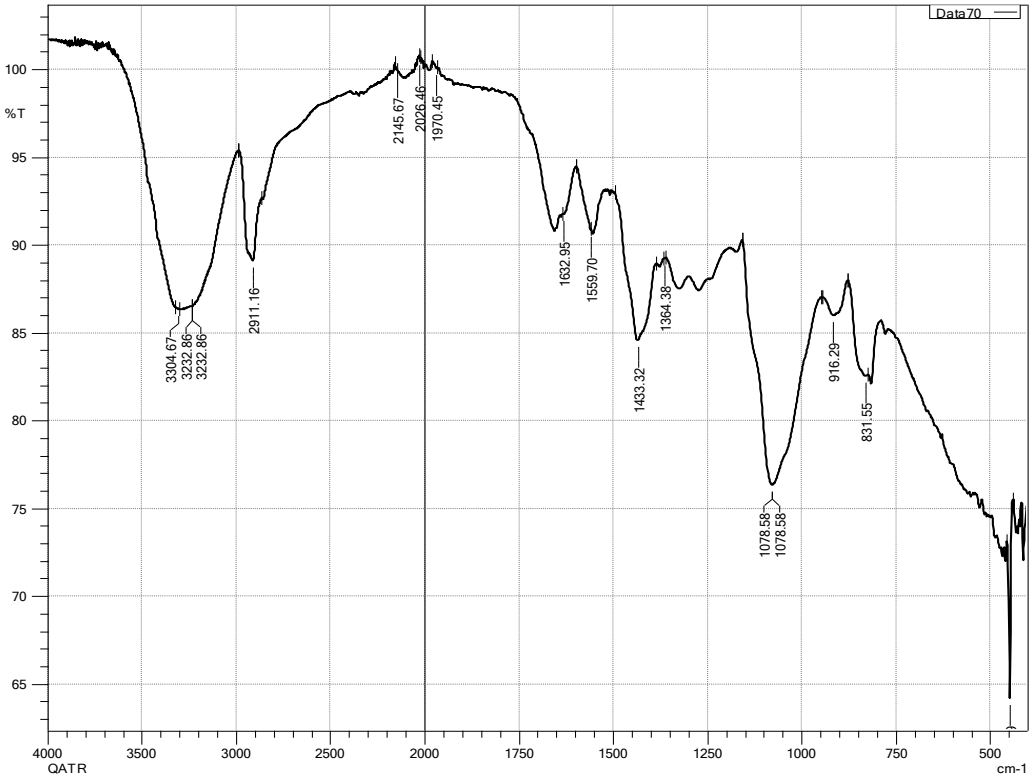

Figure 3. FTIR spectrum of textile fabric impregnated with ZnB-1 flame-retardant.

The FTIR spectrum of the textile fabric impregnated with ZnB-1 is shown in Figure 3. Broad absorption bands observed in the 3300–3400 cm^{-1} range correspond to the stretching vibrations of –OH groups from phosphoric and boric acids and –NH

groups from urea. These broad peaks indicate the presence of strong hydrogen bonding within the system, confirming the polymerized and partially cross-linked structure of the flame-retardant. Absorptions around 2911 cm^{-1} are assigned to C–H stretching vibrations of organic fragments, demonstrating the active involvement of nitrogen-containing components. Weak absorption bands in the 2145–2026–1970 cm^{-1} region are attributed to associated vibrations between urea and phosphate components. The peaks at 1632 and 1599 cm^{-1} correspond to the C=O (amide I) stretching and N–H deformation vibrations of urea, confirming the formation of phosphorus–nitrogen structures. Absorptions at 1433 and 1364 cm^{-1} are associated with C–N bonds and NH_2 group deformations. Strong bands in the 1078–1029 cm^{-1} region are characteristic of P=O and P–O–P linkages, representing the main active centers of the flame-retardant system. In particular, the peak at 1078 cm^{-1} indicates the presence of covalent P–O–C bonds, confirming the chemical binding of the flame-retardant to cellulose fibers. Peaks around 915 cm^{-1} are attributed to B–O–H and P–O–H bonds, while absorptions at 831 cm^{-1} and in the 700–500 cm^{-1} range correspond to Zn–O and P–O–Zn linkages. These results indicate the interaction of zinc oxide with phosphate and borate groups, leading to the formation of thermally stable zinc–phosphate–borate complexes.

Table 1. Physical properties of ZnB-1 flame-retardant.

Appearance	**The synthesized ZnB-1 flame-retardant is a white, viscous substance**
pH	6,5-6,8
Density (25 °C), g/cm^3	1,3
Volatile matter mass fraction, %	2
Solubility	Soluble in water

Physical Properties of ZnB-1 Flame-Retardant.

According to the data in Table 1, the ZnB-1 flame-retardant is a white, viscous substance with a pH of 6.5–6.8 and a density of 1.3 g/cm^3. The volatile matter content is low (2%), and the flame-retardant is highly soluble in water, providing technological convenience for its application to textile materials.

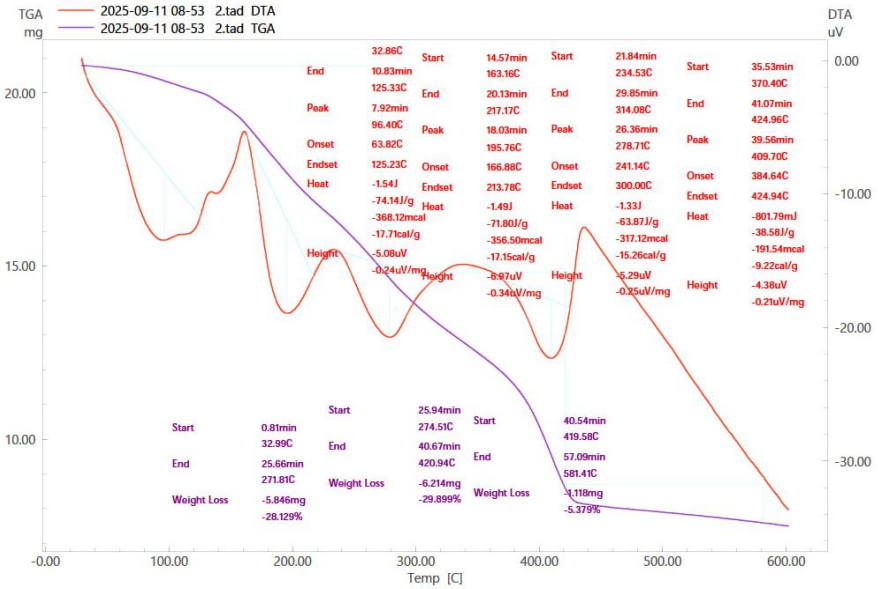

Figure 4. Thermogravimetric analysis (TGA) of ZnB-1 flame-retardant.

Thermal Analysis (TGA/DTA) of ZnB-1. The results revealed a three-stage thermal decomposition process. The first stage occurred in the temperature range of 32.99–271.81 °C, with a mass loss of 28.13%, which can be attributed to the release of adsorbed water and low-molecular-weight components.

The second stage occurred in the temperature range of 274.51–420.49 °C, corresponding to the decomposition of the main organic structure. A significant exothermic effect was observed during this stage. The third stage proceeded between 419.58 and 581.41 °C and was characterized by minimal mass loss. This stage corresponds to the formation of a thermally stable inorganic residue. For the modified samples, the delayed onset of pyrolysis and the increased char yield indicate the high efficiency of the flame-retardant system.

Conclusion

A synergistic ZnB-1 intumescent flame-retardant and antiseptic was successfully synthesized based on boric acid, orthophosphoric acid, urea, and ZnO nanoparticles. FTIR and TGA analyses confirmed the formation of a phosphorus–boron–nitrogen–zinc (P–B–N–Zn) complex, the covalent bonding of the flame-retardant with cellulose fibers, and its high thermal stability. The incorporation of ZnO nanoparticles facilitated the formation of a mineral barrier, significantly enhancing the efficiency of the flame-retardant. The obtained results scientifically substantiate the high potential of ZnB-1 for fire protection of textile materials.

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UDC: 5, 54, 543.2, 543.4

HYDROPHOBIZATION OF LINEN FABRIC USING A PARAFFIN-BASED FORMULATION MODIFIED WITH MELAMINE AND ITS EVALUATION ACCORDING TO GOST STANDARDS

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Annotatsiya. Mazkur tadqiqot zig‘ir matosini stearin kislotasi, olein kislotasi va melamin bilan modifikatsiyalangan parafin asosidagi kompozitsiya yordamida gidrofobizatsiya qilishni o‘rganadi. Gidrofob tarkib etanol-suv muhitida tayyorlandi va mato namunalari emdirish hamda keyingi termik ishlov berish orqali qayta ishlandi. Ishlov berilgan to‘qimachilik materialining xususiyatlari GOST 3816-81, GOST 12020-72 va GOST 9733.4-83 standartlariga muvofiq baholandi. Natijalar bosim ostida suv o‘tkazmaslikka nisbatan sezilarli qarshilik, tomchilarni samarali qaytarish va yuvish sikllaridan so‘ng gidrofob xususiyatlarning saqlanib qolishini ko‘rsatdi. Hosil bo‘lgan gidrofob qatlamning kimyoviy tuzilishi Furye-transform infraqizil (FT-IR) spektroskopiyasi yordamida tavsiflangan. Spektral tahlil uzoq zanjirli alifatik uglevodorodlar hamda melamin va yog‘ kislotalari bilan bog‘liq funksional guruhlar mavjudligini tasdiqladi, bu mato yuzasida barqaror gidrofob qoplamaning shakllanganidan dalolat beradi.

Kalit so‘zlar: *gidrofobizator, zig‘ir matosi, parafin, melamin, FT-IR spektroskopiyasi, GOST standartlari.*

Аннотация. В настоящем исследовании изучается гидрофобизация льняной ткани путем обработки композицией на основе парафина, модифицированной стеариновой кислотой, олеиновой кислотой и меламином. Гидрофобный состав был приготовлен в среде этанол–вода, а образцы ткани обрабатывались методом пропитки с последующей термической фиксацией. Характеристики обработанного текстиля оценивались в соответствии со стандартами ГОСТ 3816-81, ГОСТ 12020-72 и ГОСТ 9733.4-83. Полученные результаты продемонстрировали значительную устойчивость к проникновению воды под давлением, эффективное отталкивание капель и сохранение гидрофобных свойств после циклов стирки. Химическая структура сформировавшегося гидрофобного слоя была охарактеризована с помощью инфракрасной Фурье-спектроскопии (ИК-Фурье). Спектральный анализ подтвердил наличие длинноцепочечных алифатических углеводородов и функциональных групп, связанных с меламином и жирными кислотами, что указывает на формирование стабильного гидрофобного покрытия на поверхности ткани.

Ключевые слова: *гидрофобизатор, льняная ткань, парафин, меламин, ИК-Фурье спектроскопия, стандарты ГОСТ.*

Abstract. The present study explores the hydrophobization of linen fabric through treatment with a paraffin-based composition modified by stearic acid, oleic acid, and melamine. The hydrophobic formulation was prepared in an ethanol–water medium, and fabric samples were treated via impregnation followed by thermal curing. The performance of the treated textile was assessed in accordance with GOST 3816-81, GOST 12020-72, and GOST 9733.4-83 standards. The results demonstrated significant resistance to water penetration under pressure, efficient droplet repellency, and preservation of hydrophobic properties after washing cycles. The chemical structure of the formed hydrophobic layer was characterized using Fourier-transform infrared (FT-IR) spectroscopy. Spectral analysis confirmed the presence of long-chain aliphatic hydrocarbons and functional groups associated with melamine and fatty acids, indicating the formation of a stable hydrophobic coating on the fabric surface.

Keywords: *hydrophobizer, linen fabric, paraffin, melamine, FT-IR spectroscopy, GOST standards.*

Introduction

Enhancing the service performance of textile materials remains a key objective in materials science and applied chemistry. Linen and cotton-based fabrics exhibit high hygroscopicity due to the abundance of hydroxyl groups in cellulose fibers, which leads to rapid moisture absorption. This property, while advantageous in some applications, reduces durability and limits their functional use in moisture-prone environments. Therefore, imparting water-repellent characteristics to cellulosic textiles through hydrophobization is of considerable scientific and practical importance.

Literature Review

Conventional hydrophobization technologies primarily employ fluorinated compounds, organosilicon polymers, and synthetic resins. Although these systems demonstrate high effectiveness, their industrial application is often restricted by elevated cost, technological complexity, and potential environmental concerns.

Consequently, increasing attention is being directed toward the development of cost-effective, easily synthesized, and relatively environmentally benign hydrophobic formulation [1-5].

Paraffin and long-chain fatty acids such as stearic and oleic acids possess extended aliphatic hydrocarbon chains that exhibit minimal interaction with water molecules, thereby providing inherent hydrophobicity. Coatings derived from such compounds can create a water-repellent barrier on textile surfaces. However, paraffin-based layers typically suffer from insufficient adhesion to cellulose fibers and partial loss during laundering [6-10].

To enhance the fixation of the hydrophobic layer within the fiber structure, nitrogen-containing compounds may be incorporated into the formulation. Melamine contains multiple amino groups capable of forming hydrogen bonds with hydroxyl groups of cellulose. This interaction contributes to improved interfacial adhesion and structural stabilization of the hydrophobic coating. Additionally, melamine may act as a crosslinking or bridging agent between the hydrophobic components and the textile substrate, improving washing durability [11-17].

The effectiveness of hydrophobization was evaluated using standardized textile testing methods, including GOST 3816-81 for water impermeability, GOST 12020-72 for surface water repellency, and GOST 9733.4-83 for retention of properties after laundering. In addition, Fourier-transform infrared spectroscopy (FT-IR) was employed to verify the chemical nature of the deposited hydrophobic layer.

The objective of this research was to develop a stable and efficient hydrophobic coating for linen fabric by modifying a paraffin–fatty acid system with melamine and to comprehensively evaluate its performance using standardized testing methods and FT-IR analysis.

Research Methodology

Materials

- Paraffin – 5.0 g
- Stearic acid – 1.0 g
- Oleic acid – 1.0 mL
- Melamine – 1.0 g
- Ethanol (96%) – 50 mL
- Distilled water
- Linen fabric sample

Preparation of the Hydrophobic Formulation

Fifty milliliters of ethanol were placed in a laboratory beaker and heated in a water bath to 60–70 °C. Paraffin (5.0 g) was added to the heated ethanol and stirred continuously until complete dissolution. Subsequently, stearic acid (1.0 g) and oleic

acid (1.0 mL) were introduced sequentially, and the mixture was maintained at 70 °C under constant stirring for 10 minutes.

In a separate vessel, melamine (1.0 g) was dispersed in 10 mL of distilled water heated to 60 °C to obtain a suspension. This suspension was then added to the primary solution and stirred for an additional 5 minutes to ensure uniform distribution.

Hydrophobization Procedure

Pre-cleaned and dried linen fabric samples were immersed in the prepared hydrophobic solution for 2–3 minutes to ensure complete impregnation. After removal, excess liquid was allowed to drain. The samples were then dried and thermally cured in an oven at 105–110 °C for 15 minutes.

