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SALINE AND SODIC SOILS AND THEIR IMPROVEMENT METHODS

Huseynova M.A.
Mustafayeva A.C.
Ismailzade Kh.H.
Musayeva F.R.
Azerbaijan State Oil and Industry University

Introduction: *Among the 250 soil types existing worldwide, saline–sodic soils are both widely distributed and considered one of the most interesting and enigmatic types. In Azerbaijan, these soils are mainly found in the south-eastern part of the Shirvan Plain and belong to the group of saline–sodic soils.*

Saline–sodic soils that are commonly used for cultivation are usually located in patchy areas between meadow and chernozem soils. This spatial heterogeneity complicates the timely implementation of agricultural operations and, as a result, leads to a decrease in overall productivity within the soil complex.

Most of the land areas located in the Kura–Araz Plain are characterized by a long-term warm and frost-free climate, flat relief, and high soil fertility. These factors create favorable conditions for the cultivation of agricultural crops, particularly cotton. However, the high salinity in the deeper soil layers and the elevated mineralization of groundwater significantly hinder the development of agriculture in these areas.

Of the Republic's total area of 8.6 million hectares, 4.5 million hectares are used for agricultural purposes. Of these lands, 3.2 million hectares require irrigation, and more than 1.4 million hectares are currently irrigated. Approximately 636.5 thousand hectares of the irrigated lands are affected by salinization to varying degrees. As a result, the area of land suitable for agriculture is decreasing, soil fertility is deteriorating, and the productivity of agricultural crops is significantly declining [1].

Among zonal soils, saline–sodic soils are usually distributed in patches, which leads to a reduction in overall productivity. Various methods have been developed to rehabilitate such soils. Worldwide, the following approaches are mainly preferred:

Chemical reclamation – the application of specific chemical substances (ameliorants) to the soil; Agrotechnical methods – the implementation of agrotechnical measures to improve soil condition; Biological methods – the cultivation of certain plant species aimed at reducing soil sodicity and salinity.

Before testing these methods, the physical-geographical, geological, and hydrogeological characteristics of the land to be reclaimed must be studied, and information should be collected on the formation processes and development features of saline–sodic soils in the given area.

Research shows that soil salinization and sodification are not driven solely by natural factors but can also be significantly intensified by human activities. Improper management of irrigation systems, untimely and inefficient implementation of reclamation measures, and insufficient attention to soil reclamation and phytomelioration practices contribute to the spread of these processes over wider areas. As a result, returning such soils to agricultural circulation becomes a long-term process requiring substantial financial investment [2].

For this reason, the development of environmentally based scientific approaches to prevent soil sodification and to restore existing affected areas is of great importance. An ecological approach should ensure not only the restoration of soil productivity but also the preservation of its stability as an ecosystem. In this regard, it is essential to develop and implement a comprehensive set of measures based on the integration of soil science, ecology, agrochemistry, and land reclamation disciplines [3;4;5].

The relevance of the topic is primarily explained by the wide spatial distribution of saline–sodic soils and the scale of damage they cause to agriculture. In particular, the sodification processes observed in the lowland and semi-desert zones of Azerbaijan lead to a reduction in the productive land fund and render cultivated areas unsuitable for use. This makes the issue especially significant in terms of the efficient use of land resources, environmental protection, and the achievement of sustainable agriculture.

Research Objective:*The aim of the study is to develop effective methods for improving saline and saline–sodic soils that are widely distributed across the territory of the Republic.*

Research Object:*The object of the study comprises saline and saline–sodic soils found within the territory of the Republic.*

Research Methods:*The study employs the following methods: Geographic Information Systems (GIS), laboratory analyses, field observations, and statistical analysis techniques.*

In this scientific study, research will be conducted in the following areas:

1. *The genesis of salinization and sodification processes according to soil types and the patterns of their geographical distribution;*
2. *Analysis of physical, chemical, and biological changes in sodic soils;*
3. *Evaluation of reclamation and ecological measures applied for the protection of soil resources and the restoration of fertility;*
4. *Agroecological modeling of anti-salinization measures and assessment of their effectiveness.*

Analysis and Discussion:*The study was conducted on soil samples collected from the Khizi district, where the degree of salinization was 3.53% based on dry residue. The leaching experiment of the saline soils was carried out in two stages.*

In the first stage, the soils were leached using a physical modeling method. During the experiment, the soil samples were mixed with water at ratios of 1:5, 1:10, and 1:30. After thorough stirring, the mixtures were left to settle and then filtered. The above soil-to-water mixing ratios correspond to leaching with water at rates of 7.5, 15, and 30 thousand m³/ha, respectively.After leaching using the modeling method, the soil samples were subjected to chemical analysis, and the results are presented in Table 1. The data show that under the variant using ordinary water, the amount of salts in the soil samples decreased from 3.53 g to 0.99 g per 100 g of soil after leaching with a water rate of 7.5 m³/ha based on dry residue. With this leaching rate, the chloride anion content decreased from 0.987 g to 0.091 g per 100 g of soil, the sulfate anion content decreased from 1.285 g to 0.551 g, the calcium cation content decreased from 0.129 g to 0.073 g, and the magnesium and sodium cation contents decreased from 0.031 g and 1.053 g to 0.018 g and 0.214 g, respectively.

Table 1.

Changes in the degree of soil salinity (%) in soil samples after leaching using the modeling method

Leaching Rate m³/ha	Leached Salts						Total Salts	Dry Residue
	HCO_3	Cl	SO_4	Ca	Mg	Na		
Before Leaching								
0,016	0,987	1,285	0,123	0,031	1,053		3,50	3,53
Leaching with Ordinary Water								
7,5	0,024	0,091	0,551	0,073	0,018	0,214	0,97	0,99
15,0	0,024	0,075	0,420	0,069	0,017	0,149	0,76	0,76
30,0	0,024	0,040	0,295	0,043	0,009	0,109	0,52	0,53

By doubling the leaching rate and applying leaching with a water norm of 15 m³/ha, it was possible to reduce the total salt content per 100 g of soil to 0.75 g based on dry residue. Under these conditions, the chloride anion content in the soil sample decreased to 0.076 g per 100 g of soil, the sulfate anion content to 0.420 g, while the contents of calcium, magnesium, and sodium cations decreased to 0.069 g, 0.017 g, and 0.149 g, respectively.

With a further twofold increase in the leaching rate, the amount of salts leached from the soil was reduced to 0.53 g per 100 g of soil sample. In this leaching variant, the contents of chloride and sulfate anions decreased to 0.040 g and 0.296 g, respectively, while the contents of Ca, Mg, and Na cations were reduced to 0.043 g, 0.009 g, and 0.109 g, respectively [6; 7; 8].

Based on the data obtained from chemical analysis after leaching, the amounts of hypothetical salts were calculated.

In the soil sample containing 3.56 g of salts per 100 g before leaching, the amount of NaCl was 1.627 g, Na_2SO_4 accounted for 1.277 g, and $MgSO_4$ constituted 0.157 g per 100 g of soil. The contents of the non-harmful salts $Ca(HCO_3)_2$ and $CaSO_4$ were 0.021 g and 0.420 g, respectively.

Table 2.

Percentage of Hypothetical Salts Remaining in Soil After Leaching Using the Modeling Method

Leaching Rate m³/ha	$Ca(HCO_3)_2$	$CaSO_4$	$MgSO_4$	Na_2SO_4	NaCl	Total Salts	Including Total Harmful Salts (%)
Before Leaching							
0,021	0,420	0,157	1,277	1,627	3,56	3,06	87,4
Leaching with Ordinary Water							
7,5	0,032	0,222	0,088	0,478	0,150	0,97	0,72	73.8
15,0	0,032	0,206	0,082	0,308	0,125	0,75	0,52	64,4
30,0	0,032	0,120	0,047	0,256	0,066	0,52	0,37	70,8

After leaching with ordinary water at a rate of 7.5 m³/ha, the total salt content in the soil sample decreased from 3.56 g to 0.97 g per 100 g of soil. The amount of harmful salts remaining in the soil was 0.72 g, which accounted for 73.8% of the total salts present after leaching.

Following leaching with a water application rate of 15 m³/ha per hectare, the salt content in the soil was reduced to 0.75 g, while leaching with a rate of 30 thousand m³/ha made it possible to decrease the salt content to 0.52 g per 100 g of soil. These values correspond to 64.4% and 70.8% of the total salts remaining in the soil after leaching, respectively. After leaching, the amounts of the toxic salts remaining in the soil were 0.125 g and 0.066 g for NaCl, 0.308 g and 0.256 g for Na_2SO_4, and 0.082 g and 0.047 g for $MgSO_4$ in the two variants, respectively (Table 2).

In the second stage of the study, the leaching experiment was carried out in special containers with a height of 30 cm and a diameter of 5 cm.

The leaching experiment included two treatments:

-leaching with ordinary water;

-leaching combined with the application of gypsum to the soil at a rate of 10 g per hectare.

The leaching rate in both treatments was 15 mm (m³/ha).

Table 3.

Results of the Experimental Leaching Study (%). (Reclamation Rate: 10 t/ha)

Leaching Rate m³/ha	HCO_3	Cl	SO_4	Ca	Mg	Na	Total Salts	Dry Residue
Before Leaching								
	0,022	0,689	0,796	0,061	0,029	0,710	2,31	2,32
Leaching with Ordinary Water								
15	0,022	0,048	0,496	0,025	0,022	0,206	0,82	0,83
Leaching with Gypsum Application								
15	0,024	0,048	0,435	0,050	0,022	0,148	0,73	0,74

The soil sample used for the study had a salinity level of 2.31% (Table 3).

After leaching with a water application rate of 15 thousand m³/ha, the salinity level of the soil sample was reduced from 2.31% to 0.82%. Under these conditions, the chloride (Cl^-) anion content decreased from 0.688% to 0.048%, while the sulfate (SO_4^{2-}) anion content was reduced from 0.796% to 0.496%. The calcium (Ca^{2+}) cation content decreased to 0.025%, and the magnesium (Mg^{2+}) cation content to 0.206%.

In the leaching variant combining the application of 15 thousand m³/ha of water with 10 tons of gypsum per hectare, the total salt content based on dry residue was reduced from 2.32% to 0.74%. In this case, the remaining Cl^- and SO_4^{2-} ion contents in the soil decreased to 0.048% and 0.435%, respectively, while the contents of Ca^{2+}, Mg^{2+}, and Na^+ cations were reduced to 0.050%, 0.022%, and 0.148%, respectively.

Based on the data obtained from chemical analyses conducted after leaching of the soil samples, the amounts of hypothetical salts remaining in the soil were calculated (Table 4).

Analysis of the obtained results showed that in the variant of leaching with ordinary water, after the completion of leaching, 0.730 g out of the 0.818 g of salts remaining per 100 g of soil consisted of harmful salts, accounting for 80.24% of the total salts in the soil. As a result of leaching, the NaCl content in the soil decreased from 1.135 g to 0.078 g per 100 g of soil, the Na_2SO_4 content decreased from 0.816 g to 0.541 g, and the content of another harmful salt, $MgSO_4$, was reduced from 0.143 g to 0.111 g.

Table 4.

Percentage of Hypothetical Salts Remaining in Soil After Leaching (Gypsum Application: 10 t/ha, Leaching Rate: 15 mm m³/ha)

$Ca(HCO_3)_2$	$CaSO_4$	$MgSO_4$	Na_2SO_4	NaCl	Total Salts	Including Total Harmful Salts (%)
Before Leaching						
0,029	0,184	0,143	0,816	1,135	2,307	2,094	90,76
Leaching with Ordinary Water						
0,029	0,059	0,111	0,541	0,078	0,818	0,730	80,24
Leaching with Gypsum Application						
0,032	0,144	0,112	0,361	0,078	0,727	0,551	75,73

In the leaching variant involving the application of gypsum to the soil, it was possible to reduce the total salt content to 0.727 g per 100 g of soil. Of this amount, 0.078 g was NaCl, 0.361 g was Na_2SO_4, and 0.112 g was $MgSO_4$. The total amount of harmful salts in the soil was 0.551 g, which accounts for 75.73% of the total salts remaining in the soil (Table 4).

After leaching, the degree of soil sodicity was also examined. According to the data obtained from chemical analyses, leaching combined with gypsum application reduced soil sodicity from 14.5% to 7.2%. In contrast, in the variant using ordinary water, the reduction was only about 1.0%.

Conclusion

1. The conducted studies have shown that, prior to the development and utilization of the land, it is essential to implement a range of reclamation measures to improve soil conditions in the study area.

2. The results indicate that the effectiveness of leaching carried out using conventional methods is very low.

3. For the regions under consideration, the most effective soil improvement approach is chemical reclamation. Leaching combined with gypsum application makes it possible to reduce the degree of soil salinity to 0.078 g per 100 g of soil and to decrease the degree of sodicity to approximately 7%.

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Economic sciences

THE ROLE AND EVALUATION OF THE LEADERSHIP BRAND IN THE ORGANIZATION

Elsevar Khalilov
2nd year master's student,
Azerbaijan State University of Economics
Department of Business Management, Azerbaijan, Baku

Abstract

This article presents an analysis of the role and assessment of the Leadership Brand in a selected organization. The purpose of the study is to determine the level of the leadership brand within the organization and assess its impact on the company's competitiveness. In the context of increasing competition and rapid changes in the business environment, leadership branding has become a critical factor influencing not only internal organizational processes but also external market positioning. The study, conducted based on the survey methodology, involved 60 people: 46 employees, 10 middle managers and 4 representatives of senior management. This distribution of respondents allowed for a comprehensive evaluation of leadership perceptions across different managerial and operational levels within the organization. The participants' work experience was analyzed in four categories: less than 1 year, 1–3 years, 3–5 years and more than 5 years. Three main criteria were identified for assessing the Leadership Brand: the leader's personal qualities, trust in leadership and the image of the leadership brand. The average score for the leader's personal qualities was 3.97, the indicators for trust in leadership were 3.8–4.12, and for the image of the leadership brand were 3.8–4.0. These results indicate a relatively high and consistent evaluation across all assessment dimensions, reflecting a stable leadership perception within the organization. The study results show that the Leadership Brand in the surveyed company has been formed at a "good" level and is effective. These results strengthen both the perception and trust of management by employees and the reputation of the organization in the market. The article also presents in detail the methodology for assessing the leadership brand, the analysis of criteria and the interpretation of the results. Special attention is given to the use of quantitative indicators and their role in ensuring objectivity and reliability of the assessment process. The results of the study show that a strong and sustainable leadership brand plays an important role in achieving the strategic goals of the organization and ensuring competitive advantage. This article provides practical recommendations for other organizations in the field of assessing and developing the effectiveness of the Leadership Brand.

Keywords: *Leadership brand, leader qualities, trust, company image, competitiveness*

Introduction. *Leadership brand is one of the key factors in the management system and strategic development process of organizations [6]. Leadership brand not only reflects the personal qualities and skills of the leader, but also determines the acceptance of the organization among employees, the level of trust and the reputation in the market [1]. The rapidly changing competitive environment and global economic trends in modern organizations have further increased the importance of leadership brand [3]. A strong leadership brand has a direct impact on more effective management of the company's internal resources, increasing employee motivation and successful implementation of strategic decisions.*

It has been determined that strategic leadership affects competitive advantage. Based on the studies of Sibghatullah and Raza [10], it was concluded that strategic leadership affects competitive advantage.

Ojokuku et al. [8] state that leadership style has a strong relationship with organizational performance. Organizational performance itself is very strongly related to the competitive advantage created by the organization. Some researchers [7] state that competitive advantage has a positive effect on organizational performance. Strategic leadership itself is important for how to effectively manage the company's strategy development process to create competitive advantage.

Recent studies have shown that the personal qualities of the leader in organizations, trust in leadership, and the image of the leadership brand are considered to be the main indicators of the company's competitiveness [9]. The leader's openness to innovation, objective decision-making, ability to motivate employees, and ability to adapt to changes have a positive impact on the performance of the organization [4]. In addition, the level of trust in management and the company's reputation in the market are also important factors in the formation of strategic advantages [2]. The purpose of this article

is to assess the level of Leadership Brand in a selected company, determine its impact on various criteria, and examine its contribution to the competitiveness of the organization [5]. The results of the study determine the methodologies and criteria that can be used to assess the effectiveness of the leadership brand, as well as provide practical recommendations for the strategic management and development processes of organizations [7].

Material and method. *The study was conducted based on a survey methodology. 60 people participated in the survey: 46 employees, 10 middle managers and 4 representatives of senior management. Participants were divided into four categories according to their work experience: less than 1 year, 1–3 years, 3–5 years and more than 5 years. Three main criteria were used to assess the Leadership Brand: the leader's personal qualities, trust in leadership and the image of the leadership brand. For each criterion, participants made an assessment on a 5-point scale: 1 - completely disagree, 2 - disagree, 3 - partially agree, 4 - agree, 5 - completely agree. The leader's personal qualities were analyzed based on openness to innovations, objective decision-making, adaptation to changes and motivational skills. Trust in leadership was assessed by indicators such as the reliability of management, fulfillment of promises and attention to the interests of employees. The image of the leadership brand was assessed based on the company's reputation in the market and its connection with corporate values.*

Result. *During the research we conducted in the selected organization, we evaluated several criteria. Based on the analysis of these criteria, we assessed the competitiveness of the company. These criteria include the following:*

I. Information about the participant
II. Leadership Brand
• Personal qualities of the leader
• Trust in leadership
• Image of the leadership brand
III. Employer Brand
IV. Competitiveness of the company

During the survey, information about the participant was determined. At this time, they were divided into 3 categories: employee, middle manager and representative of senior management. Another piece of information is the work experience of the survey participants. At this time, taking into account their work experience, we divided them into 4 categories: less than 1 year, 1-3 years, 3-5 years, and more than 5 years.

A 5-point scale was chosen for the assessment and analysis of the criteria: 1- completely disagree, 2- disagree, 3- partially agree, 4- agree, 5- completely agree (Figure 1).

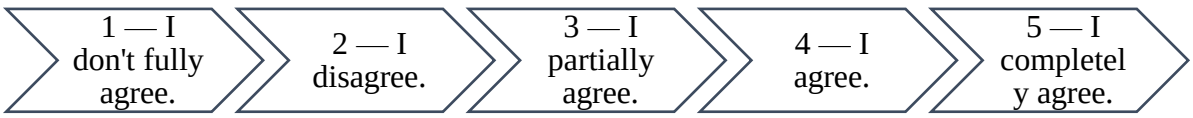

Figure 1. Assessment rates

After creating a database of survey participants, we analyzed the Leadership Brand in the second stage. At this time, we conducted an analysis in 3 stages: the leader's personal qualities, trust in leadership, and the image of the leadership brand.

For the analysis of the leader's personal qualities, the leader's openness to innovations, objective and fair behavior when making decisions, openness to changes along with innovations, and especially the ability to motivate were selected as the main indicators (Figure 2).