Analysis and Results

FT-IR Spectroscopic Analysis. Infrared spectroscopy was applied to confirm the chemical composition of the treated fabric surface and the presence of the hydrophobic layer. Absorption bands observed in the 2970–2920 cm^{-1} region correspond to C–H stretching vibrations of long-chain aliphatic hydrocarbons, characteristic of paraffin and fatty acids. These groups are responsible for the water-repellent behavior of the modified textile. Bands detected near 1700–1650 cm^{-1} are attributed to C=O stretching vibrations of carboxyl groups, confirming the presence of fatty acid components and their interaction with the cellulose matrix. Additional peaks in the 1620–1550 cm^{-1} region correspond to C=N and N–H vibrations associated with melamine. The appearance of these bands indicates the participation of melamine in stabilizing and reinforcing the hydrophobic layer on the fiber surface.

Absorption bands observed in the 730–720 cm^{-1} region are characteristic of rocking vibrations of long-chain $(CH_2)_n$ groups. The presence of these bands indicates the formation of a paraffin-like crystalline structure within the coating. Such structural organization is closely associated with enhanced stability of the hydrophobic layer and improved water-repellent performance.

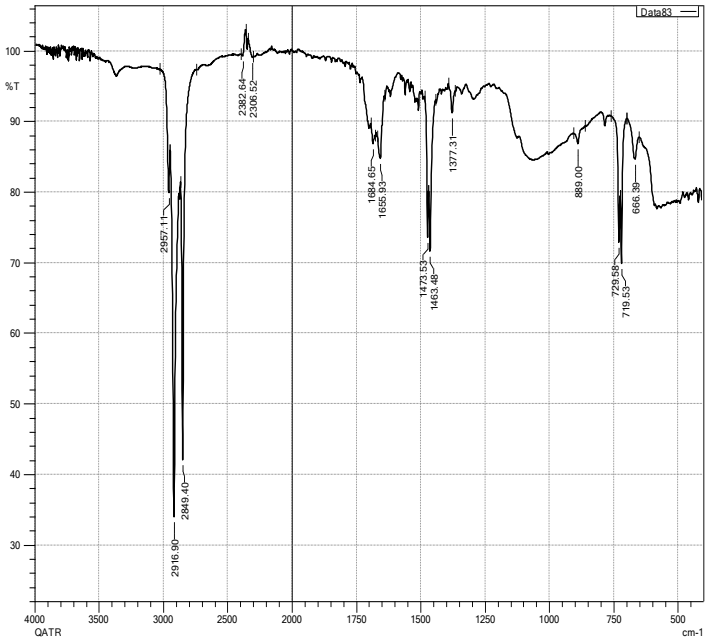

Figure 1. FT-IR spectrum of the synthesized paraffin-based hydrophobizer modified with fatty acids and melamine.

Table 1. FTIR Spectral Characteristics of Hydrophobized Fabric.

Wavenumber (cm^{-1})	Absorption Intensity	Assignment
2970–2920	Strong	$–CH_3$ and $–CH_2$ asymmetric stretching vibrations (long alkyl chains)
2850	Medium	Aliphatic C–H symmetric stretching vibration
1700–1650	Medium	C=O stretching vibrations (fatty acids, ester groups if present)
1620–1550	Medium	C=N and N–H deformation vibrations (if melamine-based modifier is used)
1470–1440	Medium	$–CH_2$ deformation vibrations
1375	Medium	$–CH_3$ symmetric deformation
890	Weak	=C–H out-of-plane vibration (unsaturated bonds)
730–720	Distinct	$(CH_2)_n$ rocking vibrations (long aliphatic chains)

The FT-IR analysis confirmed that the surface of the treated linen fabric is covered with a hydrophobic layer formed primarily by paraffin and fatty acids. Furthermore, the spectral features attributed to melamine suggest its participation in strengthening the interaction between the hydrophobic phase and the cellulose fibers. The incorporation of melamine contributed to improved fixation of the coating within the fiber structure.

The infrared spectral data are in good agreement with the results obtained from standardized performance testing. The high level of water impermeability and efficient droplet repellency observed experimentally correlate well with the presence of long-chain hydrophobic components identified in the FT-IR spectra.

The functional properties of the treated fabrics — including resistance to water pressure, surface water repellency, and durability after washing — were evaluated in accordance with GOST 3816-81, GOST 12020-72, and GOST 9733.4-83. The experimental results are summarized in Tables 2–4.

Table 2. Water Pressure Resistance of Fabric Samples.

Sample	Water Pressure, mm
Control cotton fabric	45 ± 3
Paraffin-treated	180 ± 5
Paraffin + fatty acids	260 ± 7
Paraffin + fatty acids + melamine	410 ± 10

The results demonstrate that the addition of melamine significantly increases water pressure resistance, indicating improved hydrophobic performance and enhanced barrier properties of the treated fabric.

Table 3. Water Droplet Resistance of Fabric Samples.

Sample	Absorption Time, s	Evaluation
Control	3–5	Unsatisfactory
Paraffin-treated	40–60	Satisfactory
Paraffin + fatty acids	120–150	Good
Paraffin + fatty acids + melamine	>300	Excellent

The prolonged resistance to water droplet absorption confirms the high hydrophobicity of the treated fabric, especially in the sample modified with paraffin, fatty acids, and melamine.

Table 4. Hydrophobic Properties After Washing.

Number of Wash Cycles	Water Pressure, mm	Water Droplet Absorption Time, s
0	410	>300
5 times	360	220
10 times	310	160

The results indicate that although hydrophobic properties slightly decrease after repeated washing, the fabric retains significant water resistance even after 10 washing cycles, demonstrating good durability of the hydrophobic treatment. A substantial portion of the hydrophobic performance was retained even after repeated washing cycles, indicating satisfactory durability of the applied coating. The obtained results demonstrate that paraffin and fatty acids form a continuous hydrophobic layer on the surface of the textile fibers. Melamine plays a crucial role by promoting additional intermolecular interactions with cellulose, thereby enhancing adhesion between the hydrophobic phase and the fiber matrix. During thermal treatment, the hydrophobic components become more firmly anchored within the fiber structure, contributing to the long-term stability of the coating.

Conclusion

The paraffin-based hydrophobic formulation modified with melamine provides effective hydrophobization of linen fabric. Performance evaluation conducted in accordance with GOST 3816-81, GOST 12020-72, and GOST 9733.4-83 confirmed high water impermeability, efficient droplet repellency, and satisfactory resistance to washing.

The proposed approach represents a technically feasible and practically applicable method for improving the water-repellent properties of cellulosic textiles. Owing to the relatively simple preparation procedure and the use of accessible components, the developed system may be considered a promising alternative to more complex and costly commercial hydrophobization technologies.

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UDC: 911.3:338.48(575.1)

USE OF RECREATIONAL RESOURCES IN THE FERGANA VALLEY REGIONS EFFICIENCY IMPROVEMENT ISSUES

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Annotatsiya. Maqolada Farg‘ona vodiysi viloyatlari (Andijon, Farg‘ona, Namangan)da rekreatsion resurslardan foydalanishning hozirgi holati, ularning hududiy nomutanosibliklari va iqtisodiy samaradorligi tahlil qilingan. 2015–2024 yillardagi statistik ma’lumotlar asosida rekreatsiya va turizm infratuzilmasi rivojlanish dinamikasi, uning bandlik va xizmatlar hajmiga ta’siri baholangan. Iqtisodiy-geografik yondashuv ishlab chiqilgan va rekreatsion resurslardan foydalanish samaradorligini oshirish bo‘yicha amaliy takliflar berilgan.

Kalit so‘zlar: *rekreatsion resurslar, iqtisodiy samaradorlik, hududiy nomutanosiblik, turizm geografiyasi, Farg‘ona vodiysi.*

Аннотация. В статье анализируется современное состояние использования рекреационных ресурсов в областях Ферганской долины (Андижанская, Ферганская, Наманганская), их

территориальные диспропорции и экономическая эффективность. На основе статистических данных за 2015–2024 годы оценивается динамика развития рекреационно-туристической инфраструктуры, её влияние на занятость и объём услуг. Разработаны экономико-географический подход и практические предложения по повышению эффективности использования рекреационных ресурсов.

Ключевые слова: *рекреационные ресурсы, экономическая эффективность, территориальная неравномерность, география туризма, Ферганская долина.*

Abstract. The article analyzes the current state of use of recreational resources in the Fergana Valley regions (Andijan, Fergana, Namangan), their territorial disparities, and economic efficiency. Based on statistical data for 2015– 2024, the dynamics of development of recreation and tourism infrastructure, its impact on employment, and the volume of services are assessed. An economic-geographic approach and practical proposals are developed to increase the efficiency of the use of recreational resources.

Keywords: *recreational resources, economic efficiency, territorial inequality, tourism geography, Fergana Valley.*

Introduction

In Uzbekistan, the tourism and recreation sector is emerging as one of the priority sectors of the national economy. However, the level of use of recreational resources varies significantly across regions. In particular, the economic potential of existing natural and cultural recreational resources in the densely populated Fergana Valley has not been fully utilized. The potential and prospects of recreational resources in the Fergana Valley regions were studied using dynamic analysis of official statistical data - economic-geographical assessment methods. The territorial location of recreational resources in the Fergana Valley regions is unique in terms of natural and geographical features, and the combination of foothill and valley areas creates favorable conditions for the development of recreation.

Uzbekistan experienced a prolonged drought and rainfall deficit in the fall of 2025 — some regions received 50–80% less rainfall than normal. During this period, Tashkent experienced episodes of very severe air pollution [IQAir].

PM2.5 peaks and smog episodes occurred in the Fergana Valley, particularly in Fergana city, due to topographic closure and air quality. Extreme AQI limits were recorded.

Table 1. Air and drinking water quality in cities of the Fergana Valley regions—the impact of climate change on public health.

Category	2019–2024 (average situation)	Situation in the fall of 2025 (ecological shock) period)	Additional number of patients
PM2.5 average level — Fergana Valley cities# (µg/m³)	~16–30 (to the city) looking)	5–10 times WHO on extreme days above the norm; dust and smog episodes	—

Breathing diseases (ARI, bronchitis, asthma)	Seasonal increase (autumn–spring)	Appeals during PM2.5 peaks sharply increased	18–25 thousand person
Cardiovascular diseases exacerbation	Stable seasonal background	Increased risk associated with air pollution	6–9 thousand people
Water related diseases (diarrhea etc.)	Water in the sense of problems there is	Drought and increased sanitary risks	12–18 thousand person
Work ability temporarily loss	Default level	Increase due to respiratory and infectious diseases	30–40 thousand person/day
Health care addition to the system loading	Normal mode	Hospitalization and outpatient referrals increased	+250– per year 300 billion soums eq.

#The indicators were calculated based on data from monitoring stations located in the cities of Andijan, Fergana, and Namangan.

Due to the above situation, certain diseases are more frequently observed:

- acute respiratory diseases (ARI, bronchitis, asthma) - warned by PM2.5 and high dust concentrations;
- exacerbation of cardiovascular diseases - the risk associated with air pollution increases;
- water-borne infections (diarrhea) - the risk has increased in rural and urban areas as water supplies have weakened;

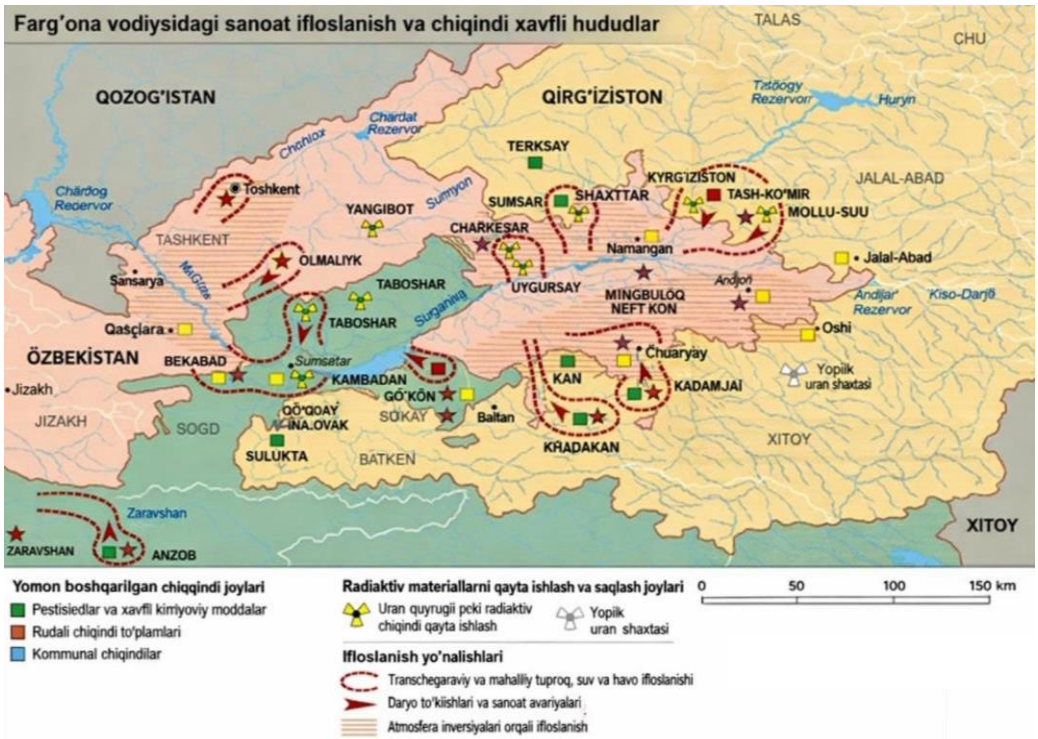

Figure 1. Map diagram of the release of pollutants through air, water, and soil in the Fergana Valley distribution directions.

The map above shows the areas of industrial pollution and waste accumulation in the Fergana Valley, as well as the routes of spread of pollutants through air, water, and soil.

As a result of the listed reasons, it can be noted that respiratory (respiratory tract) and allergy rehabilitation centers are experiencing an increased need for a number of types of sanatoriums due to the increase in ARI, bronchitis, and asthma referrals as a result of autumn dust and PM2.5 peaks, according to which: direct air-distance therapy, inhalations, thyroid and allergist examinations, interior with structural filtration (HEPA); branches in city centers and stagnant zones; cardiological monitoring, stress management, physiotherapy, rehabilitation; Increased levels of air pollution can increase the risk of respiratory diseases and lead to an increase in hospitalizations. In this context, the importance of sanatorium services aimed at prevention and rehabilitation is increasing.

The Fergana Valley has promising thermal and mineral water sources, which are distinguished by their healing and therapeutic properties. These resources are an important natural and geographical basis for the development of balneological sanatoriums: mineral and sand baths; hydro kinesiotherapy; physiotherapy treatments.

These resources are considered effective natural factors for rheumatological, dermatological, and rehabilitation treatments: scientifically tested clay samples; laboratory control; complex physiotherapeutic procedures.

Due to the different microclimate conditions in the Fergana Valley and foothills, there is a growing demand for boarding houses and health camps specializing in climatotherapy. This area is considered effective in the prevention of stress and respiratory diseases.