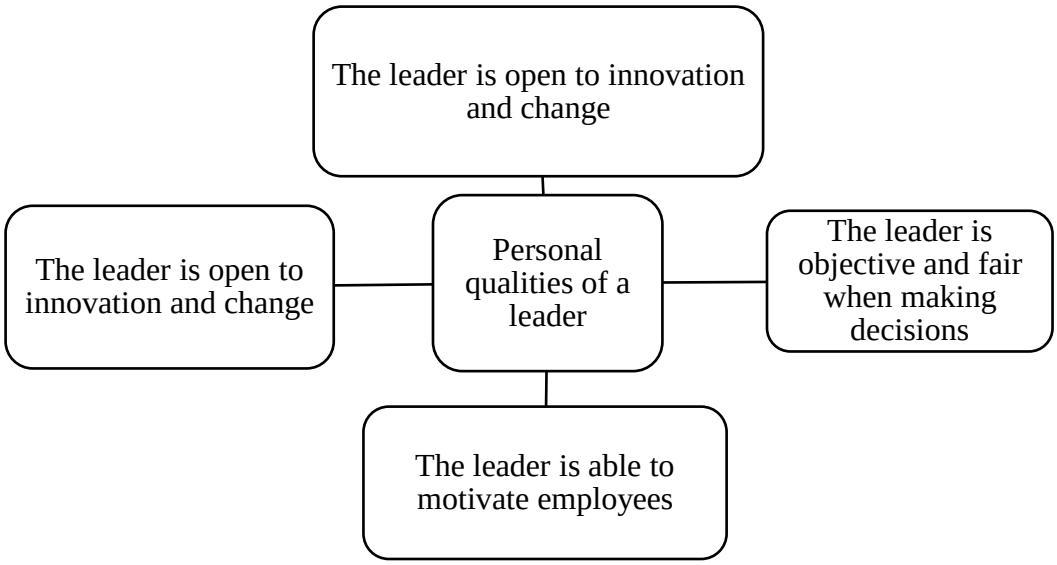

Figure 2. Personal qualities of a leader

The second issue analyzed in the Leadership Brand analysis was trust in leadership. In this case, we assessed the trust of respondents in the company's management, the management's ability to fulfill promises, and the management's consideration of employee interests (Figure 3).

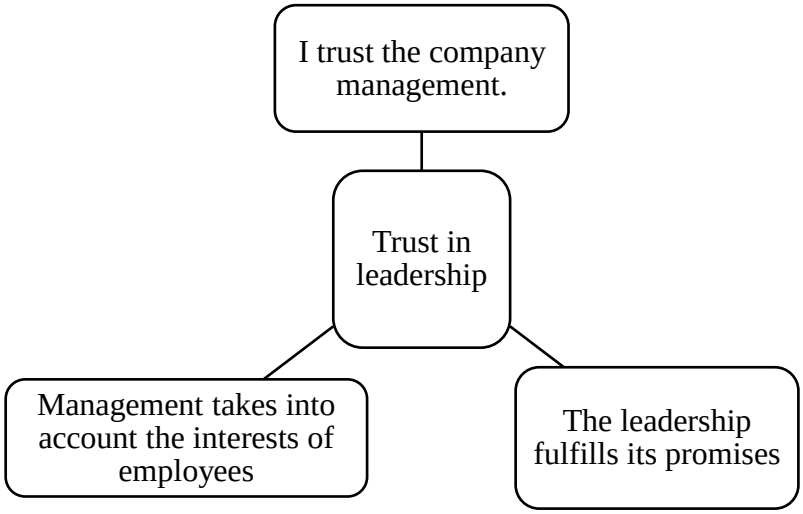

Figure 3. Trust in leadership

The assessment of the image of the leadership brand is also important for the Leadership Brand Assessment stage. At this time, the main factors are analyzed - the company's image in the market (Figure 4).

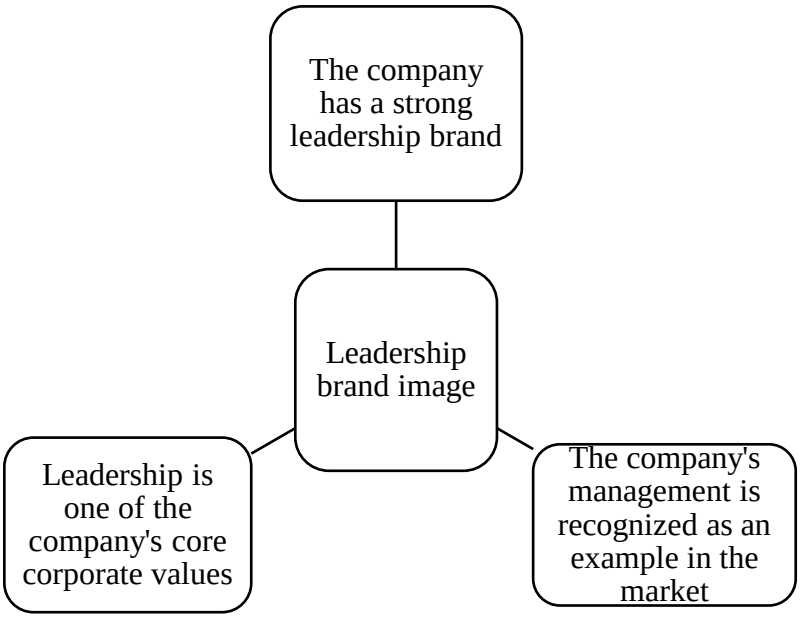

Figure 4. Leadership brand image

During the research, we conducted a survey on the impact of the "Leadership" brand on the company's competitiveness. A total of 60 people participated in this survey.

As a result of this survey, various criteria were evaluated. Various officials participated in the survey. Of these, 46 were employees, 10 were middle managers, and 4 were representatives of senior management (Figure 5).

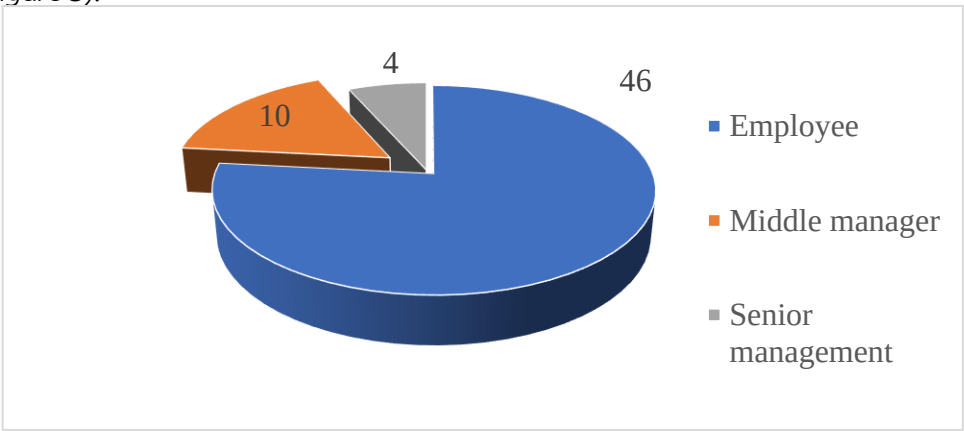

Figure 5. Duties of survey participants, in people

The length of time these individuals have worked in the company varies. 23 of these individuals have worked in the company for less than 1 year, 16 for 1-3 years, 6 for 3-5 years, and 15 for more than 15 years (Figure 6).

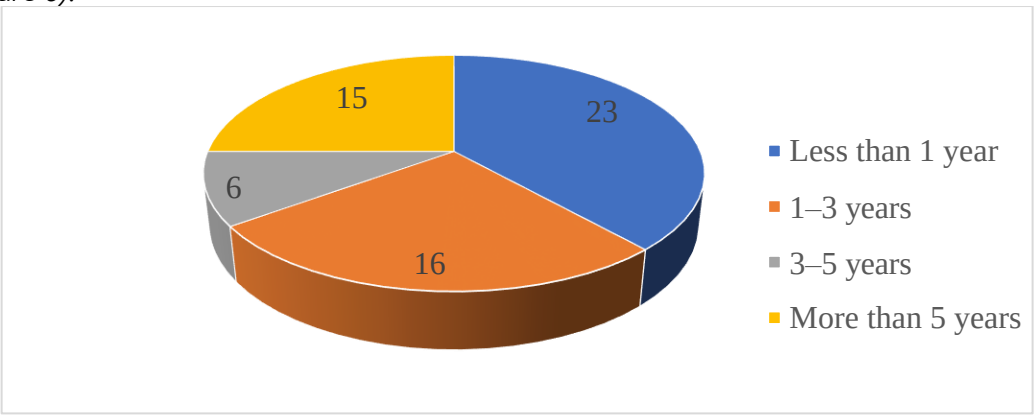

Figure 6. Work experience of respondents, in people

The average score was calculated based on the responses given by the survey participants and the results were analyzed based on this. When assessing the personal qualities of the leader, the average score of the personal qualities of the leader based on the responses of the survey participants was 3.97 (Figure 7).