It is advisable to organize mobile medical and sanatorium services in urban and rural areas with high population density but limited transport connections. This model allows for rapid monitoring and preventive medical care in cases of episodic smog. The Shohimardon and Vodil regions in the Fergana region, the Chortoq mineral water sources in the Namangan region, and the foothill recreation areas in the Andijan region are of great importance. At the same time, the main part of recreational facilities is located in the foothills, and there are relatively few in the central parts of the valley.

Although the Namangan region is among the regions with high recreational potential, statistical indicators show that its economic performance is lower than that of the Fergana region. Below is a comparative analysis of key indicators for 2018–2024 (see Table 2).

The dynamics of 2018–2024 show a steady expansion of the recreation sector in the Fergana Valley regions. The highest growth rates were recorded in the Fergana region, where the number of facilities increased from 280 to 410 (+130, 146.4%).

The volume of tourist services in this region also grew at the highest rate (2.2 times), and employment in the sector expanded by 58.3%. In the Namangan region, growth was relatively balanced, with a 36.8% increase in the number of facilities and a 37.5% increase in employment. Regional development is mainly associated with domestic tourism and natural recreation resources.

Although the number of facilities and employment growth in the Andijan region have positive dynamics, the volume of services per tourist remains relatively low.

This indicates the need to diversify and improve the quality of recreational services in the region. The Fergana Valley is one of the most densely populated regions of

Uzbekistan. Andijan region occupies a leading position in terms of population density in this region. According to 2024 data, the population density per km² in the Andijan region is approximately 1.3 times higher than in the Namangan region.

Table 2. Some indicators of the recreation sector in the Fergana Valley regions (2018–2024).

Indicator	**Fergana region**	**Namangan region**	**Andijan region**
Recreation and tourism number of objects, units	280 (2018) → 410(2024) 170 → 230	190 → 260	170 → 230
Absolute growth, unity	+ 130	+ 70	+ 60
Growth rate, %	146.4%	136.8%	135.3%
Growth in the volume of tourist services, times	2.2	1.6	1.5
Sector employment, thousand persons	24 → 38	16 → 22	14 → 20
Absolute employment growth, thousand people	+ 14	+ 6	+ 6
Employment growth rate, %	158.3%	137.5%	142.8%
Right for a tourist volume of incoming services	High	Medium	Medium–low
Regional specialization trend	Diversified	Climate + domestic tourism	Short-term recreation
Development drivers	Tourism clusters	Ecotourism resources	Demographic demand
Main restrictions	Environmental impact	Infrastructure density	Natural resources are limited.

Compiled by the author based on data from the State Statistics Committee of the Republic of Uzbekistan and regional tourism departments.

At the same time, an assessment of the efficiency of the recreation sector in relation to the population shows that relatively high economic results are observed in the Andijan region. In particular, the added value created in the recreation sector per 1 thousand inhabitants is approximately 1.5 times higher in Andijan than in Namangan. This indicates that the factors of management efficiency and territorial organization, rather than natural resources, are of decisive importance in the development of the recreation system. The data in Table 1.2 show that there is a significant difference between the regions in terms of the number of recreation facilities and employment indicators. Fergana region is the leader in terms of the number of facilities and the volume of services, while Namangan region has a balanced growth, and Andijan region has a predominance of demand factors.

Calculations show that if the economic efficiency of the recreation sector in the Namangan region is brought closer to the level of the Andijan region:

- an increase in the volume of tourist services by 1.4–1.6 times,
- additional revenue of 400–450 billion sums to the regional economy,

– 8-10 thousand new jobs can be created in the recreation sector. These assessments show that the efficiency of using recreational potential in the

The Namangan region is insufficient, and this situation is causing not only local but also regional economic losses. Instead of developing recreation facilities separately in the Namangan region, it is advisable to form regional clusters based on the "sanatorium - service - transport - local market" system.

While the proximity of facilities to urban centers in the Andijan region ensures stable demand, some recreational areas in Namangan are not sufficiently connected in terms of transport. Therefore, it is necessary to develop infrastructure connecting the foothill zones with regional centers.

The priority criteria for the placement of public-private partnership projects should be economic return and demand indicators, rather than the availability of natural resources. The development of interregional tourist routes and unified service packages can integrate the resources of the Namangan region with the market opportunities of Andijan.

The analysis showed the following limiting factors:

- territorial unevenness of recreational infrastructure;
- increased environmental load in foothill areas;
- regional differences in attracting investment;
- differentiation of service quality.

These factors limit the efficiency of recreational resource use. Although recreational resources in the Fergana Valley regions have great economic potential, the data in Table 1.2 and statistical analysis show that the efficiency of their use is formed differently across regions. In particular, in the Namangan region, there is a gap between available resources and economic results. The economic efficiency of the recreation sector can be increased by improving the infrastructure. The proposed measures, if implemented, will have a positive impact on the socio-economic development of the region.

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UDC: 72.03(540)

HISTORY OF CONSTRUCTION AND DECORATION OF TAJ MAHAL COMPLEX

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Annotatsiya. Ushbu maqolada Tojmahal majmuasini buyuk san'at darajada qurilganligi, uning shakli, rangi, o'simliklari, me'moriy qismlari va uning xar bir bezaklarining mantiqiy yechim xamda majmuadagi qismlarining ramziy ma'nolari, mo'jizaviy me'moriy majmuasi xaqida bayon etiladi.

Kalit so'zlar: *Tojmahal, kolorit, masjid, mehmonxona, simmetrik, an'analar, astronomik qismlar, epigrafika, peshtoq, guldasta, arxitektura, g'oya, rabot, ramz, timsol, naqsh, xona, ilohiy, moviy rang, mantiq, geometrik bezak.*

Аннотация. В данной статье описывается грандиозное художественное сооружение комплекса Тадж-Махал, его форма, цветовая гамма, растительность, архитектурные элементы и логическое решение каждого из его украшений, а также символическое значение частей комплекса и его удивительного архитектурного великолепия.

Ключевые слова: *Тадж-Махал, цвет, мечеть, отель, симметричный, традиция, астрономические части, эпиграфический, пештоқ, букет, архитектура, идея, работ, символ, эмблема, узор, комната, божественный, синий цвет, логика, геометрический орнамент.*

Abstract. This article describes the Taj Mahal complex's great artistic construction, its shape, color, vegetation, architectural elements, and the logical solution of each of its decorations, as well as the symbolic meanings of the parts of the complex and its miraculous architecture.

Keywords: *Taj Mahal, color, mosque, hotel, symmetrical, tradition, astronomical parts, epigraphic, peshtoq, bouquet, architecture, idea, Rabot, symbol, emblem, pattern, room, divine, blue color, logic, geometric decoration.*

Introduction

In history, it has been a tradition to represent certain material monuments with a certain symbol, because the relationship of man to the sky was reflected in the parts of architectural monuments and their decorations. For example: "Amon Ra" in Egypt, "Stonehenge" in England, ziggurats in the West and East, mounds in Central Asia, pyramids in the Middle East. The color and appearance of these monuments are

consistent with mythological concepts, and in a way based on traditions, they also acquired a certain astronomical meaning.

Literature review

In the history of the science of catastrophe, the Sabians made seven ihrams for the seven heavenly lights. Each ihram had its own shape and color. For example: Jupiter's shrine – triangular in shape, made of green stones; Ehrome of Mars – an oblong rectangle, painted in red; Solar prostration – square shape, golden; Ehrome of Venus – an oblong triangle, havorang. Ehrum of Mercury is a hexagonal shape with a square inside; Moon Ahromsi – octagonal, silver; Saturin Ehram is a hexagonal structure made of black stones [1].

The famous Danish astronomer T. Brahe built the Uraniborg Observatory in the form of a square on his estate on the island of Ven and planned it to depict and simulate the universe as it was imagined at the beginning of the new century. Brahe was an opponent of the Copernican system and defended more conservative views on the structure of the universe.

Here we will analyze the astronomical parts of the Taj Mahal complex, an architectural monument of the Mughal dynasty in India, and its astronomical decorations.

The Taj Mahal is an architectural monument of the Mughal dynasty in India (1631–52). It was built on the banks of the Yamuna River near the city of Agra by Shah Jahan in memory of his beloved wife Arjumand (known as Mumtaz Mahal Begum, Mumtaz Bibika Rauza) after his death (July 7, 1631). He was later buried here. It combines elements of Islamic, Indian, and Persian architectural styles [2].

Figure 1. Digital camera image of the Taj Mahal.

The mausoleum (designed by Usta Ahmed Lohari) was built under the leadership of the Turkish architect Muhammad Isakhan Effendi. The Taj Mahal is a 3-story, 5-domed, marble structure. It is built on a marble base (104×104×7m). The slender minarets at the four corners (45 meters high) give the mausoleum a special beauty (Figure 2). The walls are covered with white marble and are decorated with intricate carvings of various precious stones (agate, pearl, mother-of-pearl, amber, emerald, ruby, ivory, etc.). The main entrance (56.7 meters wide) has a porch. In front of the mausoleum are two rows of trees, a pond with a fountain, and a long path lined with flowers.

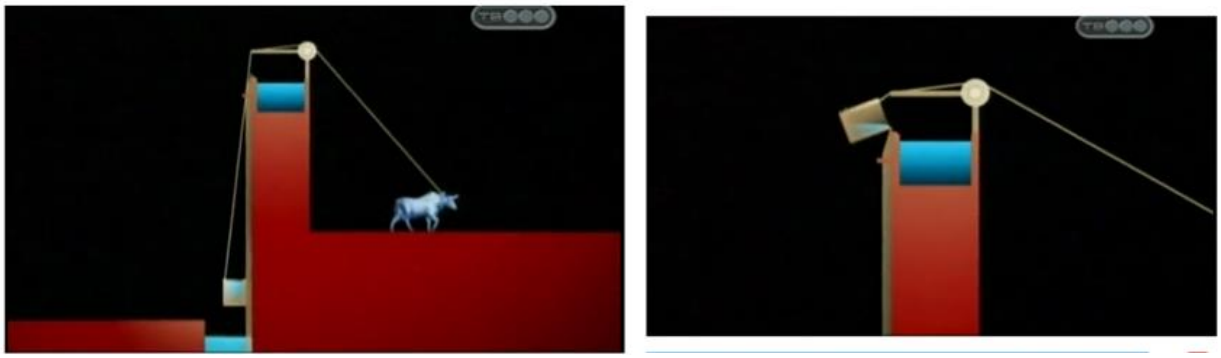

Figure 2. Fountains were a special structure built to provide water to the Garden of Eden. Oxen were used to carry the water up to the top [3].

The mausoleum is entered through a carved door, which is accessed by a staircase up a marble platform. The large central domed chamber houses a black marble sagana (imported from Sri Lanka). The Taj Mahal's unparalleled beauty is clearly visible through the garden's Paradise Gate [4]. The construction of this magnificent building reflects the unique styles of architects not only from India, but also from Central Asia, Iran, and Byzantium. The mausoleum was built by the bricklayer Muhammad Sayyid from Kandahar, the local master of the minaret Ismail Khan Rumi, Muhammad Sharif from Samarkand, the Kazim Khans from Lahore, and many painters and calligraphers, including the painters Ata Muhammad and Shukur from Bukhara [5]. Building materials were brought here from all over India, and even from neighboring Asian countries, so more than a thousand elephants were used to transport them. More than 22,000 craftsmen from across the empire, as well as those from Central Asia, Persia, and the Middle East, were invited to build the complex [6].

Research Methodology

This study employed a qualitative approach integrating art historical analysis, visual documentation, and iconographic interpretation to investigate the architectural and symbolic elements of the Taj Mahal complex. High-resolution photography documented architectural features, decorative elements, marble inlay work, and chromatic variations at different times of day. Historical analysis examined Mughal-era texts, construction records, and biographical accounts of architects and craftsmen from Central Asia, Persia, and India. Comparative analysis positioned the monument within Islamic funerary traditions, Persian garden design, and astronomical symbolism found in structures such as Sabian shrines and Tycho Brahe's Uraniborg. Interpretation focused on architectural forms as carriers of symbolic meaning, color symbolism in marble transformations, and historical contextualization within seventeenth-century Mughal artistic traditions. Primary data included on-site documentation, while secondary sources comprised scholarly publications on Mughal architecture and Islamic art. Limitations include restricted site access and the interpretive nature of symbolic analysis. This methodology enabled systematic investigation of the Taj Mahal's artistic construction and symbolic meanings.

Analysis and Results

Nearby is a garden with a fountain. It was called the Garden of Eden. Why did the water in the fountains rise? Because there was no electricity at that time. A tall building was built, a water reservoir was built in it, and water was lifted with the help of oxen and poured into the reservoir through a ditch. Water pressure was created at the top, and the gardens were supplied with water from the fountains. In order for the water to be sprayed from the fountains at a certain height, a simple device that creates water pressure was installed under a standing pipe, and then pressure was created at a certain level. As a result, water was sprayed from the fountains at a certain level. This mechanism can be seen in the photo. The walls are covered with transparent marble, which had to be brought here from afar. They are decorated with smooth stones. Therefore, the walls look snow-white during the day, pink at dawn, and silver on a clear night.

Construction of the building began on June 7, 1632 (according to other sources, in December 1631). Since the construction was carried out in stages, there are different points of view on the completion of the Taj Mahal [7].

The entire complex was built over a period of 22 years, but the construction of the central mausoleum was completed in 1648 (according to other sources, in 1643), and the construction of the remaining structures was completed after 5 years. The entire complex consists of five separate buildings:

1. Gate (the main gate of the shrine).
2. Bagheycha (the garden surrounding the buildings).
3. Mosque.
4. Rest house.

Conclusion

In summary, the Taj Mahal complex was built at the level of Great Art, its shape, color, plants, architectural elements, and each of its decorations have their own logical solution. Its symbolic meaning in this complex has not yet been sufficiently studied, the miraculous architectural complex is waiting for its solution.

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UDC: 72.01

WISDOM HIDDEN IN THE SYMBOLS OF ARCHITECTURE

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Annotatsiya. Ushbu ishda geometrik naqshlarning arxitekturadagi ramziy ifodasi va ularning semantik ahamiyati yoritilgan. Geometrik shakllar — doira, kvadrat, ko‘pburchak va yulduzsimon kompozitsiyalar — me’moriy bezaklarda ilohiy tartib, muvozanat va abadiylik g‘oyalarini ifodalaydi. Ayniqsa, islom arxitekturasida geometrik naqshlar ramz sifatida keng qo‘llanilib, binolarga nafaqat estetik, balki ma’naviy mazmun ham bag‘ishlaydi. Tadqiqot geometrik naqshlarni arxitekturani badiiy va falsafiy makon sifatida anglashda muhim vosita ekanini ko‘rsatadi.

Kalit so‘zlar: *Samarqand, minora, ramz, timsol, koshin, minorasimon inshootlar, mayoq, guldasta, burj, qafasa, mezana, qubba, sharafa, fonus, koinot, astronomik ramz, galaktika, yulduz, xarakat, ulug‘lik, spiral.*

Аннотация. Данная работа проливает свет на символическое выражение геометрических узоров в архитектуре и их семантическое значение. Геометрические фигуры — круги, квадраты, многоугольники и звездообразные композитсии — представляют идеи божественного порядка, равновесия и вечности в архитектурном декоре. В частности, геометрические узоры широко исползуются в качестве символов в исламской архитектуре, придавая зданиям не толко эстетический, но и духовный смысл. Исследование показывает, что геометрические узоры являются важным инструментом для понимания архитектуры как художественного и философского пространства.

Ключевые слова: *Самарканд, башня, символ, эмблема, плитка, башеннообразные сооружения, маяк, букет, созвездие, клетка, мезана, купол, чест, фонар, вселенная, астрономический символ, галактика, звезда, движение, величие, спирал.*

Abstract. This article sheds light on the essence of the concepts of symbol, icon, and semantics, as well as their role in culture, art, and especially architecture. Symbols and icons, as figurative expressions of human thought, serve to convey ideological, philosophical, and aesthetic meanings through space and form. Semantics is a scientific discipline that analyzes the content of these signs and forms, through which the hidden meanings, historical, and cultural context of architectural objects are revealed. The abstract considers the semantic interpretation of symbols and icons as an important theoretical basis for understanding the architectural environment.

Keywords: *Tower, symbol, emblem, tile, tower-like structures, lighthouse, bouquet, constellation, cage, mezana, dome, honor, lantern, universe, astronomical symbol, galaxy, star, movement, greatness, spiral.*

"The visible world is a shadow and symbolic reflection of the world of ideas"
Plato

Introduction

Symbols have been formed as an important spiritual and cultural tool in the process of human development. Through symbols, a person expressed his thoughts, beliefs, worldview, and relationships in society. Unlike a simple sign, they have a deep meaning, philosophical and spiritual content, and were formed and enriched during historical processes.

Literature Review

Currently, in the Republic of Uzbekistan, the problem of educating young people in a modern spirit, taking into account the centuries-old national and cultural values of our people, and training professionals with high human qualities is one of the urgent issues of the state. Today, a number of programs are being implemented in our republic aimed at the comprehensive development of our Motherland in accordance with the requirements of world standards. In particular, great importance is attached to the widespread use of culture, values, and examples of our world-famous national art created by our ancestors in the education of young people.

The art of Central Asia is famous throughout the world for its antiquity and uniqueness. The unique, deeply meaningful, and highly artistic cultural monuments created by our ancestors, in particular, the historical monuments of Samarkand, Bukhara, Khiva, Termez, Tashkent, Fergana, and other cities of our country, as well as examples of folk decorative arts, are among the unique masterpieces of world culture that tell the story of the great past of our people. The monuments that have stood on this land and the artifacts found in the underground layers testify to the rich cultural past of our people. In this regard, each person has created their own national symbols and emblems. They are especially important in the process of restoring national statehood, strengthening the foundations of society, and forming the principles of life inherent in a legal democratic state.

Taking into account that one symbol can have more than one different meaning, an attempt was made to delve deeper into the world of ancient symbols, referring to various sources, to see how this or that object, phenomenon, being, symbolism of abstract objects, looks in mythology and folklore, religion and iconography, astrology and alchemy, magic and magic, heraldry and emblematics, and how they are reflected in literature and fine arts, history, politics, military art and other types of human activity.

SIGN - an object, event, or action that is perceived materially and emotionally. In cognition, this action is manifested as signs or in other objects, properties, or relationships. The concept of a sign is analyzed in philosophy, logic, linguistics, psychology, and sociology - that is, it occupies an important place in all disciplines related to the study of human activity. Ancient philosophers (Plato, Aristotle, Stoics), 17^{th} -18^{th} century (Locke, Leibniz, Condillac) paid great attention to the role of signs in cognition. In the 19^{th} -20^{th} centuries, as a result of the development of linguistics and mathematical logic, a special science of signs - semiotics – emerged [1].

Research Methodology

This qualitative study employed theoretical analysis, literature review, and semiotic interpretation to investigate architectural symbolism. Philosophical and semiotic literature was examined from Plato to C.S. Peirce, tracing the evolution of sign theory. Scholarly sources on symbolism in mythology, religion, astrology, and heraldry were analyzed to understand multiple meanings of symbols. Case studies of architectural monuments including the Taj Mahal and Registan were examined to determine how symbols express historical memory, religious beliefs, and aesthetic values in architectural form and space.

Analysis and Results

SEMIOTICS (Greek semeiotikos - the doctrine of signs), semiology - a science that studies the general properties of signs and sign systems that serve to store and transmit information, data. It has an important methodological importance in the humanities. Semiotics deals with natural (human language, animal sign systems) and artificial (artificial languages, programming languages, systems of symbols in physics, chemistry, mathematics, and logic). The science of semiotics arose at the end of the 19th century. Its founder is the American logician C.S. Peirce. The achievements of semiotics are widely used in computerization, telemechanics, telecommunications, cellular telephone systems, space communication satellites, automatic control systems, and other areas. Since semiotics is related to human language and thinking, its philosophical aspects, in particular, heuristic, epistemological, axiological, and sociological aspects, are widely studied in modern philosophy [2].

A SYMBOL is a person or thing-event that represents or represents something or someone. Taking into account that one symbol can have more than one different meaning, an attempt was made to delve deeper into the world of ancient symbols, referring to various sources, to see how this or that object, phenomenon, being, symbolism of abstract objects, looks in mythology and folklore, religion and iconography, astrology and alchemy, magic and magic, heraldry and emblematics, how they are reflected in the design of elements of literature and architecture, in history, politics, military art and other types of human activity.

The emblem is concentrated in historical monuments, holy places, museums, and is of great importance in the educational process. Because the majestic places that embody the status, image, and symbols of the country have always been in the spotlight of everyone. Each famous city has its own unique architectural symbols that make it known to the world. For example, such sights as the Moscow Kremlin, the Eiffel Tower in Paris, the Pyramids of Giza in Egypt, the Taj Mahal in India, and the Registan in Uzbekistan can be cited.

In ancient times, the emblem had a very primitive meaning. For example, it was in the form of half of a broken bowl. When two friends or two brothers were parting ways, they divided the bowl between them. Thus, when necessary, it served to divide the necessary thing, depending on the whole bowl. Therefore, a symbol is a part of a whole in form, and in content, it is the integration of parts that have been divided into two or more parts. So, what is a symbol?

Symbol (Arabic - to point out) in fiction - a method of conventionally depicting events, objects, and concepts through objects and phenomena. For example, a lion is a symbol of courage, and a fox is a symbol of cunning. In the history of literature, there is a system of symbolic images that has been used for centuries: a flower is a symbol of beauty, a lover, a nightingale is a symbol of loyalty, an owl is a symbol of misfortune, yellow is a symbol of sadness, black is a symbol of mourning, an ant is a symbol of generosity, an ant is a symbol of humility, wisdom, etc.

The language of mysterious symbols and symbols is a valuable spiritual heritage of very ancient times, embodied in conditional signs based on various ideas, in which the wisdom of the people accumulated over thousands of years is hidden. Time, which has sunk powerful empires into the depths of history, has been powerless before human thought. Ancient symbols still surround us from all sides, but we sometimes do not notice them. Each symbol contains some coded information, but it is quite difficult to decipher it, even without a special key. The purpose of creating this encyclopedia is to help the curious reader find a suitable key to the language of ancient symbols. Symbols, although they consist of very small, colorful conditional signs, contain a lot of information, and moreover, one symbol can convey many meanings. Sometimes they are clear and obvious, since they are based on well-known qualities of a natural or artistic object, but in most cases their meaning is completely hidden, since they are built on incomprehensible allegory, personification, and phonetic associations of some ancient language.

Conclusion

The concepts of symbol, symbolism, and semantics in architecture show that architectural form and space have not only functional, but also ideological and spiritual content. The symbols and emblems used in architectural objects express the historical memory, religious beliefs, philosophical views, and aesthetic taste of society. Semantic analysis allows us to understand the meanings embodied in the form, decoration, and layout of architectural structures. Therefore, the conscious use of symbols and emblems increases the artistic value of a work of architecture, further enriches it as a cultural heritage, and strengthens the meaningful connection between man and space.

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UDC: 72.03(540)

THE PHILOSOPHY OF THE ESOTERIC SYMBOLS IN THE TAJ MAHAL DOME

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Annotatsiya. Maqolada, Xindistondagi Tojmaxal maqbarasining gumbazidagi ezotrik ramzlarni astronomik tahlil qilishi natijasida Shohjahon buyrug‘i bilan me’morlar Tojmahal maqbarasining asosiy gumbazini ongli ravishda nosimmetrik qilishgani orqali, o‘tkinchi dunyoda insonlarning xohishi bilan imkoniyati xech qachon mos kelmasligini ramzida ifodalanganligi ya’ni qisqa qilib aytganda “bir kam dunyo,” mukammallik Allohga hosdir degan islomiy xikmatga egaligi xaqida bayon etilgan.

Kalit so‘zlar: *Gumbaz, simmetrik, assimetriya,Tojmahal, kolorit, masjid, an’analar, astronomik qismlar, sferik sirt, peshtoq, arxitektura, g‘oya, ramz, timsol, naqsh, xona, ilohiy, moviy rang, mantiq, geometrik bezak.*

Аннотация. В статье говорится, что в результате астрономического анализа эзотерических символов на куполе Тадж-Махала в Индии архитекторы по приказу Шах-Джахана намеренно сделали главный купол Тадж-Махала асимметричным. Это символизирует то, что в загробной жизни желания и возможности людей никогда не совпадают, или, короче говоря, “маленький мир,” и объясняется, что в этом заключена исламская мудрость о том, что совершенство принадлежит Аллаху.

Ключевые слова: *Купол, симметричный, асимметрия, Тадж-Махал, цвет, мечеть, традиции, астрономические элементы, сферическая поверхность, купол, архитектура, идея, символ, эмблема, узор, помещение, божественный, синий цвет, логика, геометрическое оформление.*

Abstract. The article states that, as a result of astronomical analysis of the esoteric symbols on the dome of the Taj Mahal in India, the architects, by order of Shah Jahan, deliberately made the main dome of the Taj Mahal asymmetrical. This symbolizes that in the afterlife, people’s desires and capabilities never coincide, or in short, a “small world,” and is explained as embodying the Islamic wisdom that perfection belongs to Allah.

Keywords: *Dome, symmetrical, asymmetry, Taj Mahal, color, mosque, traditions, astronomical parts, spherical surface, dome, architecture, idea,*

symbol, emblem, pattern, room, divine, blue color, logic, geometric decoration.

Introduction

When it comes to the architecture and culture of the Eastern peoples, it is necessary to recognize that it is inextricably linked with the Islamic religion. In connection with the emergence of Islam as a world religion, a wide path was opened for science in Muslim countries. Because Islam showed great interest in science and enlightenment. The first revealed verse of the Holy Quran was “Iqra” - “Read”.

“Allah is beautiful, and He loves beauty.” In the Holy Quran. Therefore, the aesthetic point of view of Islam is to be familiar with beauty. If Allah is beautiful, then the man He created, the world He created, and the blessings He bestowed on His servants are also beautiful. Accordingly, our words that describe the names and attributes of Allah, our music, and our buildings that demonstrate His power - architectural monuments - should be beautiful; everything in this world that was created by the will, name, and attributes of Allah should be beautiful. They should make the mosques, cities, and other things that they have built beautiful and comfortable, and they should create a pleasant and beautiful place, and in it, they should have good human qualities such as decency and morality, justice and honesty, contentment and nobility, intelligence and insight [1].

Here we will dwell on the world of Islamic wisdom in the beauty and harmony of the Taj Mahal complex, an architectural monument of the Mughal dynasty in India. We will dwell on the scholar of wisdom in the dome of the Taj Mahal complex. What is a dome in architecture?

Literature Review

A dome is one of the main parts of architecture, a dome-shaped roof; a hemispherical roof of buildings and structures of circular, rectangular, polygonal and other shapes. In Central Asian architecture, it is mainly built of wood, mud brick, and baked brick. There are balkh, harkh, chortak, chorkunjak, mirzai, kulakhi, sholgami and other types of domes [2].

The dome also has a symbolic meaning, taking the form of a “sky dome” or “sky dome,” which indicates that a person lives under the sky and under the protection of the universe [3]. Therefore, a person understands that he is in close contact with the universe, feeling material, cultural, and spiritual protection. The dome has long symbolized the sky. Buddhist stupas of sacred significance, regardless of their size or size, have their upper part shaped like a dome. The dome was also compared to the universe in the Middle Ages [4].

According to scholars, the outer blue dome of the Sanjar Mausoleum, together with the eight-pointed star inside, undoubtedly symbolizes paradise [5]. The ancient desire to reach the cosmos among peoples is evidenced by concepts such as the “Tree of Life,” “Mountain of the World,” and the custom of venerating heights and hills. Mountains and hills were understood as the abodes of gods. Therefore, religious buildings were often built on natural or artificial hills. Such buildings include temples, ziggurats, stupas, minarets, and minarets.

The domes above the Taj Mahal are a symbol of greatness. The moon is a symbol of Islam, indicating that the person in the tomb was a Muslim. A pomegranate is depicted above the moon. In India, the pomegranate is a symbol of divine love. In India, the lotus is used as a symbol of divine beauty and spiritual purity. The dome symbolizes the universe. This tomb symbolizes the fact that a Muslim woman who has achieved divine beauty, that is, spiritual purity, lies in it.

Research Methodology

This study employed astronomical and iconographic analysis to investigate the deliberate asymmetry of the Taj Mahal's main dome and its symbolic significance within Islamic architectural tradition. The research was conducted through visual documentation and architectural measurement using high-resolution photography and existing technical drawings, building upon the 2018 findings of Indian archaeologist M.V. Rajani who documented a 90-centimeter asymmetry between the two sides of the dome through photographic evidence and computer-aided drawings. Historical and textual analysis examined primary sources related to Shah Jahan's architectural philosophy emphasizing symmetry, while contemporary accounts of the construction process involving master craftsmen from Central Asia, Persia, and India were reviewed to understand technical capabilities and intentional design choices. Symbolic and religious interpretation analyzed the dome within the broader context of Islamic cosmology and architectural iconography, examining traditional symbolism of domes as representations of the celestial sphere or "sky dome" in Islamic and pre-Islamic traditions, alongside Quranic concepts regarding worldly imperfection and divine perfection, with comparative analysis of other Islamic monuments including the Sanjar Mausoleum and Buddhist stupas. This methodological framework integrated geometric analysis of the dome's properties with hermeneutic interpretation of its symbolic message to conclude that the asymmetry was deliberately executed to embody the Islamic wisdom that perfection belongs solely to Allah while human existence in the temporal world is characterized by asymmetry between desires and capabilities.

Analysis and Results

World scientists, along with conducting scientific research on the Taj Mahal complexes, have studied how its main dome was built [6]. Foreign scientists have studied the construction techniques of the Taj Mahal dome by making a model of it from small bricks (Figures 1,2,3,4,5). Indian archaeologist M.V. Rajani studied the Taj Mahal dome in 2018 and found that the two sides of the dome are not the same. He proved this based on photographs and drawings in Figure 6 [7].