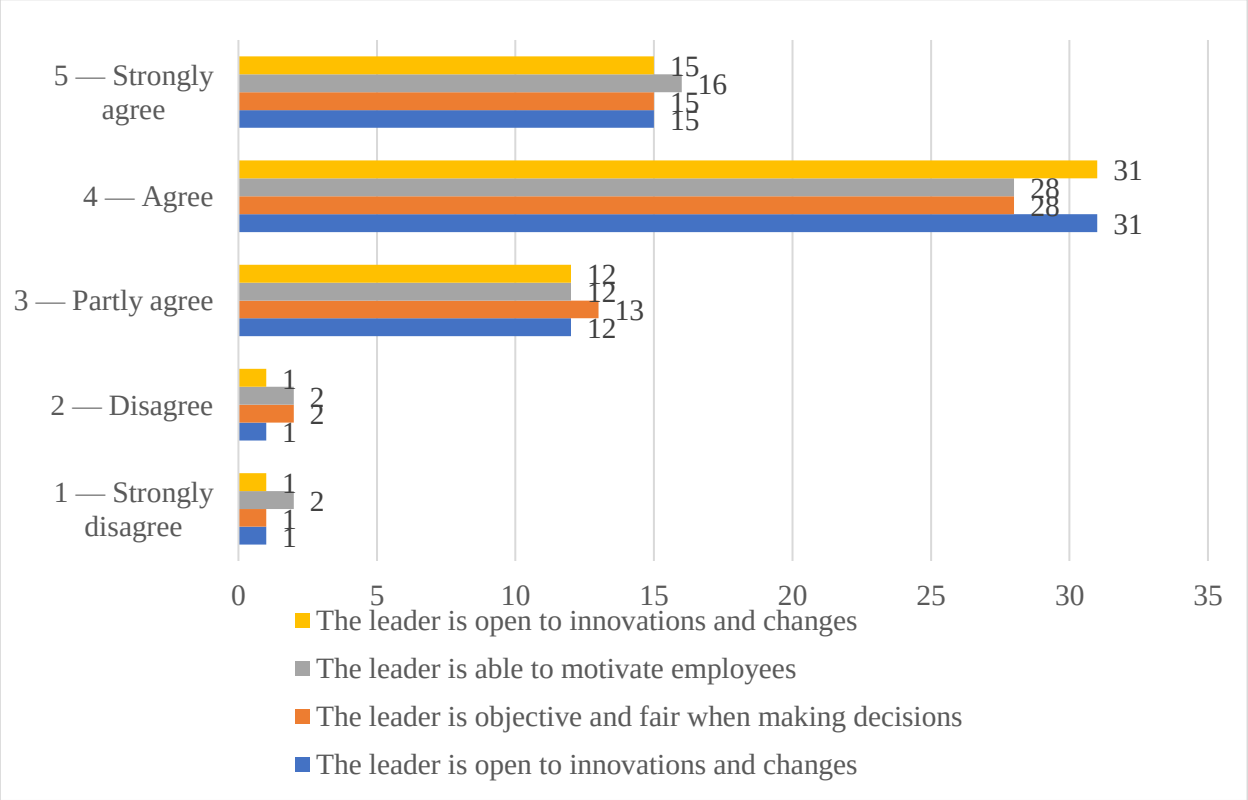

Figure 7. Personal qualities of a leader, by person

Trust in leadership was based on 3 criteria, of which trust in the company's management was determined as 4.12 points out of 5 points, the management's fulfillment of promises was determined as 3.9 points, and the management's consideration of the interests of employees was determined as 3.8 points (Figure 8).

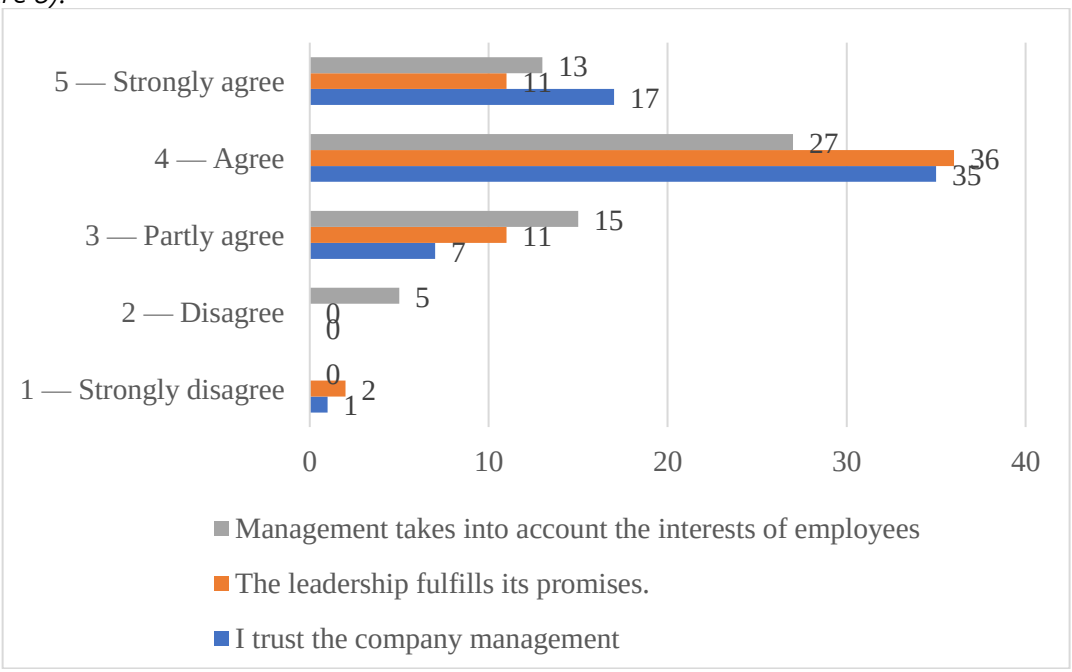

Figure 8. Trust in leadership, in person

When assessing the image of the leadership brand, it was determined that the company has a strong leadership brand with a score of 3.87, that the company is recognized as an example in the market

with a score of 3.8, and that leadership is one of the company's core corporate values with a score of 4 (Figure 9).

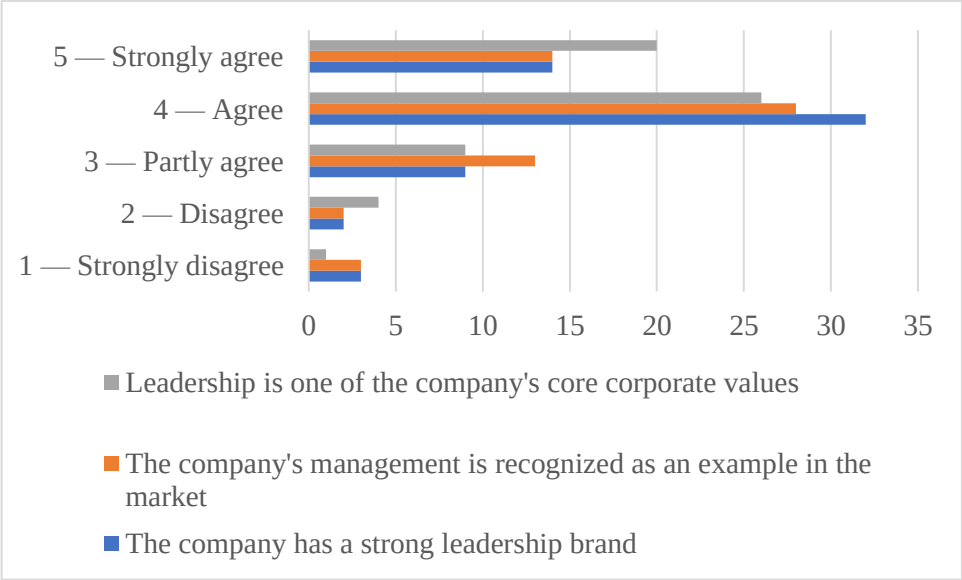

Figure 9. Leadership brand image, with people

When determining the level of leadership brand, 5 levels were distinguished. Based on the analysis, it was found that the "Leadership brand level" in the company we surveyed was 3.97. This indicates that the leadership brand is effective with a good level (Table 1).

Table 1.

Leadership brand assessment criteria based on average score

Average score range	*Level*	*comment*
1.00 – 1.80	*Very poor*	*Leadership brand not formed*
1.81 – 2.60	*Poor*	*Leadership mechanisms are ineffective*
2.61 – 3.40	*Average*	*Leadership brand partially formed*
3.41 – 4.20	*Good*	*Leadership brand is effective*
4.21 – 5.00	*Very high*	*Strong and sustainable leadership brand*

Conclusion. *According to the survey results, the average score for the leader's personal qualities was 3.97, the indicators for trust in leadership were 3.8–4.12, and for the leadership brand image 3.8–4.0. These results show that the leadership brand in the surveyed company is well-formed and effective. Leadership Brand has a positive impact on the competitiveness of the organization, increases employees' trust in management, and strengthens the company's image in the market. The study also shows that the development of the leader's personal qualities and strengthening trust in leadership directly affect the company's overall performance and competitive advantage.*

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STRATEGİC FACTORS INFLUENCİNG CORPORATE BUSİNESS STRATEGY: EVİDENCE FROM AZERBAİJAN'S ENERGY SECTOR

Khankishiyeva İlaha Aslan

Abstract

This study examines the external and internal factors shaping business strategy formulation in the context of digital transformation, geopolitical uncertainty, and energy transition. Using SOCAR (State Oil Company of the Azerbaijan Republic) as a case study, we employ a multi-method analytical framework including PESTEL analysis, Porter's Five Forces, SWOT analysis, and the VRIN resource-based view to identify and systematize strategic determinants. Our findings reveal that while traditional competitive advantages based on vertical integration and state support remain important, sustainable competitiveness increasingly depends on dynamic capabilities for organizational transformation. The study contributes to strategic management theory by integrating classical analytical models with contemporary challenges of decarbonization and demonstrating how national oil companies can navigate the energy transition. Practical implications include strategic recommendations for developing renewable energy portfolios, digital transformation initiatives, and human capital development programs essential for long-term viability in evolving energy markets.

Keywords: *Business strategy, strategic factors, PESTEL analysis, resource-based view, energy transition, SOCAR, Azerbaijan*

1. Introduction

The development of effective business strategy represents a fundamental challenge for contemporary strategic management, particularly in dynamic external environments characterized by intensifying global competition (Porter, 1980; Grant, 2016). The relevance of studying factors influencing business strategy development stems from the need for systematic understanding of how firms adapt to external challenges and efficiently utilize internal resources to achieve sustainable competitive advantage (Barney, 1991). In the context of digital economic transformation, geopolitical instability, and shifting consumer preferences, a company's ability to identify and account for multiple external and internal factors when formulating strategy becomes critical for long-term market success and survival (Teece, Pisano, & Shuen, 1997).

Despite significant theoretical developments in strategic management, the question of how external and internal factors comprehensively influence strategy formulation in current economic conditions requires additional investigation and clarification, accounting for new challenges and opportunities. This is particularly salient in the energy sector, where companies face the dual challenge of maintaining operational efficiency in traditional hydrocarbon businesses while simultaneously transforming their portfolios to align with global decarbonization commitments (UNFCCC, 2023).