Archaeologist M.V. Rajani says that although the Taj Mahal dome (diameter 18 m) looks symmetrical from a distance, if you look closely, you will see that it is asymmetrical. The right and left sides of the dome are 90 cm apart. However, Shah Jahan loved symmetry very much. Because symmetry is beauty, Shah Jahan considered symmetry to be the criterion of beauty and promoted the philosophical idea that beauty should always be harmonious in the whole world. That is why Shah Jahan attached great importance to symmetry in architecture [8]. One wonders why the dome was built asymmetrically, even though the world's greatest masters worked on it. Shah Jahan,

firstly, did not use human figures in the construction and decoration of the Taj Mahal, and secondly, he strictly adhered to symmetry [9]. Scholar M.V. Rajani says that information about the Taj Mahal dome remains a mystery.

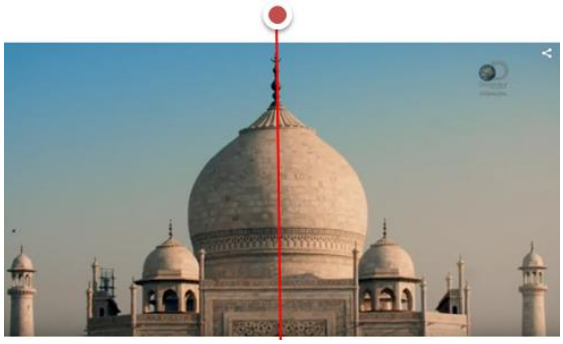

Figure 1. A view of the main dome of the Taj Mahal.

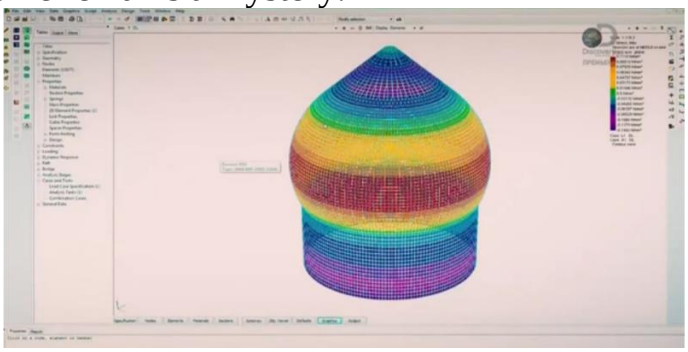

Figure 2. Foreign scientists studied the model of the Taj Mahal dome on a computer.

After the death of Shah Jahan's wife, he came to the conclusion that although everything in the world seems symmetrical, it is actually asymmetrical. A person living in this mortal world realizes that his desires and opportunities never coincide in life. With deep sorrow, realizing that this world is a small world, we believe that only the dome in the complex was built asymmetrically by the craftsmen. Although the dome appears to be completely symmetrical, it is noticeable that it is actually not symmetrical.

Figure 3. Foreign scientists studied the construction technique of the Taj Mahal dome by making a model of small bricks.

Figure 4. Indian archaeologist scientist M.V. Rajani was studying the dome's symmetrical position in 2018.

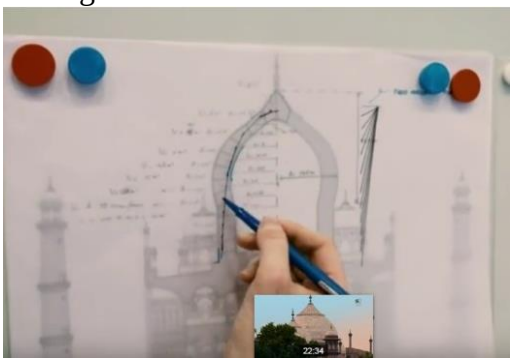

Figure 5. The state of the Taj Mahal dome was studied by foreign scientists in the drawing.

Figure 6. M.V. Rajani's drawing of Gumbaz's non-symmetrical state is almost 90 cm different on the computer.

Conclusion

As a result of astronomical analysis of the dome of the Taj Mahal mausoleum in India, by order of Shah Jahan, the architects deliberately made the main dome of the Taj Mahal mausoleum asymmetrical. This was due to the fact that it was revealed that this symbolizes the fact that in this mortal, i.e., transient world, people's desires and opportunities never coincide, that is, in short, "a little world," and that perfection belongs to Allah.

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UDC: 63, 631, 631.5

THE EFFECT OF DIFFERENT DESIGNS OF STUDDED–SLATTED DRUMS ON THE IMPURITY SEPARATION PROCESS

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Annotatsiya. Ushbu maqolada paxta tarkibidagi mayda ifloslikларni ajratish jarayoniga zirxli-barabanlarning turli konstruktiv parametrlarining ta’siri bo‘yicha o‘tkazilgan eksperimental tadqiqotlar natijalari keltirilgan. Barabanning umumiy diametri 400 mm saqlangan holda, ichki qobiq diametrlari (300, 270, 240 va 210 mm) hamda zirx uzunliklari (50, 65, 80 va 95 mm) o‘zgartirildi. Tajribalar I va III nav paxta uchun soatiga 3, 5 va 7 tonna ishlab chiqarish quvvatlarida o‘tkazildi. Natijalar shuni ko‘rsatdiki, zirx uzunligini oshirish va ichki qobiq diametrini kamaytirish paxtaning yumshash darajasini yaxshilaydi va chigitlarning mexanik shikastlanishini kamaytiradi. Eng maqbul ko‘rsatkichlar ichki diametr 240 mm va zirx uzunligi 80 mm bo‘lganida kuzatildi, bu minimal chigit shikastlanishi bilan yuqori tozalash samaradorligini ta’minladi. Taklif etilgan konstruktiv yaxshilanishlar paxta tozalash mashinalarining texnologik samaradorligini oshirishga va paxtani qayta ishlash sifatini yaxshilashga xizmat qiladi.

Kalit so‘zlar: *paxta-xom ashyo, mayda iflosliklar, tozalash jarayoni, zirxli-baraban, baraban diametri, zirx uzunligi, ichki qobiq, paxtani yumshatish, mexanik shikastlanish, chigit, ishlab chiqarish quvvati, tozalash samaradorligi, havo oqimi, laboratoriya tadqiqotlari, 1XK tozalagich.*

Аннотация. В статье приведены результаты экспериментальных исследований влияния различных конструктивных параметров колково-планчатых барабанов на процесс отделения мелких сорных примесей хлопка-сырца. При сохранении общего диаметра барабана 400 мм были изменены диаметр внутренней оболочки (300, 270, 240 и 210 мм) и длина колков (50, 65, 80 и 95 мм). Испытания проводились при производительности 3, 5 и 7 т/ч для хлопка I и III сортов. Полученные результаты показали, что увеличение длины колков и уменьшение диаметра внутренней оболочки способствуют повышению степени разрыхления хлопка и снижению механического повреждения семян. Наиболее оптимальные показатели достигнуты при диаметре 240 мм и длине колков 80 мм, что обеспечило высокую эффективность очистки при минимальном повреждении семян. Предложенные конструктивные решения позволяют повысить технологическую эффективность очистительных машин и улучшить качество переработки хлопка.

Ключевые слова. *хлопок-сырец, мелкие примеси, очистка, колково-планчатый барабан, диаметр барабана, длина колков, внутренняя оболочка, степень разрыхления, механические повреждения, семена хлопка, производительность, эффективность очистки, воздушный поток, лабораторные исследования, установка 1XK.*

Abstract. This article presents the results of experimental studies on the influence of different конструктив parameters of peg-and-plank drums on the process of separating fine impurities from raw cotton. While maintaining the overall drum diameter at 400 mm, the internal shell diameters (300, 270, 240, and 210 mm) and peg lengths (50, 65, 80, and 95 mm) were varied. The experiments were conducted at processing capacities of 3, 5, and 7 tons per hour using grade I and grade III cotton. The results demonstrated that increasing the peg length and reducing the internal shell diameter improved the degree of cotton loosening and reduced mechanical damage to the seeds. The optimal performance was observed at an internal diameter of 240 mm and a peg length of 80 mm, ensuring high cleaning efficiency with minimal seed damage. The proposed конструктив improvements contribute to enhancing the technological efficiency of cotton cleaning machines and improving the quality of cotton processing.

Keywords: *raw cotton, fine impurities, cleaning process, peg-and-plank drum, drum diameter, peg length, internal shell, cotton loosening,*

mechanical damage, cotton seeds, processing capacity, cleaning efficiency, airflow, laboratory research, 1XK cleaner.

Introduction

Numerous researchers have conducted studies on improving the studded drums of equipment used for cleaning cotton from fine impurities [1–2]. These studies examined the rotational speed, diameter, and various structural designs of studded–slatted drums, as well as the shape, length, and diameter of the studs, and the spacing between the studs and mesh surfaces or grate (grid) bars [3–4]. In particular, in the scientific research conducted by B.Ch. Pardayev [5], while maintaining the overall diameter of the multifaceted studded–slatted drum, the diameters of the drum linings differed from one another and increased sequentially (D1 < D2 < D3, …), whereas the stud lengths were varied from h1 to h2 and up to hn. In this case, the disk diameters were 300, 280, 260, 240, 220, and 200 mm, and the stud lengths were 50, 60, 70, 80, 90, and 100 mm, respectively. The spacing between two rows of studs was 176.625 mm, while the distance between the rows of studs and slats was 88.3125 mm. Thus, unlike conventional studded–slatted drums, the spacing between the rows of studs and slats was not uniform.

Literature Review

Production-scale experiments showed that the cleaning efficiency of the existing technology was 81.8%, whereas the technology equipped with the recommended multifaceted studded–slatted drums achieved 84.8%, resulting in a 3% increase in cleaning efficiency.

However, in the theoretical and practical studies conducted by this author, the effect of increasing the blade (stud) length on the impurity separation process was not investigated [6–7]. In addition, eight rows of studs were mounted on an octagonal lining, with equal spacing between the rows (the angle between stud rows was 45°). The drum consisted of four linings, each equipped with two rows of studs. Accordingly, the arrangement followed a sequence of two rows of studs, then slats, and again two rows of studs [8–10]. In the existing design of studded drums, the spacing between studs and slats was uniform, which ensured a consistent process flow.

Research Methodology

In order to study the effect of the structural parameters of a studded–slatted drum—while maintaining its overall diameter—namely, the height of the studs and slats on the impurity separation process, we conducted experimental research.

In our study, a circular studded–slatted drum with a diameter of 400 mm was used. The diameters of the lining on which the studs were mounted were 300 mm (existing variant), 270 mm, 240 mm, and 210 mm. The stud lengths were 50 mm (existing variant), 65 mm, 80 mm, and 95 mm.

Analysis and Results

The lining of the studded–slatted drums was manufactured from 2 mm thick sheet steel. Four linings were prepared for each drum, and they were installed with equal spacing, taking into account the slats. To produce a lining with a diameter of 270 mm,

a sheet measuring 322 mm in length and 300 mm in width was cut. Along the 322 mm side of the sheet, 55 mm was bent from each edge to form the slats. The sheet, bent 55 mm on both sides, was shaped into a circular quadrant with a radius of 135 mm using a stamping process.

After that, holes with a diameter of 12 mm were drilled at intervals of 30 mm on the bent surface to arrange two rows of studs in a staggered (checkerboard) pattern. Studs with a diameter of 12 mm and a protruding length of 65 mm from the lining surface were welded into the prepared holes. The linings equipped with studs were fastened together using bolts and nuts through holes made in the slats. The assembled linings were then securely mounted onto the shaft using a flange.

The studded–slatted drum has an overall diameter of 400 mm, with a lining diameter of 300 mm for mounting the studs, and a stud length of 50 mm (existing variant).

The studded–slatted drum has an overall diameter of 400 mm, a lining diameter of 270 mm for mounting the studs, and a stud length of 65 mm.

The studded–slatted drum has an overall diameter of 400 mm, a lining diameter of 240 mm for mounting the studs, and a stud length of 80 mm.

The studded–slatted drum has an overall diameter of 400 mm, a lining diameter of 210 mm for mounting the studs, and a stud length of 95 mm.

Figure 1. Schematic diagram and general view of different design variants of studded–slatted drums.

In the cleaning process, increasing the height of the studs and slats makes it possible to increase the thickness of the cotton flow and to enhance the airflow generated by the slats.

The schematic diagrams of different design variants of the studded–slatted drums are presented in Figure 1. The research results obtained from experiments conducted

with the cleaning machine equipped with the studied drum variants are presented in Tables 1–3 according to the machine productivity levels.

In the experiments, raw cotton of the Nam-77 selection variety was used, with a moisture content before cleaning of 8.11% and 8.6%, and impurity levels of 7.5% and 10.3%. In the initial experiments, all eight studded–slatted drums installed in the 1XK equipment were manufactured with identical designs corresponding to the research variant.

At a machine capacity of 3 tons/hour, with a studded–slatted drum overall diameter of 400 mm, an inner lining diameter of 300 mm, and a stud height of 50 mm, processing Grade I cotton resulted in a reduction of impurities to 4.55%, a cotton opening degree of 88.41%, and an increase in mechanical seed damage of 0.73%.

For Grade III cotton, the impurity reduction reached 5.96%, the cotton opening degree was 82.74%, and the increase in mechanical seed damage was 0.75%.

Table 1. Research results of studded–slatted drums in the improved cleaner (machine capacity: 3 tons/hour)

n/s	Indicators	Stud drum lining and stud height, mm							
		d=300; l=50		d=270; l=65		d=240; l=80		d=210; l=95	
		I Grade	III Grade	I Grade	III Grade	I Grade	III Grade	I Grade	III Grade
1.	Moisture content of cotton before cleaning, %	8,11	8,6	8,11	8,6	8,11	8,6	8,11	8,6
2.	Impurity content of cotton before cleaning, %	7,5	10,3	7,5	10,3	7,5	10,3	7,5	10,3
3.	Impurity content after cleaning, %	4,55	5,96	4,22	5,60	4,16	5,50	4,22	5,62
4.	Cotton opening degree after cleaning, %	88,41	82,74	95,76	91,98	97,86	93,45	95,34	91,77
5.	Increase in mechanical seed damage after cleaning, %	0,73	0,75	0,66	0,68	0,71	0,75	0,66	0,68

With a studded–slatted drum of 400 mm overall diameter, an inner lining diameter of 270 mm, and a stud height of 65 mm, processing Grade I raw cotton resulted in impurity reduction to 4.22%, a cotton opening degree of 95.76%, and an increase in mechanical seed damage of 0.66%. For Grade III cotton, impurity reduction reached 5.60%, the opening degree was 91.98%, and mechanical seed damage increased by 0.68%.

When the inner lining diameter of the studded–slatted drum was 240 mm and the stud height was 80 mm, processing Grade I cotton reduced impurities to 4.16%, increased the opening degree to 97.86%, and caused a 0.71% increase in mechanical seed damage. For Grade III cotton, impurity reduction reached 5.50%, the opening degree was 93.45%, and mechanical seed damage increased by 0.75%.

With an inner lining diameter of 210 mm and a stud height of 95 mm, processing Grade I cotton reduced impurities to 4.22%, achieved a cotton opening degree of 95.34%, and increased mechanical seed damage by 0.66%. For Grade III cotton, impurity reduction reached 5.62%, the opening degree was 91.77%, and mechanical seed damage increased by 0.68%.

As the stud length of the studded–slatted drum increases and the inner lining diameter decreases, a reduction in the increase of mechanical seed damage is observed. One of the main reasons for this is that the length of the slats also increases, leading to a stronger airflow generated by them. This enhanced airflow positively affects the movement of cotton as it is carried across the mesh surface by impact, and it accelerates the removal of separated impurities through the openings of the mesh surface.

Table 2. Research results of studded–slatted drums in the improved cleaner (machine capacity: 5 tons/hour).

n/s	Indicators	Stud drum lining and stud height, mm							
		d=300; l=50		d=270; l=65		d=240; l=80		d=210; l=95	
		I Grade	III Grade	I Grade	III Grade	I Grade	III Grade	I Grade	III Grade
1.	Moisture content of cotton before cleaning, %	8,11	8,6	8,11	8,6	8,11	8,6	8,11	8,6
2.	Impurity content of cotton before cleaning, %	7,5	10,3	7,5	10,3	7,5	10,3	7,5	10,3
3.	Impurity content after cleaning, %	4,70	6,20	4,34	5,76	4,26	5,63	4,33	5,78
4.	Cotton opening degree after cleaning, %	83,58	78,33	92,61	88,62	95,13	90,72	92,19	88,83
5.	Increase in mechanical seed damage after cleaning, %	0,75	0,76	0,63	0,66	0,69	0,72	0,68	0,70

At a cleaning machine capacity of 5 tons/hour, with a studded–slatted drum overall diameter of 400 mm, an inner lining diameter of 300 mm, and a stud height of 50 mm, processing Grade I raw cotton resulted in impurity reduction to 4.70%, a cotton opening degree of 83.58%, and an increase in mechanical seed damage of 0.75%. For Grade III cotton, impurity reduction reached 6.20%, the opening degree was 78.33%, and mechanical seed damage increased by 0.76%.

With an inner lining diameter of 270 mm and a stud height of 65 mm, processing Grade I cotton reduced impurities to 4.34%, increased the opening degree to 92.61%, and caused a 0.63% increase in mechanical seed damage. For Grade III cotton, impurity reduction reached 5.76%, the opening degree was 88.62%, and mechanical seed damage increased by 0.66%.

When the inner lining diameter was 240 mm and the stud height was 80 mm, processing Grade I cotton reduced impurities to 4.26%, achieved a cotton opening degree of 95.13%, and resulted in a 0.69% increase in mechanical seed damage. For Grade III cotton, impurity reduction reached 5.63%, the opening degree was 90.72%, and mechanical seed damage increased by 0.72%.

With an inner lining diameter of 210 mm and a stud height of 95 mm, processing Grade I cotton reduced impurities to 4.33%, achieved a cotton opening degree of 92.19%, and caused a 0.68% increase in mechanical seed damage. For Grade III cotton,

impurity reduction reached 5.78%, the opening degree was 88.83%, and mechanical seed damage increased by 0.68%.

At a cleaning machine capacity of 7 tons/hour, with a studded–slatted drum overall diameter of 400 mm, an inner lining diameter of 300 mm, and a stud height of 50 mm, processing Grade I raw cotton resulted in impurity reduction to 4.86%, a cotton opening degree of 79.59%, and an increase in mechanical seed damage of 0.77%.

For Grade III cotton under the same conditions, impurity reduction reached 6.40%, the opening degree was 73.92%, and mechanical seed damage increased by 0.83%.

With the same overall drum diameter (400 mm), but an inner lining diameter of 270 mm and a stud height of 65 mm, processing Grade I cotton reduced impurities to 4.38%, increased the opening degree to 90.93%, and limited the increase in mechanical seed damage to 0.62%.

Table 3. Research results of studded–slatted drums in the improved cleaner (machine capacity: 7 tons/hour)

n/s	Indicators	Stud drum lining and stud height, mm							
		d=300; l=50		d=270; l=65		d=240; l=80		d=210; l=95	
		I Grade	III Grade	I Grade	III Grade	I Grade	III Grade	I Grade	III Grade
1.	Moisture content of cotton before cleaning, %	8,11	8,6	8,11	8,6	8,11	8,6	8,11	8,6
2.	Impurity content of cotton before cleaning, %	7,5	10,3	7,5	10,3	7,5	10,3	7,5	10,3
3.	Impurity content after cleaning, %	4,86	6,40	4,38	5,84	4,31	5,72	4,38	5,85
4.	Cotton opening degree after cleaning, %	79,59	73,92	90,93	87,36	93,45	89,25	90,72	87,36
5.	Increase in mechanical seed damage after cleaning, %	0,77	0,83	0,62	0,69	0,64	0,67	0,67	0,69

For Grade III cotton, impurity reduction reached 5.84%, the opening degree was 87.36%, and mechanical seed damage increased by 0.69%.

With a studded–slatted drum inner lining diameter of 240 mm and a stud height of 80 mm, processing Grade I raw cotton resulted in impurity reduction to 4.31%, a cotton opening degree of 93.45%, and an increase in mechanical seed damage of 0.64%. For Grade III cotton, impurity reduction reached 5.72%, the opening degree was 89.25%, and mechanical seed damage increased by 0.67%.

With an inner lining diameter of 210 mm and a stud height of 95 mm, processing Grade I cotton reduced impurities to 4.38%, achieved a cotton opening degree of 90.72%, and caused a 0.67% increase in mechanical seed damage. For Grade III cotton,

impurity reduction reached 5.85%, the opening degree was 87.36%, and mechanical seed damage increased by 0.69%.

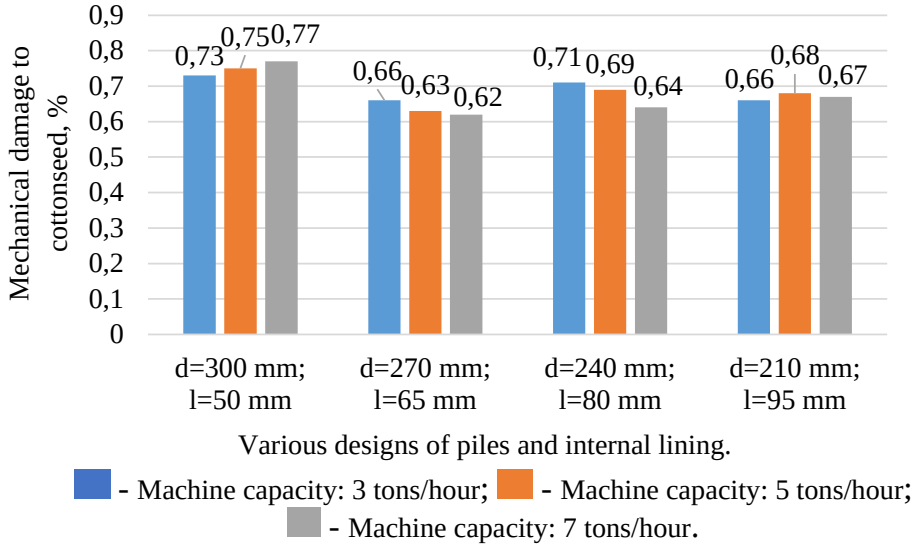

Figure 2. Histogram of changes in mechanical seed damage for studded–slatted drums of different designs.

As the machine productivity increases, the mechanical damage to seeds after cleaning reaches 0.2% with the conventional studded–slatted drum. In contrast, increasing the stud length and reducing the inner lining diameter leads to a decrease in mechanical seed damage to 0.2–0.3% (Figure 2). This indicates that increasing the height of studs and slats has a less negative effect on mechanical seed damage compared to conventional studded drums. This positive structural solution warrants further detailed investigation in future studies.

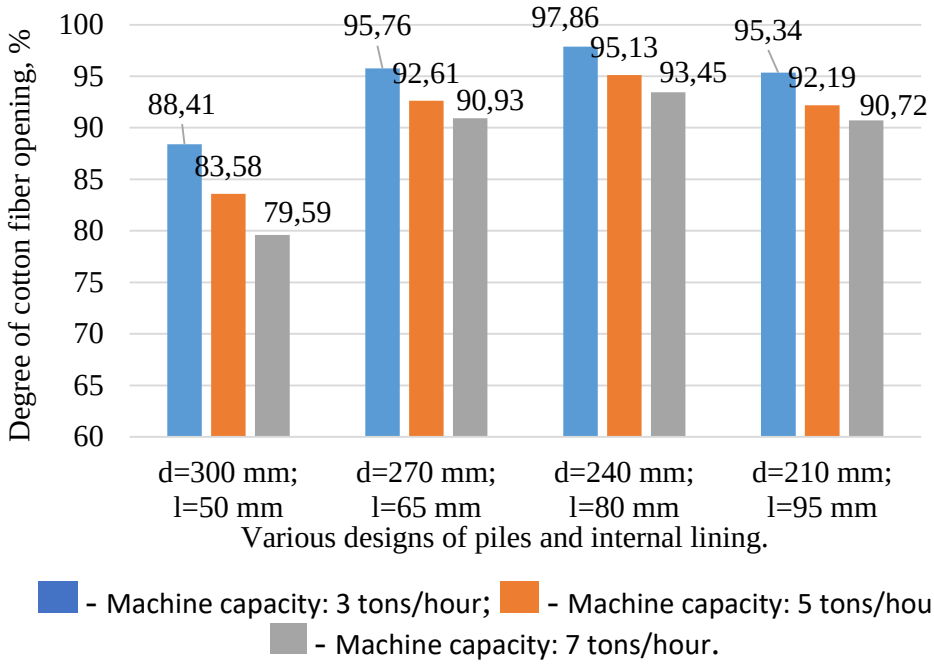

Figure 3. Histogram of changes in cotton opening degree for studded–slatted drums of different designs.

It is well known that in the cotton cleaning process, a higher degree of fiber opening in the raw cotton improves the exposure of impurities and increases friction with the mesh surface, thereby enhancing cleaning efficiency. In all experimental variants, it was observed that increasing the machine productivity led to a decrease in the cotton opening degree after cleaning (Figure 3).

Conclusion

In the conducted studies, the experimental variants of studded–slatted drums were installed on eight laboratory-model studded drums of the 1XK cotton-cleaning machine, and their effect on impurity separation was investigated. In the following sections, we examine the impact of both uniform construction and combined arrangement of these experimental studded–slatted drum variants on cleaning efficiency.

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UDC: 537, 539

ENERGY SPECTRUM OF SCATTERED Ar+ IONS FROM THE DEFECT SURFACE OF InP (001) < ī10>

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Annotatsiya. Ushbu maqolada InP (001)<ī10> ning pog‘onali yuzasidan sochilgan Ar^+ ionlarini turli tushish burchagi qiymatlarida va E_0=1 keV da ketma-ket yaqinlashuv usuli yordamida kompyuterda modellashtirish natijalari keltirilgan. Sochilgan ionlar energiyasining ularning sochilish burchagiga bog‘liqligi olingan va tushishning kichik burchaklarida sirtning ideal qismidan sochilish kuzatilishi ko‘rsatilgan. Tushish burchagi qiymatlarining ortishi atom pog‘onasidan ionlarning sochilishiga olib keladi, bu esa sirtda modellashtirilgan. Olingan natijalar shuni ko‘rsatdiki, pog‘onali sirt sochilganda, sochilgan ionlarning E(θ) ga bog‘liqligida, bir xil sochilish burchagida energiyaning ikkita qiymatiga mos keladigan ovallar kuzatiladi. Shuningdek, energiya spektrlari olingan bo‘lib, ular ionlarning tushish burchagining ortishi bilan spekulyar ravishda sochilgan, oxirgi atomdan sochilgan va dekanallangan ionlarga mos keladigan cho‘qqilar kuzatilishini tasdiqlaydi.

Kalit so‘zlar: *ion sochilishi, dekanalanish, kompyuterda modellashtirish, nuqsonlar, energetik spektri.*

Аннотация. В данной статье представлены результаты компьютерного моделирования рассеянных ионов Ar_+ на ступенчатой поверхности InP (001) <$\bar{1}$10> при различных значениях угла падения и при энергии E_0=1 кэВ с использованием метода приближения бинарных столкновений. Получена зависимость энергии рассеянных ионов от угла их рассеяния, и показано, что при малых углах падения наблюдается рассеяние от идеальной части поверхности. Увеличение значений угла падения приводит к рассеянию ионов от атомной ступени, смоделированной на поверхности. Полученные результаты показали, что при рассеянии на ступенчатой поверхности в зависимости E(θ) рассеянных ионов наблюдаются овалы, соответствующие двум значениям энергии при одном и том же угле рассеяния. Также получены энергетические спектры, подтверждающие, что с увеличением угла падения ионов наблюдаются пики, соответствующие зеркально рассеянным, рассеянным от концевого атома и деканалированным ионам.

Ключевые слова: *рассеяние ионов, деканалирование, компьютерное моделирование, дефекты, зеркальное рассеяние.*

Abstract. This article presents the results of computer modeling of scattered ions Ar^+ from the stepped surface of InP (001) < $\bar{1}$10> at different values of the angle of incidence and at the E_0=1 keV using the binary collision approximation method. The dependence of the energy of scattered ions on their scattering angle is obtained, and it is shown that at small angles of incidence, scattering from the ideal part of the surface is observed. Increasing the values of the angle of incidence leads to scattering of ions from an atomic step, which is modeled on the surface. The obtained results showed that when scattering a stepped surface, in the dependence of E(θ) of scattered ions, ovals are observed corresponding to two values of energy at the same scattering angle. Also, energy spectra are obtained, which confirm that with an increase in the angle of incidence of ions, peaks are observed corresponding to specularly scattered, scattered from the end atom, and dechanneled ions.

Keywords: *ion scattering, dechanneling, computer modeling, defects, energy spectrum.*

Introduction

The interaction of ions with the surface of a solid is a complex multi-stage process that intertwines the phenomena of atomic physics, solid-state physics, and surface science. In an idealized model of a crystal lattice, where the atoms are arranged in a strict order, ion scattering follows certain patterns that allow one to analyze the structure and composition of the surface. However, real materials inevitably contain defects such as vacancies, interstitial atoms, dislocations, and grain boundaries, which significantly disrupt this ideal picture [1-3].

Literature Review

The presence of defects leads to a local distortion of the interaction potential between ions and surface atoms, which in turn radically changes the trajectories of scattered ions. Defects can act as additional scattering centers, creating new scattering channels and leading to a change in the angular and energy distributions of scattered particles. For example, vacancies can lead to the appearance of "shadow" regions, where the probability of ion scattering decreases, and interstitial atoms can, on the contrary, increase the probability of scattering in certain directions [4-7].

The study of ion scattering from defective surfaces allows one to penetrate into the fundamental mechanisms of ion interaction with a solid at the atomic level. Analysis of the angular and energy distributions of scattered ions, as well as their dependence on the energy of primary ions and the type of defects, provides valuable information on interatomic potentials, electronic processes, dynamics of surface atoms, and mechanisms of defect formation. Also, the study of defects on the surface of semiconductor compounds is of great interest. Ion scattering from the surface of semiconductors is an important process that determines their physicochemical properties and technological characteristics. In particular, the presence of defects in the crystal lattice significantly affects the trajectory of ions, their energy, and scattering angles. The study of these phenomena allows one to better understand surface processes, which are important for micro- and nanoelectronics, as well as for the development of new functional materials [8-10]. This article presents the results of a computer simulation of the scattering of Ar^+ ions from a stepped InP (001)<$\bar{1}$10) surface at different values of the incidence angle.