1.1 Research Objectives

This study aims to comprehensively analyze factors influencing corporate business strategy formulation and develop recommendations for strategic planning improvement based on identified factors. Specifically, we seek to:

1. *Examine theoretical foundations of strategic management and systematize approaches to business strategy development*
2. *Classify factors influencing company strategy formulation*
3. *Investigate fundamental theoretical models for analyzing external and internal factors*
4. *Analyze external macroenvironmental factors and internal resources of the studied company*
5. *Develop recommendations for business strategy improvement based on factor analysis results*

1.2 Research Context

This investigation focuses on the strategic development process of a modern company operating in a dynamic external environment. The research object encompasses the factors of external and internal environment influencing business strategy development and implementation, as well as the mechanisms through which these factors interact and affect strategic decision-making.

The empirical analysis centers on SOCAR, Azerbaijan's national oil company, which provides an illuminating case of strategic transformation in the energy sector. Founded in 1992, SOCAR operates across the full value chain from exploration to retail, employing over 60,000 people across five countries (SOCAR, 2023). The company faces strategic imperatives common to national oil companies worldwide:

maintaining production from maturing fields, managing price volatility, and navigating the global energy transition while fulfilling national economic development objectives.

2. Theoretical Framework

2.1 Evolution of Strategy Concepts in Management

The concept of strategy in management has undergone substantial evolution, now representing one of the central concepts in organizational management theory. The term "strategy" originated from military science, where it denoted the art of planning and coordinating operations to achieve victory. The concept's application to business occurred in the mid-twentieth century, when increasing environmental complexity and intensifying competition required more systematic approaches to activity planning (Chandler, 1962).

Igor Ansoff's (1965) seminal work "Corporate Strategy" first systematized approaches to long-term planning and defined a matrix of strategic alternatives for corporate growth. Alfred Chandler (1962) empirically substantiated the relationship between strategy and organizational structure in his fundamental study "Strategy and Structure," formulating the famous thesis that "structure follows strategy."

Michael Porter made crucial contributions to strategic management theory. In his classic work "Competitive Strategy" (1980), he noted: "Competitive strategy is about being different. It means deliberately choosing a different set of activities to deliver a unique mix of value" (Porter, 1980, p. 1). Porter (1980) developed a conceptual model of five competitive forces enabling systematic analysis of industry structure and competitive environment. Porter (1985) further elaborated the value chain concept and a typology of generic competitive strategies (cost leadership, differentiation, focus) that continues to play a foundational role in strategic analysis.

An alternative perspective on strategy essence appears in the works of Henry Mintzberg, who critically rethought the rational model of strategic planning. Mintzberg (1987) proposed the concept of "five Ps of strategy" (plan, ploy, pattern, position, perspective), expanding the notion of strategy beyond formal planning. In collaborative work "Strategy Safari," Mintzberg, Ahlstrand, and Lampel (1998, p. 372) systematized ten schools of strategic thought, emphasizing that "strategy formation is a complex process that combines all the schools of thought presented in this book and more."

The resource-based view (RBV) of strategic management, developed by Wernerfelt (1984), Barney (1991), and Prahalad and Hamel (1990), shifted strategic analysis focus from external environment to a firm's internal resources and capabilities. Barney (1991, p. 99) formulated the core thesis of RBV: "firms can obtain sustained competitive advantages by implementing strategies that exploit their internal strengths, through responding to environmental opportunities, while neutralizing external threats and avoiding internal weaknesses." Barney developed VRIN criteria (valuable, rare, inimitable, non-substitutable) for assessing strategic potential of firm resources.

The dynamic capabilities concept proposed by Teece, Pisano, and Shuen (1997) extended the resource-based approach by focusing on an organization's ability to create, extend, and modify its resource base in response to external environment changes. Teece et al. (1997, p. 516) define dynamic capabilities as "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments."

2.2 Classification of Strategic Factors

Numerous factors influence corporate business strategy, and their systematization and analysis prove essential for effective strategy development. Classification of these factors helps structure information about a company's strategic environment and ensures comprehensive approach to strategic planning.

The most general classification divides factors into external and internal. External factors lie beyond the company's direct control and represent environmental conditions and circumstances to which the firm must adapt. Internal factors relate to the company's own resources, capabilities, and characteristics that are largely subject to management influence. This division is fundamental for strategic analysis, as it determines different approaches to addressing different factor groups (Barney, 1991).

External factors subdivide into macroenvironmental factors and microenvironmental or immediate environment factors. Macroenvironmental factors include broad social forces affecting entire industries and not directly connected to specific companies. These encompass economic factors such as economic growth rates, inflation, interest rates, exchange rates, unemployment, and other macroeconomic indicators affecting consumer purchasing power and resource costs (Porter, 1980).

Political and legal factors cover government policy, legislation, degree of industry regulation, political stability, tax systems, and trade barriers. Socio-cultural factors include demographic characteristics, cultural values and norms, lifestyles, attitudes toward work and leisure, environmental awareness,

and other social environment aspects influencing consumer choices and business conditions. Technological factors relate to the level of technological development, pace of innovation, government science and technology policy, degree of automation and digitalization, emergence of new technologies and obsolescence of existing ones. Environmental factors encompass natural conditions, availability of natural resources, climate change, environmental protection regulations and requirements, and public concern about environmental issues.

Microenvironmental or immediate environment factors directly affect the company's ability to serve its customers and include industry and competitive characteristics. These comprise suppliers who determine resource cost and quality; consumers, their numbers, preferences, and purchasing power; competitors including their numbers, sizes, strategies, and competitive positions; potential entrants creating threats for new competitors; and substitute products that can satisfy the same consumer needs alternatively (Porter, 1980).

Internal factors encompass a company's resources and capabilities determining its potential to implement particular strategies. Material resources include production capacity, equipment, technology, geographical location, and access to raw materials. Financial resources are determined by the company's financial position, capital, access to debt financing, and capital structure. Human resources include workforce numbers, qualifications, experience, motivation, corporate culture, and HR management systems (Barney, 1991).

Organizational factors relate to management structures, systems, and processes existing within the company, including organizational structure determining authority and responsibility distribution; planning and control systems; management quality and style; corporate culture and values; and information systems and management technologies. Reputation factors include brand recognition, company reputation, customer loyalty, and stakeholder relationships.

According to Porter's five forces model, "the collective strength of these forces determines the ultimate profit potential of an industry" (Porter, 1980, p. 3). As Barney (1991, p. 99) articulates in the resource-based view, "firms can obtain sustained competitive advantages by implementing strategies that exploit their internal strengths."

A specific factor group relates to top management characteristics, including their values, perspectives, and preferences. Leader personality and qualities, past experience, risk appetite, ambition, and motivation significantly influence strategic decisions. Although traditional strategic analysis models often underestimate these factors, in practice they can play decisive roles in strategy formulation (Hambrick & Mason, 1984).

2.3 Theoretical Models for Analyzing External and Internal Factors

To systematically analyze factors influencing business strategy, strategic management theory has developed numerous conceptual models and tools, each focusing on specific aspects of a company's strategic environment.

The PESTEL analysis model, which systematically studies political, economic, social, technological, environmental, and legal factors in the external environment, ranks among the most renowned macroenvironment analysis models. This model provides comprehensive understanding of macroeconomic and social trends that can affect company operations long-term. PESTEL analysis helps identify key drivers of industry change, assess potential impact of external factors on business, and prepare for future changes.

For analyzing competitive environment and industry factors, the five competitive forces model finds wide application. It examines five key factors determining competition intensity and industry attractiveness: rivalry among existing competitors, threat of new entrants, threat of substitutes, bargaining power of buyers, and bargaining power of suppliers. Analysis of each force enables understanding of industry structure, identifying sources of competitive pressure, and determining opportunities for creating competitive advantages (Porter, 1980).

Internal factor analysis relies on the resource-based conception of strategic management, which views the company as a unique bundle of resources and capabilities determining its competitive advantage. According to this approach, sustainable competitive advantage can only be achieved through resources that are valuable, rare, difficult to imitate, and non-substitutable. The resource-based conception shifts strategic analysis focus from external environment to internal capabilities and emphasizes importance of developing unique competencies as foundation for competitive advantage (Barney, 1991).

SWOT analysis, combining results of external and internal factor analysis, serves to comprehensively assess a company's strategic position. This model systematically identifies the company's strengths and weaknesses, opportunities and threats in external environment, and enables strategy development based on various combinations of these factors. SWOT analysis helps create connections between

internal characteristics and external conditions, identify strategic alternatives, and determine strategic development priorities.

The value chain model analyzes a company's internal processes in terms of their contribution to creating customer value. This model divides company activities into primary and support activities, each adding value to the final product or service. Value chain analysis helps identify sources of competitive advantage, pinpoint areas for improvement, and determine opportunities for cost reduction or product differentiation (Porter, 1985).

3. Methodology

3.1 Research Design

This study employs a combination of general scientific and specialized methods, including:

- ***Systems analysis**: To examine business strategy as an integrated system of interrelated elements*
- ***Comparative analysis**: To compare different theoretical approaches and practical solutions*
- ***Strategic analysis methods**: Including PESTEL analysis for macroenvironment factors, SWOT analysis for assessing strengths, weaknesses, opportunities and threats, competitive analysis for studying industry factors using Porter's Five Forces*
- ***Expert assessments**: To determine relative importance of various factors*

3.2 Data Sources

The research base comprises:

- *Peer-reviewed journal publications on strategic management and related disciplines*
- *Monographs and academic publications by leading experts in strategic management*
- *Analytical reports from consulting firms and research organizations*
- *SOCAR's official reports, particularly the 2023 Sustainable Development Report*
- *Statistical data from government agencies and international organizations*
- *Materials from industry associations and professional communities*

3.3 Research Limitations

This study limits itself to analyzing factors influencing business strategy formulation at the corporate level without detailed investigation of functional and operational strategies. The temporal scope covers the current period of strategic management theory and practice development. The empirical portion bases itself on analysis of a specific company, which prevents full extrapolation of results to all industries and organization types without accounting for specific characteristics.