Research Methodology

It is known that ion scattering spectroscopy provides important information about the surface of a solid. At low energies of the bombarding ions with surface atoms on the surface of a solid can be considered as isolated pair collisions and their sequences. This conclusion is based on the consideration of the interaction time of the incident ion and the crystal atom, as well as the energies characteristic of such collisions. Since the repulsive component of the potential decreases rapidly with increasing interatomic distance, the interaction time for such collisions is on the order of 10^{-15}-10^{-16} s, which is much less than the period of lattice oscillations, which is approximately 10^{-13} s. Therefore, when the energy transferred during the collision exceeds the binding energy of the target atom (5-20 eV), this atom can be considered isolated from the lattice [11-13].

If a particle with mass M_1 and with atomic number Z_1, having a velocity v_0 (and kinetic energy E_0), elastically collides with a stationary target atom of mass oh M_2 and atomic number Z_2, then the particle with mass M_1 is dispersed in the laboratory coordinate system at an angle θ_{of1} relative to the direction of its initial motion. The relationship between these parameters is determined by the following relationships:

$$E_1 = (1+\mu)^{-2} E_0 (\cos\theta_1 \pm \sqrt{(f\mu)^2 - \sin^2\theta_1})^2$$

the Biersack-Ziegler-Littmark potentials [14] were used:

$$V_{SBL} = \frac{Z_1 Z_2 e^2}{r}((0{,}1818\exp(-3{,}2\frac{r}{a}) + 0{,}5099\exp(-0{,}9423\frac{r}{a}) +$$

$$+ 0{,}2802\exp(-0{,}4029\frac{r}{a}) + 0{,}02817\exp(-0{,}2616\frac{r}{a}))$$

where, $a=0.8853a_0(Z_1^{0.23} + Z_2^{0.23})$ is the screening function.

In this collision, energy is lost and its elastic part is determined by the Firsov formula, modified by Kishinevsky [15]:

$$\varepsilon(Eo, P) = \frac{0{,}310^{-7} v Z_1 (Z_1^{1/2} + Z_2^{1/2})(Z_1^{1/6} + Z_2^{1/6})}{(1 + \frac{0{,}67\sqrt{Z_1} r_0}{a_{tf}(Z_1^{1/6} + Z_2^{1/6})})} + (1 - 0{,}68\frac{V(r_c)}{E_r})$$

where, $a_{tf} = 0.468$Å, v and E_r are the relative velocity and energy of the atom, Z_1 - and Z_2 are the charge of the colliding ions and atoms, v is cm/s, E_r is eV, r_{min} is in angstroms.

Figure 1 shows a semichannel formed on the stepped surface of InP (001)< ī10) and some trajectories of scattered ions. The width and depth of this semichannel are 2.86Å and 4.01Å , respectively . It should be noted that zigzag trajectories of scattered ions can also be observed.

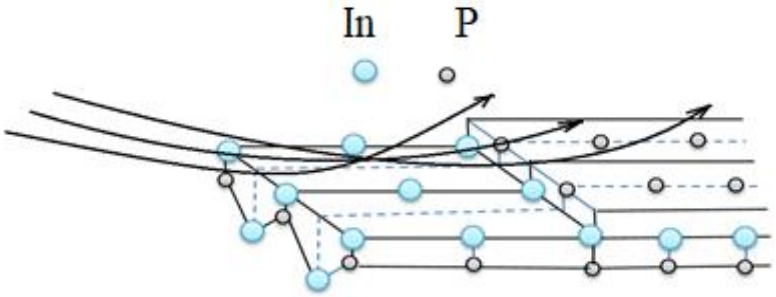

Figure 1. The scheme of stepped surface InP (001)< ī 10>

Analysis and Results

Figure 2 shows the dependence E(θ) of scattered ions Ar^+ from the stepped surface of InP (001)<ī10) at different values of the incidence angle. Figure 2a shows this distribution at ψ=7°. Our calculations have shown that in the dependence, there are only two ovals corresponding to multiple scatterings of ions at θ=11.6° and θ= 12.85°. Scattering of ions at other values of the scattering angle is not observed. This is due to the large values of the semichannel width and small values of the ion incidence angle. An increase in the ion incidence angle (ψ=9°) leads to the formation of large values of the scattering angle, which is presented in the dependence E(θ) of scattered ions (Figure 2b). It is evident from Figure 2b that, in addition to the oval formed at θ=18°, another oval appears at $\theta=90^0$. Those ovals corresponding to multiple scattered ions, formed at large values, are formed at small values of the energy of the scattered ions. At ψ=11° the number of ovals increases, and the values of the ion scattering angle have a larger range (Figure 2c). It should be noted that at small values of the scattering angle, small

ovals are formed, and at large values of the scattering angle, open ovals are formed, which is explained by the large values of the masses of the incident argon ions compared to the phosphorus atoms, which form a surface step. In this case, an oval-shaped dependence is observed in the range of the ion scattering angle $\theta = 20^{\circ} - 70^{\circ}$. At values of the ion scattering angle greater and less than these values, a small number of ions are observed. This picture can also be observed at $\psi=13^{\circ}$, shown in Figure 2d. From this dependence, one can also observe an increase in the number of ovals of multiple scattered Ar^{+} ions. In this case, an oval-shaped dependence is observed in the range of the ion scattering angle $\theta = 20^{\circ} - 90^{\circ}$. At other values of the scattering angle, a small number of ions is observed. Analysis of the results showed that increasing the angle of incidence of the incident ions leads to an even further narrowing of the ovals depending on. We also calculated the energy distribution of scattered Ar^{+} ions from the stepped surface of InP (001)<$\bar{1}$10) at different values of the angle of incidence (Figure 3). Figure 3a shows the energy distribution at an incidence angle of $\psi = 7^{\circ}$. It is evident that this distribution has only one peak. To explain this peak, we analyzed the trajectories of scattered ions. The analysis showed that this peak was formed due to specular scattering of ions ($\theta=14^{\circ}$) from the ideal part of the surface. i.e., the ions have not yet collided with the step atoms. The energy of these ions lies in the range of 966-971 eV. Figure 3b shows the energy distribution of scattered ions at $\psi=9^{\circ}$. The peak located in the high-energy part of the spectrum refers to ions scattered at $\theta=18^{\circ}$ (specular scattering).

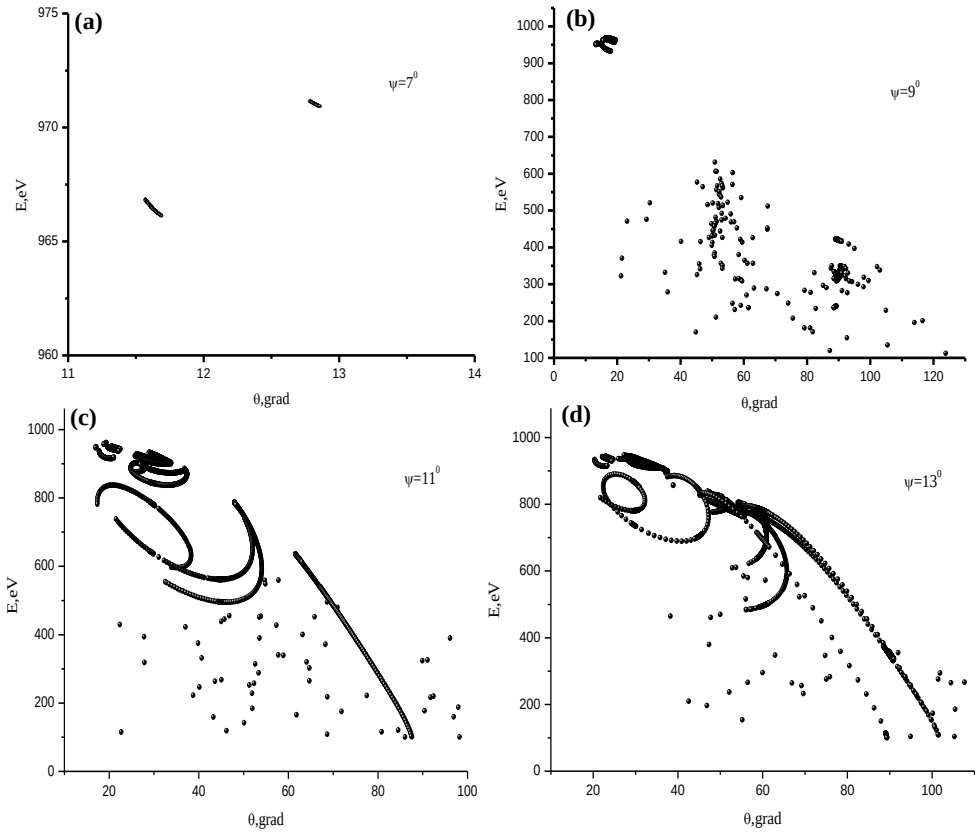

Figure 2. Dependence of E(θ) of scattered ions on the stepped surface of InP (001)<$\bar{1}$10> at different values of the angle of incidence and E_0=1 keV of Ar^{+} ions (a- $\psi = 7^{\circ}$, b- $\psi = 9^{\circ}$, c- $\psi = 11^{\circ}$, d- $\psi = 13^{\circ}$).

Their energy lies in the range of 940-968 eV. And the peak located at energies of 230-420 eV refers to ions scattered from the end atom of the step, and their scattering angle $\theta=90^{\circ}$. It should be noted that the lowest energy part of the spectrum contains low-intensity peaks related to dechanneled ions. Their scattering angle $\theta>90^{\circ}$. Calculation of the trajectory of dechanneled ions shows that they have a straight line at first, and after being captured in the channel formed by the step, they have a zigzag shape. Figure 3c shows the energy spectrum of scattered ions at $\psi=11^{\circ}$. In this energy spectrum, the most intense peak formed by the high-energy part of the spectrum refers to specularly scattered ions $\theta=22^{\circ}$. Before this peak, a peak of scattered ions at a scattering angle of $\theta=33^{\circ}$ was formed. Those ions scattered with an energy of 500-600 eV refer to ions scattered at $\theta=45^{\circ}$. Low-intensity peaks located in the low-energy part of the spectrum refer to dechanneled ions and their number is small. Figure 3d shows the energy spectrum of $\psi = 13^{\circ}$. The intense peak that formed in the highest energy part refers to specularly scattered ions from the ideal part of the surface ($\theta=26^{\circ}$). The peak that formed at energies of scattered ions of 700-800 eV refers to ions scattered at $\theta=$ 50-70°. And the peak formed at 300 eV and 450 eV refers to ions scattered at $\theta=90^{\circ}$. Low-intensity peaks of dechanneled ions were formed at energies of 200-300 eV.

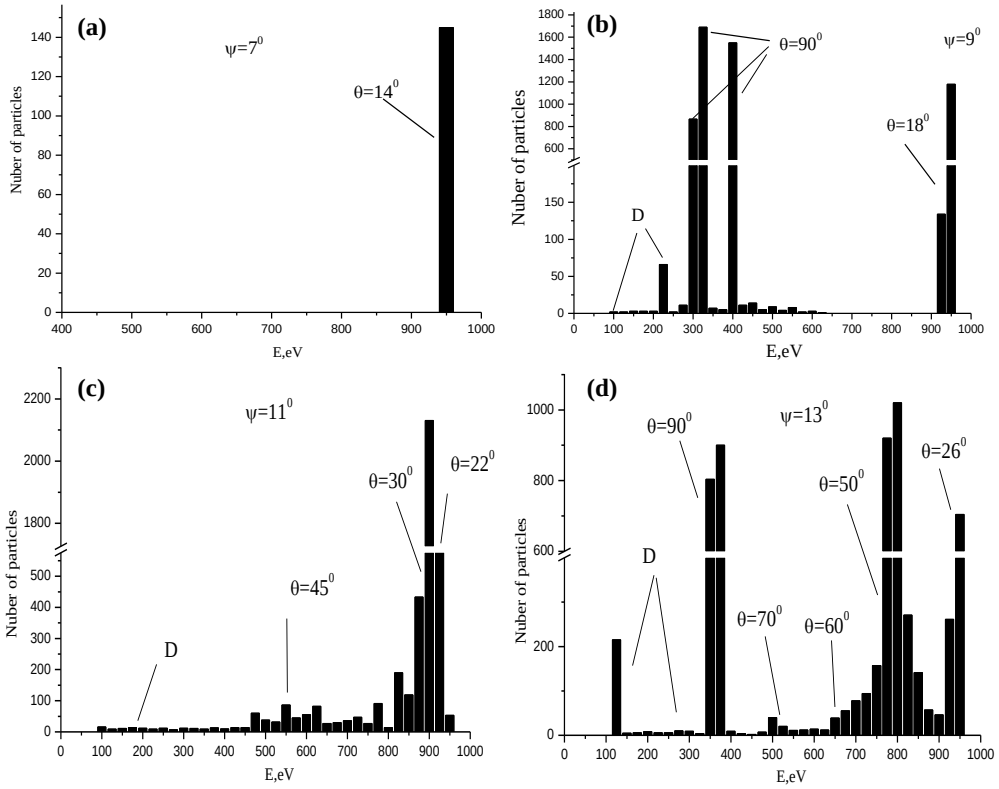

Figure 3. Energy distributions of scattered Ar^{+} ions from the stepped surface of InP (001)< $\bar{1}$10> at different values of the angle of incidence and E_0=1 keV (a- $\psi=7^{\circ}$, b- $\psi=9^{\circ}$, c- $\psi=11^{\circ}$, d- $\psi=13^{\circ}$).

Conclusion

We have obtained the dependence E(θ) of scattered ions Ar^{+} from the stepped surface InP (001)<$\bar{1}$10) at different values of the incidence angle. Our calculations showed that up to $\psi=7^{\circ}$ specular scattering of ions is observed. With $\psi=9^{\circ}$ ion scattering

occurs greater than the specular scattering angle, and scattering at large angles is observed (up to $\theta=100^{\circ}$). This is explained by the fact that those ions that are captured by the surface channel are scattered at large angles when leaving the channel. The energy spectrum of scattered ions also confirms the scattering of ions from the ideal and defective parts of the surface. The energy spectrum shows peaks of specularly scattered ions and ions scattered from the end atom and dechanneled from the surface channel formed by the step atoms. Thus, the study of ion scattering from defective surfaces not only expands our knowledge of the fundamental aspects of ion-solid interactions but also opens up new possibilities for diagnostics and modification of materials at the atomic level.

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UDC: 532, 519.85

INVESTIGATION OF THE DYNAMICS OF MULTIPHASE STRATIFIED FLOWS BASED ON MATHEMATICAL MODELING

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Annotatsiya. Maqolada ko‘p fazali qatlamli oqimlar dinamikasini o‘zaro kirishuvchi va ta’sirlashuvchi ko‘p fazali muhitlar harakati modeli asosida tadqiq qilish masalalari ko‘rib chiqilgan. Tadqiqotda atmosferaning quyi qatlamlari va suv havzalari o‘rtasidagi o‘zaro ta’sir, dispers aralashmalar oqimlarining barqarorligi hamda quvurlardagi ko‘p fazali oqimlar dinamikasi o‘rganilgan. Olingan natijalar gidrotexnik inshootlarni loyihalash va ulardan foydalanish samaradorligini oshirishga xizmat qiladi.

Kalit so‘zlar: *ko‘p fazali muhitlar, stratifikatsiya, barqarorlik, matematik model, dispers aralashma, Richardson soni, sonli algoritmlar.*

Аннотация. В статье рассматриваются вопросы, связанные с исследованием динамики многофазных стратифицированных течений на основе модели движения взаимопроникающих и взаимодействующих многофазных сред. В работе изучается взаимодействие нижних слоев атмосферы с водными объектами, устойчивость течений дисперсных смесей, а также динамика многофазных потоков в трубопроводах. Полученные результаты служат повышению эффективности проектирования и эксплуатации гидротехнических сооружений.

Ключевые слова: *многофазные среды, стратификация, устойчивость, математическая модель, дисперсная смесь, число Ричардсона, численные алгоритмы.*

Abstract. The article examines issues related to the investigation of the dynamics of multiphase stratified flows based on a model of the motion of interpenetrating and interacting multiphase media. The study explores the interaction between the lower atmospheric layers and water bodies, the stability of dispersed mixture flows, and the dynamics of multiphase flows in pipelines. The obtained results serve to enhance the efficiency of designing and operating hydraulic structures.

Keywords: *Multiphase media, stratification, stability, mathematical model, dispersed mixture, Richardson number, numerical algorithms.*

Introduction

Significant attention is being paid worldwide to the study of hydraulic and hydrodynamic processes, taking into account the influence of various factors,

systematic analysis, mathematical models aimed at supporting decision-making, the development of efficient numerical algorithms, and software packages. The rapid development of modern information technologies makes the modeling of hydraulic engineering and the dynamics of multiphase stratified flows one of the most relevant issues in the current context of water scarcity. Such flows are observed in reservoirs, riverbeds, and pipeline conduits, and understanding their motion patterns enables efficient use of water resources and ensures the safety of structures.

Literature Review

In the Republic of Uzbekistan, extensive measures are being implemented to prevent the disruption of the balance of water management from natural and anthropogenic sources. In particular, the Decree of the President of the Republic of Uzbekistan No. PF-60 dated January 28, 2022, "On the Development Strategy of New Uzbekistan for 2022-2026," states: "...developing the national economy, ensuring growth rates in line with modern requirements, including transforming the digital economy into a primary 'driver' sector and increasing its volume by at least 2.5 times, ... fundamentally reforming the water resource management system of the republic and implementing a separate state program on water conservation," which demonstrates the state's special attention to water and agricultural resources [1, 2].

In many industrial sectors, particularly in water resource management, oil-gas, and chemical technologies, the joint motion of two or more phase liquids is frequently observed. A stratified flow is a state with a clear separation boundary (interface) due to density differences between phases [4, 5]. Studying the dynamics of such flows is necessary to reduce energy losses in pipelines and prevent emergency situations. The research object is taken as layered flows of single- and multiphase media.

Research Methodology

In the research process, separate conservation laws are applied for each phase to describe stratified flows. Assuming the fluid is incompressible, the flow dynamics are expressed by the Navier-Stokes equations, and the following continuity equation is used [2, 4, 6]:

$$\nabla \cdot u_k = 0$$

The motion model of interpenetrating and interacting multiphase media, as developed by Rakhmatulin Kh.A., utilizes the method of small perturbations, elements of similarity and dimensionality theory, including the momentum conservation equation [3].

$$\rho_k \left(\frac{\partial u_k}{\partial t} + u_k \cdot \nabla u_k \right) = -\nabla p_k + \mu_k \nabla^2 u_k + \rho_k \mathrm{g} + F_{int} = 0$$

here, k is the phase index (e.g., liquid and gas); the velocity vector; density; pressure; the interphase interaction force.

Boundary conditions and interface dynamics require continuity of velocities and stresses at the interface where two phases meet; additionally, Laplace pressure accounting for surface tension forces is considered [2]:

$$\nabla p = \sigma k$$

here, σ is the surface tension coefficient, κ is the curvature of the interface.

A scalar function C (color function) representing the volume fraction of the liquid in each computational cell is introduced via the phase function and advection equation:

$$\begin{cases} If\ C = 1, the\ cell\ is\ completely\ filled\ with\ liquid\ (phase - 1). \\ If\ C = 0, the\ cell\ is\ completely\ filled\ with\ gas\ (phase - 2). \\ If\ 0 < C < 1, there\ are\ interphase\ boundaries\ in\ the\ cell. \end{cases}$$

The change of this function over time is described by the following advection equation [3]:

$$\frac{\partial C}{\partial t} + u \cdot \nabla C = 0$$

The change of this function over time is described by the following advection equation [3]:

$$\rho(C) = C\rho_1 + (1 - C)\rho_2$$
$$\mu(C) = C\mu_1 + (1 - C)\mu_2$$

Mixture properties are determined by smoothing density and viscosity in the flow domain via the function C [2, 6]:

In the stages of numerical solution implementation (PISO - Pressure-Implicit with Splitting of Operators algorithm), the algorithm for solving the coupling between pressure and velocity is applied [5].

This process consists of the following steps:

$$\nabla\left(\frac{1}{\rho}\nabla \mathrm{p}^{n+1}\right) = \frac{\nabla \cdot \mathrm{u}^*}{\Delta t}$$

- Prediction: The discrete form of the Navier-Stokes equation is solved to find an intermediate velocity value [6];

$$\mathrm{u}^{n+1} = \mathrm{u}^* - \frac{1}{\rho}\nabla \mathrm{p}^{n+1}$$

- Pressure correction: A new pressure value is calculated using the Poisson equation
- Velocity correction: The velocity vector is updated based on the found pressure gradient as follows:
- Interface update: The C function is advected based on the velocity field, and the new state of the phase boundary is determined.

Stability criteria of the model: For stable operation according to the numerical scheme, the Courant-Friedrichs-Lewy (CFL) condition must be satisfied:

$$C_0 = \frac{\Delta \mathrm{t} \cdot |\mathrm{u}|}{\Delta x} \leq 0.5$$

here, Δt is the time step, Δx is the grid size; in stratified flows accounting for surface tension forces, an additional restriction on the time step is introduced:

$$\Delta \mathrm{t} < \sqrt{\frac{(\rho_1 + \rho_2)\Delta x^3}{4\pi\sigma}}$$

The proposed algorithm allows high-accuracy modeling not only of layered flows but also of transitions to wavy and slug flow regimes. In the analysis of numerical

research results, the method, model, and numerical results obtained based on the PISO algorithm are typically presented through visualization of phase geometry, velocity fields, and pressure distribution in pipes [2, 6].

Analysis and Results

The visualization of phase boundary dynamics in the following graphic shows the change over time of the interface in a gas-liquid stratified flow. This occurs typically due to Kelvin-Helmholtz instability as gas velocity increases. Gas velocity = 5 m/s, liquid velocity = 1 m/s. The mathematical model of regulated multiphase stratified flows and graphical representations of their dynamics are as follows (see Figure 1). Explaining the graphic: Blue line - initial interface state (time t=0). Green, yellow, red lines: Deformation of the interface over time (t=1s, t=3s, t=5s). Due to higher gas velocity, waves form at the interface, and their amplitude increases over time. Dashed line – average interface height.

This visualization demonstrates the development of Kelvin-Helmholtz instability and its potential tendency to lead to slug flow formation. Numerical simulations allow the determination of pressure drop along the pipe length and velocity profiles in each phase. For example, velocity gradients change sharply near the interface, leading to increased friction forces.

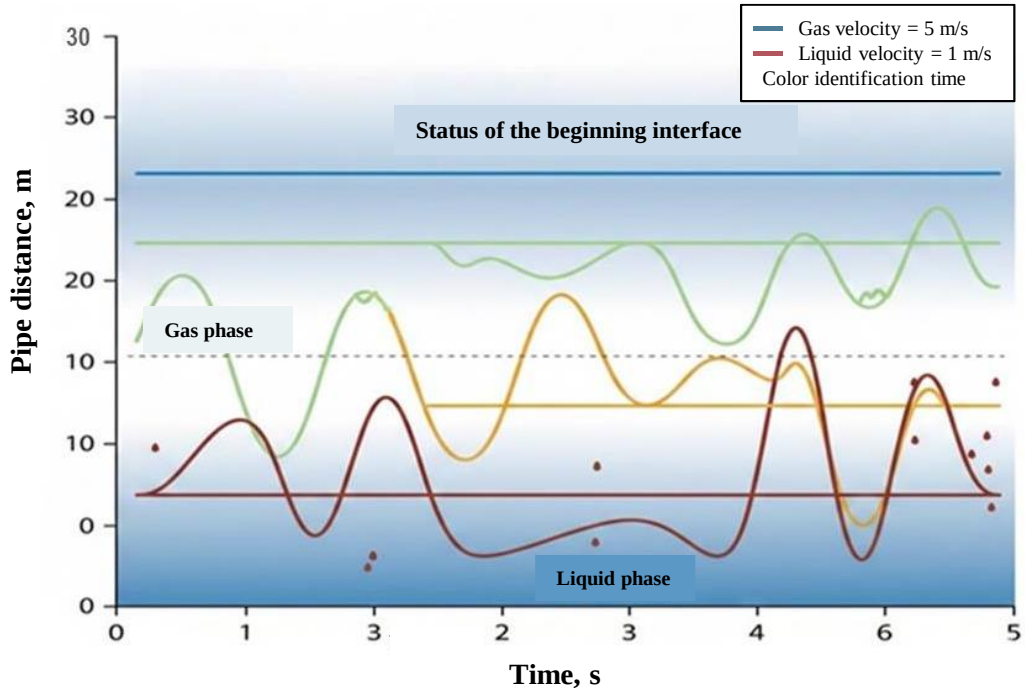

Figure 1. Evolution of the gas-liquid interface due to Kelvin-Helmholtz instability from numerical modeling results (volume of fluid method).

In the numerical research and results analysis, it should be noted that volume of fluid or level set methods were used to solve the mathematical model. These methods allow precise tracking of phase boundary deformation over time, with key observed phenomena: Kelvin-Helmholtz instability, i.e., wave formation at the interface when gas velocity exceeds a certain value, and pressure drop, i.e., the ratio of layer thicknesses directly affects total pressure loss in the pipe.

Physical experiments and computer processing of the obtained results were performed. Within the research, a series of results were achieved on the stability and dynamics of multiphase stratified flows. Stability criteria were formed, namely the theory of small perturbation stability in viscous dispersed mixture flows. Using local and dynamic Richardson numbers, as well as the Monin-Obukhov scale and bicubic spline model to describe stratification stability, models describing the interaction between water bodies and atmospheric layers were developed; comparative analysis results in tabular form are as follows (Table 1).

Table 1. Comparative analysis of intelligent algorithms and classical computational fluid dynamics (CFD) results.

№	Indicator	Classical CFD (Navier-Stokes)	Intelligent method (ML/NN)
1	Computation time	High (hours/days)	Very low (milliseconds)
2	Interface accuracy	Very high	Medium/High
3	Real-time control	Impossible	Possible
4	Required resources	Supercomputer/GPU cluster	Regular server/Edge device

Visualization of mathematical model results holds significant importance in the following graphic (see Figure 2):

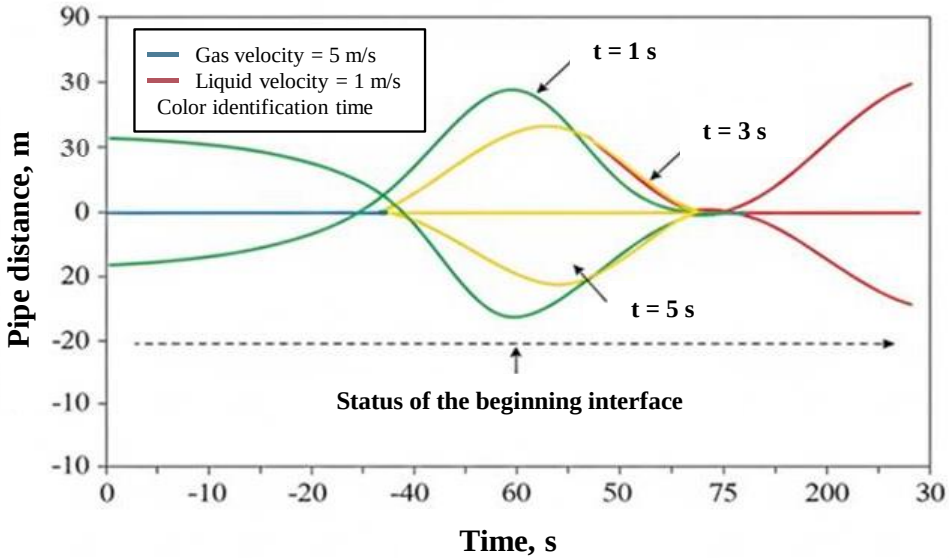

Figure 2. Numerical modeling results of gas-liquid boundary development based on Kelvin-Helmholtz instability.

A) Velocity profile and layering (stratification): This graphic shows the velocity distribution along the flow depth and the separation boundary of phases (e.g., heavy and light layers).

B) Influence of Richardson number on flow stability: The graphic indicates whether the flow is stable or unstable (turbulent).

When the Richardson number is below the critical value (approx. 0.25), waves and mixing occur between layers [2, 3]. Analysis of the model's stability properties shows that when the system of equations above is analyzed via the Richardson number, if inertial forces dominate gravitational forces, stratification is disrupted.

In numerical solution descriptions, these differential equations were computed on a computer using finite differences or the aforementioned bicubic spline, enabling high-accuracy determination of velocity and pressure at any point in the flow. In particular, numerical-analytical algorithms accounting for solar radiation and heat exchange factors were created. For flows in pipes, a method was proposed to determine three-layer indicators and overall boundaries in the stratification process of turbulent two-phase fluid flow in a cylindrical pipe. Based on the research results, practical significance and software tools were developed: “Modeling the dynamics of development of multiphase stratified flows in water bodies” and “Calculation of pressure loss along pipe length.” These programs enable an approximate 7% increase in the useful volume of reservoirs, a 6% improvement in the reservoir utilization coefficient; they serve to evaluate pipeline throughput and manage uniform flows.

Mathematical modeling of the dynamics of multiphase stratified flows creates the possibility to accurately determine their stability boundaries and hydraulic parameters. The developed models and algorithms demonstrate high efficiency in solving complex practical problems in hydraulic engineering and water management.

t = 0 s, blue line - the flow is fully stratified, i.e., gas and liquid layers are in a flat horizontal state. t = 1-3 s, green and yellow lines - small oscillations appear at the interface due to the velocity difference between gas and liquid. In this region, energy begins to transfer from the gas phase to interface waves. t = 5 s, red line - wave amplitude reaches maximum. This state indicates the threshold of transition from “wavy-stratified” regime to “slug” regime.

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