4. Empirical Analysis: SOCAR Case Study

4.1 Company Overview

The State Oil Company of the Azerbaijan Republic (SOCAR) was established by Presidential Decree on September 13, 1992, representing Azerbaijan's first national oil company engaged in the oil and gas industry.

SOCAR's mission states: "To promote sustainable development and energy security at local, regional and international levels by utilizing our rich experience with modern technologies and competencies in oil and gas operations" (SOCAR Sustainable Development Report, 2023, p. 9).

The company's vision declares: "To be a leading energy company by developing our operations through energy transition, innovation and digitalization" (SOCAR Sustainable Development Report, 2023, p. 9).

SOCAR operates across the complete oil and gas value chain through three main segments:

***Production**: Exploration, development and operation of oil and gas fields; geological exploration activities. As of 2023, SOCAR's proven oil reserves totaled 82.4 million tons, with natural gas reserves of 15.8 billion m³ (SOCAR, 2023).*

***Transportation**: In 2023, the volume of oil delivered for processing and export reached 7,976.5 thousand tons, with total natural gas distribution of 19,289.6 million m³.*

***Processing and Marketing**: Operating the Heydar Aliyev Oil Refinery, carbamide plant, gas processing plant, and methanol plant. In 2023, oil processing reached 6,501.7 thousand tons and gas processing 3,506.94 million m³.*

Financially, SOCAR demonstrated the following consolidated performance (million manat):

Indicator	*2021*	*2022*	*2023*
Consolidated revenue	*19,228*	*77,531*	*85,201*
Net profit	*9,424*	*2,115*	*2,073*

Source: SOCAR Sustainable Development Report 2023, p. 10

In 2024, SOCAR's consolidated revenue reached $49.817 billion, down $301.2 million compared to 2023 due to energy price volatility. Fitch Ratings projected 2024 revenue at $50.61 billion with operating EBITDA of $3.54 billion, forecasting EBITDA margin improvement from 7% in 2024 to 7.2% in 2025.

SOCAR's workforce structure as of December 31, 2023 totaled 48,320 employees in Azerbaijan, with international operations adding 12,176 employees (Turkey: 5,509; Georgia: 4,055; Ukraine: 1,794; Switzerland: 818), bringing total Group employment to 60,496 people.

4.2 External Factor Analysis: PESTEL Framework

Table 1 presents a comprehensive PESTEL analysis of SOCAR's macroenvironment:

Table 1: PESTEL Analysis of SOCAR's Macroenvironment

Factor	*Impact on SOCAR*	*Assessment*
POLITICAL		
Regional geopolitical stability	*Azerbaijan strengthened energy partnership with EU in 2023; memorandum signed to double gas exports to Europe by 2027*	*High (+)*
State energy policy	*SOCAR operates under full state ownership ensuring strategic support*	*High (+)*
Sanctions policy	*Western sanctions on Russia create opportunities for alternative suppliers*	*Medium (+)*
ECONOMIC		
Oil and gas price volatility	*Revenue decreased $301.2M in 2024 due to energy price fluctuations*	*Very High (-)*
Agreement to double gas exports to EU	*Export supply potential increase of 1.7 billion m³ annually*	*High (+)*
Access to financing	*$1.2B reduction in credit obligations in 2024 demonstrates improving financial position*	*Medium (+)*
SOCIAL		
Demographic changes	*Average employee age of 44; need for workforce renewal*	*Medium (-)*
CSR requirements	*SOCAR allocated 300M manat to social programs in 2023*	*Medium (+)*
Gender diversity	*Women comprise only 16% of total workforce due to industry characteristics*	*Low (-)*
TECHNOLOGICAL		
Digital transformation	*"Target Operating Model" developed and approved for efficiency improvement through digitalization*	*High (+)*
Energy transition	*Agreements signed with Masdar, ACWA Power, Energy China and BP for renewable energy development*	*Very High (+)*
Intelligence innovations	*Use of modern geological exploration technologies to maintain resource base*	*High (+)*
ENVIRONMENTAL		
Climate commitments	*SOCAR joined Oil and Gas Decarbonization Charter (OGDC) at COP28 with targets: zero routine flaring by 2030; 30% emissions reduction by 2030; carbon neutrality by 2050*	*Very High (+/-)*
Renewable energy development	*Contracts for 2 GW offshore wind and hydrogen; 1 GW solar and 1 GW onshore wind*	*High (+)*
LEGAL		
Anti-corruption legislation	*Zero tolerance anti-corruption policy; no corruption cases detected in 2023*	*Medium (+)*
Labor legislation	*Full compliance with Azerbaijan Labor Code*	*Low*

Source: Compiled by author based on SOCAR Sustainable Development Report 2023 and 2024-2025 analytical data

The external analysis reveals several critical strategic implications:

*1. **Energy Transition Imperative**: The very high impact of technological and environmental factors related to renewable energy and decarbonization necessitates fundamental business model transformation*

*2. **Geopolitical Opportunities**: Europe's diversification away from Russian gas creates substantial growth opportunities for Azerbaijani supplies*

*3. **Price Volatility Risk**: Continued exposure to hydrocarbon price fluctuations requires portfolio diversification strategies*

*4. **Demographic Challenge**: Aging workforce (average age 44) and low gender diversity constrain organizational capability development*

4.3 Industry Analysis: Porter's Five Forces

Table 2 applies Porter's framework to assess competitive dynamics:

Table 2: Competitive Forces Analysis (Porter's Model)

Competitive Force	Intensity	Analysis for SOCAR	Strategic Response
Rivalry among existing competitors	Medium (6/10)	Competition with regional national oil companies (KazMunayGaz, Turkmenneft), but protected position through state support	- Diversify export geography - Focus on supply quality and reliability
Threat of new entrants	Low (3/10)	High barriers to entry: capital intensity ($6.7B for STAR refinery), government regulation, resource base control	- Strengthen infrastructure control - Strategic alliances
Threat of substitutes	High (8/10)	Growing competition from renewable energy sources, transport electrification and hydrogen economy	Critical: Active transformation to energy company with renewable portfolio
Bargaining power of suppliers	Low (4/10)	SOCAR controls own resource base; dependence on equipment and technology (Schlumberger, Baker Hughes)	- Develop local equipment production - Diversify suppliers
Bargaining power of buyers	Medium (6/10)	Large contracts with EU via TAP/TANAP strengthen buyer position; customer base diversification reduces risks	- Long-term contracts with indexation - Develop retail segment (206 filling stations in Switzerland)

Overall Industry Attractiveness: 5.4/10 (moderate attractiveness requiring transformation)

Source: Compiled by author based on SOCAR Sustainable Development Report 2023

The competitive analysis demonstrates that while SOCAR maintains strong positions through vertical integration and state support, the high threat from substitute energy sources and moderate overall industry attractiveness necessitate strategic repositioning toward integrated energy provision rather than exclusive hydrocarbon focus.

4.4 Internal Factor Analysis: Resource-Based View

Applying Barney's (1991) VRIN framework to assess SOCAR's strategic resources:

Table 3: VRIN Analysis of SOCAR's Key Resources

Resource/Capability	Valuable (V)	Rare (R)	Inimitable (I)	Non-substitutable (N)	Competitive Advantage
Control of Azerbaijan's oil fields	✓	✓	✓ (state monopoly)	~ (energy substitutes)	Sustainable (short-term)
Integration into European gas pipelines (TANAP/TAP)	✓	✓	✓ (25 years construction)	✓	Sustainable
130+ years Caspian Sea experience	✓	✓	~ (can be acquired)	~	Temporary
Access to government financing	✓	✓ (for region)	✓	✓	Sustainable
SOCAR brand	✓	~	~	~	Parity
Organizational culture	~	~	~	~	Disadvantage (requires transformation)

Source: Compiled by author based on SOCAR Sustainable Development Report 2023

The VRIN analysis reveals that SOCAR's sustainable competitive advantages rest primarily on unique physical assets and state support, but achieving long-term viability requires developing dynamic capabilities for energy transition.

4.5 SWOT Synthesis

Integrating external and internal analyses yields the following SWOT matrix:

Table 4: SOCAR SWOT Analysis

Strengths (S)

- *Vertical integration: Full cycle operations from exploration to retail*
- *State support: 100% state ownership ensures strategic stability*
- *Geographic diversification: Presence in 5 countries*
- *Strategic positioning: Key role in East-West energy corridors (BTC, TANAP, TAP)*
- *Strong financial position: $1.2B reduction in credit obligations in 2024*

Weaknesses (W)

- *Declining proven reserves: Oil reserves decreased from 93.9M to 82.4M tons (2022-2023)*
- *Gender imbalance: Women comprise only 16% of workforce*
- *Hydrocarbon price exposure: $301.2M revenue decrease in 2024 due to price volatility*
- *Aging infrastructure: Production facilities require modernization*
- *Low EBITDA margin: 7% (2024) versus 15-20% industry average*

Opportunities (O)

- *Energy transition: Agreements for 4 GW renewable energy development*

- *Growing European gas demand: Agreement to double EU gas exports by 2027*
- *Digitalization: Industry 4.0 implementation can improve operational efficiency 15-20%*
- *New market expansion: Potential in Central Asia and Europe*
- *Hydrogen economy: Development of green hydrogen as new business*

Threats (T)

- *Geopolitical risks: Regional instability can affect export routes*
- *Global economic decarbonization: Long-term demand reduction for fossil fuels*
- *Price volatility: Unpredictability of oil and gas prices*
- *Technological risks: Falling behind in new production technologies*
- *Environmental regulation: Stricter emission requirements may increase operational costs*

Source: Author's analysis based on SOCAR Sustainable Development Report 2023 and analytical data

4.6 Dynamic Capabilities Assessment

Following Teece et al. (1997), we evaluate SOCAR's dynamic capabilities for transformation:

Table 5: Assessment of SOCAR's Dynamic Capabilities

Capability	*Development Level*	*Indicators*	*Recommendations*
Sensing *(identifying opportunities)*	*Medium (6/10)*	*- Supervisory Board created 2021 - 585 employees trained on corruption risks - No systematic foresight*	*- Create Strategic Foresight unit - Participate in global energy forums - Analyze disruptive technologies*
Seizing *(exploiting opportunities)*	*High (8/10)*	*- Rapid contract signing with Masdar, ACWA Power (2023) - Launch of "Target Operating Model" - $18.2B investment in Turkey*	*- Accelerate decision-making - Venture fund for cleantech investments - Agile transformation*
Transforming *(business model reconfiguration)*	*Medium (5/10)*	*- Energy transition initiated - 16,729 hours Leadership Academy training - But 66% of workforce are low-adaptability workers*	*- Mass workforce reskilling - Organizational culture change - Innovation stimulation (Innovation Lab)*

Source: Compiled by author based on SOCAR Sustainable Development Report 2023

The dynamic capabilities assessment reveals that while SOCAR demonstrates strong capacity for seizing identified opportunities, capabilities for sensing emerging trends and transforming the organizational model require significant enhancement to support the energy transition strategy.

5. Strategic Recommendations

5.1 Priority Strategic Directions

Based on the integrated factor analysis, we propose the following strategic priorities organized by the SWOT framework:

Table 6: Strategic Priorities Based on SWOT Analysis

Strategy	*Factor Combination*	*Specific Recommendations*	*Expected Effect*
SO (Strength-Opportunity)	*Vertical integration + Energy transition*	*Develop full cycle green hydrogen production (from renewable generation to export)*	*Create new business with potential $500M revenue by 2030*
WO (Weakness-Opportunity)	*Reserve depletion + Digitalization*	*Apply AI and machine learning to optimize oil recovery (+5-10%)*	*Increase extracted reserves by 8-12M tons*
ST (Strength-Threat)	*Financial stability + Decarbonization*	*Invest in CCS (carbon capture and storage) at existing fields*	*Achieve 30% emissions reduction by 2030 per commitments*
WT (Weakness-Threat)	*Low EBITDA margin + Price volatility*	*Operational Excellence Program: 10% cost reduction through process automation and optimization*	*Increase EBITDA margin from 7% to 9-10% by 2027*

Source: Compiled by author

5.2 Digital Transformation Roadmap

Given the high strategic importance of digitalization identified in the PESTEL analysis, we propose a phased implementation:

Table 7: SOCAR Digital Transformation Roadmap (2024-2030)

Phase	Period	Key Initiatives	Investment ($M)	KPIs
Foundation	2024-2025	- Unified ERP system implementation - Data lake creation - Core process automation	50-70	100% centralization of corporate data
Optimization	2026-2027	- Predictive analytics for equipment - RPA for routine operations - Digital twins of oil fields	80-100	- 30% reduction in unplanned downtime - 10% operational cost reduction
Transformation	2028-2030	- AI-optimized extraction - Autonomous platform operations - Blockchain for supply chain	120-150	- 5-7% recovery factor improvement - 40% unmanned operations at facilities

Source: Compiled by author

5.3 Decarbonization Program

To address the very high environmental factor impact, SOCAR requires a comprehensive decarbonization strategy:

Table 8: SOCAR Decarbonization Program (2024-2050)

Target Metric	Baseline (2022)	Target 2030	Target 2035	Target 2050	Key Measures
Zero routine flaring	15% flared	0%	0%	0%	- Gas collection network construction - Small gas processing plants - Utilization for power generation
Emissions intensity reduction (upstream)	100% (base)	-30%	-50%	-100%	- Platform electrification - Use of renewable sources - CCS technology
Corporate emissions reduction	100% (base)	-15%	-30%	-100% (net zero)	- Refinery energy efficiency - Transition to green hydrogen - Offsetting residual emissions
Methane emissions reduction	Current level	-50%	Near-zero	Zero	- LDAR programs - Equipment replacement - Continuous monitoring
Renewable share in energy balance	<1%	10%	25%	60%	- 4 GW solar and wind - 2 GW offshore wind - Hydrogen projects

Source: SOCAR Sustainable Development Report 2023, p. 5; OGDC COP28 commitments

5.4 Human Capital Development Strategy

To address the demographic weakness identified in the SWOT analysis (average age 44, only 16% women), SOCAR requires comprehensive talent management:

Short-term (2025-2030) Objectives:

- Reduce average employee age to 40 through active youth recruitment (minimum 2,000 annually)
- Increase women's workforce share to 25% (from 16% in 2023)
- Increase specialist and technical worker proportion to 35% (from 29.3% in 2023) through reskilling programs
- Ensure each employee receives minimum 40 hours annual training (4x increase from 9.76 hours in 2023)
- Create talent pipeline for all key leadership positions (100% coverage)
- Establish SOCAR Corporate University with accredited professional development programs

Medium-term (2030-2040) Objectives:

- Achieve generational parity: minimum 30% employees under 35, 40% aged 35-50, 30% over 50
- Reach 35% women in leadership positions, including at least 25% at senior management levels
- Deliver 60+ annual training hours per employee focusing on digital and green competencies
- Achieve 75%+ Employee Engagement Index (per Gallup methodology)
- Prepare minimum 500 specialists in renewable energy, hydrogen technologies and digitalization
- Create pool of at least 50 high-potential leaders ready for top management
- Position SOCAR as employer of choice in regional energy sector

6. Discussion and Theoretical Contributions

This study contributes to strategic management theory in several ways:

6.1 Integration of Classical Models in Transition Contexts

We demonstrate how classical strategic analysis frameworks (PESTEL, Porter's Five Forces, RBV, VRIN) can be productively applied to analyze national oil company transformation in energy transition contexts. The integration of these models provides comprehensive understanding of how external environmental shifts (particularly regulatory and technological changes driving decarbonization) interact with internal resource configurations to create both strategic imperatives and constraints.

6.2 Resource-Based View and Dynamic Capabilities

Our analysis empirically supports Barney's (1991) proposition that sustainable competitive advantage derives from VRIN resources, while also confirming Teece et al.'s (1997) argument that in rapidly changing environments, dynamic capabilities to "integrate, build, and reconfigure internal and external competences" become critical. SOCAR's case illustrates how resources providing advantage in one era (e.g., hydrocarbon reserves, production expertise) must be complemented by organizational capabilities for transformation when paradigm shifts occur.

Specifically, we find that:

- ***Sensing capabilities** require enhancement through systematic environmental scanning, participation in global energy forums, and analysis of disruptive technologies*
- ***Seizing capabilities** are relatively strong, evidenced by rapid contract formation with renewable energy partners*
- ***Transforming capabilities** need substantial development, particularly regarding workforce reskilling and organizational culture change*

6.3 Stakeholder Theory Application

Freeman's (1984) stakeholder theory gains empirical support through our analysis of how SOCAR must balance diverse stakeholder interests: state revenue requirements, employee welfare, European energy security needs, and global climate commitments. The company's ESG strategy represents practical implementation of stakeholder theory, moving beyond shareholder primacy to multi-stakeholder value creation.

6.4 Upper Echelons Theory

While our primary focus remains environmental and resource factors, the analysis also highlights the critical role of top management characteristics in strategic transformation. SOCAR's Supervisory Board establishment (2021) and Leadership Academy programs reflect recognition that leadership capabilities significantly influence organizational capacity to navigate transitions, consistent with Hambrick and Mason's (1984) upper echelons theory.

6.5 Contextual Considerations

Our findings must be interpreted within specific contextual parameters:

***National Oil Company Context**: SOCAR operates under full state ownership, which both enables long-term strategic investment (free from quarterly earnings pressures) and constrains strategic autonomy (requiring alignment with national development objectives). This differs fundamentally from publicly traded international oil companies.*

***Geographic and Historical Context**: Azerbaijan's position in the Caspian region, its 130+ year petroleum history, and its role in East-West energy corridors create unique strategic opportunities (e.g., pipeline infrastructure to Europe) not generalizable to all oil companies.*

***Transition Timing**: SOCAR faces energy transition imperatives while operating in a region with substantial remaining hydrocarbon resources and markets with continued fossil fuel demand. This creates different strategic calculus than for companies in markets with accelerated phase-out timelines.*

7. Practical Implications

The research yields several actionable implications for practitioners:

7.1 For SOCAR Specifically

1. ***Accelerate Portfolio Transformation**: Current renewable energy commitments (4 GW) represent positive direction but should expand given the high threat from energy substitutes identified in our Five Forces analysis*
2. ***Prioritize Dynamic Capability Development**: Investment in organizational learning, workforce reskilling, and agile structures should receive comparable priority to capital projects, as transformation capabilities determine success of strategy implementation*
3. ***Strengthen ESG Integration**: Move beyond compliance to strategic integration of environmental, social and governance factors as sources of competitive advantage and risk mitigation*

7.2 For National Oil Companies Generally

1. ***Proactive Rather Than Reactive Transformation**: Companies should initiate energy transition strategies based on long-term trajectory analysis rather than waiting for demand destruction in core businesses*
2. ***Leverage Existing Strengths**: Infrastructure, customer relationships, and operational capabilities developed in hydrocarbon businesses can be reconfigured to support new energy businesses (e.g., hydrogen, CCUS, offshore wind)*
3. ***Systematic Strategic Factor Analysis**: Regular, disciplined analysis using frameworks like PESTEL, Five Forces, and RBV/VRIN helps identify strategic imperatives before they become crises*

7.3 For Policymakers

Our analysis highlights policy implications for governments overseeing national oil companies:

1. ***Enabling Transformation**: Policies should facilitate rather than impede national oil company diversification into new energy businesses*
2. ***Balancing Revenue and Transition**: Recognition that maximizing short-term hydrocarbon revenues may conflict with long-term energy security and climate objectives*
3. ***Supporting Workforce Transition**: National education and retraining programs should align with energy sector transformation needs*

8. Limitations and Future Research

Several limitations constrain this study's scope:

8.1 Single Case Design

While SOCAR provides rich illustration of strategic factor dynamics, single case analysis limits generalizability. Future research should employ comparative case designs across multiple national oil companies in different contexts (e.g., Middle Eastern, Latin American, African NOCs) to identify universal versus context-specific patterns.

8.2 Temporal Constraints

Our analysis captures SOCAR's strategic position at a particular moment (2023-2024) in a rapidly evolving environment. Longitudinal research tracking strategy evolution over extended periods would provide deeper insights into factor dynamics and capability development processes.

8.3 Level of Analysis

This study focuses on corporate-level strategy without detailed examination of functional and business unit strategies. Future research could investigate how corporate-level strategic factors translate into specific functional area implications (e.g., technology strategy, marketing strategy, operations strategy).

8.4 Measurement Challenges

Some critical constructs (e.g., organizational culture, dynamic capabilities) resist precise quantification. While we employed multiple data sources for triangulation, future research using primary data collection and validated measurement instruments could enhance construct validity.

8.5 Recommended Future Research Directions

1. ***Comparative Analysis**: Multi-case comparison of NOC transformation strategies across different national and market contexts*
2. ***Longitudinal Studies**: Tracking strategic factor evolution and organizational adaptation over time*
3. ***Quantitative Modeling**: Developing and testing quantitative models of relationships between strategic factors and performance outcomes*
4. ***Micro-Foundations**: Investigating individual and group-level processes underlying organizational capability development*
5. ***Stakeholder Perspectives**: Primary research examining how different stakeholder groups perceive and influence strategic priorities*

9. Conclusion

This comprehensive analysis of factors influencing business strategy formulation, using SOCAR as an empirical case, yields several fundamental conclusions:

9.1 Multi-Factorial Nature of Strategy

Business strategy emerges from complex interactions among numerous external and internal factors, as well as top management characteristics and preferences. No single factor category (e.g., market forces or resource endowments) fully determines strategic choices; rather, effective strategy requires systematic consideration of multiple factor groups and their interactions.

9.2 Dynamic Capabilities as Critical Success Factor

In contexts of fundamental environmental change—particularly the global energy transition—sustainable competitive advantage increasingly depends on dynamic organizational capabilities (sensing, seizing, transforming) rather than static resource positions. Companies must develop systematic approaches to environmental scanning, rapid opportunity exploitation, and organizational renewal.

9.3 Integration of Classical Analytical Frameworks

Classical strategic analysis tools (PESTEL, Porter's Five Forces, RBV/VRIN, SWOT) remain valuable when applied systematically and integrated comprehensively. Each framework illuminates different facets of strategic reality; their combination provides robust foundation for strategy formulation.

9.4 Imperative for National Oil Company Transformation

National oil companies face strategic imperatives to transform from traditional hydrocarbon producers to integrated energy providers capable of operating in decarbonizing economies. This transformation requires:

- *Portfolio diversification into renewable energy and low-carbon technologies*
- *Development of new organizational capabilities and business models*
- *Substantial investment in human capital development and reskilling*
- *Strategic repositioning from resource extraction to energy service provision*

9.5 Stakeholder Integration

Modern corporate strategy extends beyond narrow economic objectives to encompass multiple stakeholder interests and sustainability imperatives. Successful strategies create long-term value for diverse stakeholders including shareholders, employees, customers, communities, and society broadly.

The case of SOCAR illustrates these principles concretely. The company's transformation from traditional oil and gas corporation to integrated energy company capable of operating in the global energy transition reflects broader strategic paradigm shifts in the energy sector. SOCAR's ambitious sustainable development strategy, presented at COP29 in Baku in November 2024, positions the company as a regional leader in sustainable energy while demonstrating practical implementation of strategic renewal concepts in contexts of fundamental industry paradigm change.

Success of this strategic transformation will ultimately depend on SOCAR's ability to integrate traditional hydrocarbon competencies with new capabilities in green energy, digitalization, and sustainable development—precisely the dynamic capability development that strategic management theory identifies as essential for sustained competitive advantage in turbulent environments.

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DIGITAL MARKETING IN THE TRANSFORMATION OF ECONOMIC RELATIONS: CHALLENGES AND STRATEGIES

Mammadova Afat Mammadhuseyn
Ph.D. (Econ.), Associate Professor
Azerbaijan University of Architecture and Construction
Department of Economic Theory and Marketing
https://orcid.org/0000-0002-7169-3081

Abstract

Marketing determines the development of economic entities in the digital age. The article analyzes the role of innovative digital marketing, key strategies (personalization, omnichannel, AI), challenges of digitalization (information overload, data security) and business opportunities. A model of sustainable marketing based on the trends of 2026 is proposed.

Keywords: digital marketing, personalization, omnichannel strategies, AI, economic transformation.

Introduction

Marketing is the most important part of the overall market activity, which affects the financial and economic activities of each economic entity and determines the direction of its development. It defines the main activities and rules of any economic entity, because this is especially important in business organization. [1]

Innovative and digital marketing, which is developing under the influence of new information technologies, occupies one of the main positions in modern business at a time of changing economic relations. This strengthens competitive advantages by increasing customer loyalty and optimizing costs in an environment of economic instability. [8]

Innovative marketing is aimed at the constant development of new methods and techniques for promoting marketing strategies that will allow an economic entity to successfully sell its products in a modern, competitively developing market of goods and services. A distinctive feature of successful digital marketing activities is that they are highly profitable in a competitive market and focus on significantly lower advertising costs. Of course, it is appropriate to use creative solutions and digital technologies to achieve high financial results.

Digitalization, which is currently taking place in all spheres of society, penetrates into all aspects of the activities of modern economic entities, changing the way they interact with macro- and microstructures existing in the environment. This process is marked not only as a technological innovation, but also as a fundamental change in all fields of activity.

1. Challenges of digitalization of marketing services

The global nature of digitalization and the fact that local economic actors are, in a certain sense, part of the global economic system create new opportunities, as well as some challenges. These problems also require marketers to find new solutions and adapt to new processes. [7]

At the same time, the process of digitalization creates new challenges in the organization of marketing services, as well as opens up wide opportunities. Along with the rapid development of technology, new directions are opening up for marketers.

Key challenge factors: [5]

• Information overload: the advent of the digital age brings information to the mass consumer that can be used to organize marketing services. Processing large amounts of data requires special skills and tools.

• Data security: As the amount of information increases, the risk of unauthorized dissemination or misuse increases. Marketers face the pressure of strict privacy protection requirements.

• Technology dynamism: The pace of digital technology development is accelerating, requiring constant updating of knowledge and flexibility.

• Increased competition: New technologies accelerate the competition for attention, demanding creative content.

• Changing consumer behavior: digitalization is changing expectations, forcing us to re-evaluate strategies. [6]

• The speed of adaptation of an economic entity to the modern environment and the flexibility of applying new methods of working with consumers are the main focus of the work of specialized specialists. [7]

2. The benefits of digital technology for business

The benefit of digital technologies for an economic entity is that they allow for a more accurate and deeper understanding of consumer needs and behavior. The integration of innovative methods and tools into marketing strategies is effective in establishing closer relationships with the consumer audience. [3]

This is achieved through the personalization of data-based offers, real-time communication in omnichannel ecosystems, and predictive analytics that allows you to predict trends and minimize risks. As a result, customer loyalty increases, costs are optimized, and competitiveness in the global market is growing.

Key tools:

• Big data, AI and machine learning for segmentation and automation.

• Creating value ecosystems for sustainable development through the ethical use of data. It is a unique tool for building customer-oriented, personalized, purposeful, mutually beneficial relationships that strengthen market connections and retain customers.

Digitalization requires constant updating of marketing knowledge, adaptation to new technologies, and the search and implementation of innovative solutions to establish effective and interactive relationships with the consumer audience.

In a globally competitive environment, it is critically important to create personalized user routes based on deep data analytics, AI, and process automation.

3. Key digital marketing strategies

Important marketing strategies in the digital age include data-driven personalization, omnichannel interaction, and the use of AI for predictive analytics. [3]

Strategy	*Description*	*of the Advantage*
Personalization and hyperpersonalization	*Create customized offers in real time with big data and AI, emotion analysis and biometrics.[15]*	*Increase loyalty and conversions [3]*
Autonomous AI systems	*Platforms that independently design and optimize campaigns.*	*Minimization of manual labor, rapid adaptation. [8]*
Emotional Marketing	*Focus on emotions through XR technology, voice search and UGC in nano communities.*	*Increased engagement. [4]*
Micro-segmentation and smart CRM	*Division into micro-groups with CDP for proactive communication*	*Purchase forecasting [3]*
Marketing automation	*Chatbots, email, social media for feedback.*	*Simplification of processes. [9]*
Interactive content	*Content for interaction after purchase.*	*Increased profitability. [9]*

Omnichannel (combining all channels into a single history-preserving system) provides a seamless online/offline experience, increasing customer retention by up to 89%.[3]

Conclusion

The modern era is changing approaches to business through the global Internet, social media, and data analysis. Digital tools allow marketers to adapt to innovation by focusing on personalization and automation. The balance of challenges and opportunities strengthens the position of business in an unstable economy. It is recommended to invest in training, data ethics, and omnichannel platforms for sustainable growth [9].

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G7 AND BRICS+: ECONOMIC GROWTH EFFICIENCY

Sevinc İbrahimova
Associate Professor of Odlar Yurdu University, Baku, AZ,1072, Azerbaijan
https://orcid.org/0009-0004-3670-2132
Mayil Orujov
Honorary Professor of SMBS (Swiss Montreux Business School),
Odlar Yurdu University, Baku, AZ,1072, Azerbaijan
https://orcid.org/0009-0001-8177-3851
Azer Orujov
Social Services Agency, Baku, Azerbaijan
https://orcid.org/0009-0008-5638-8020
Nermin Orujova
Social Services Agency, Baku, Azerbaijan
https://orcid.org/0009-0007-1222-4238
Nurane Yunusova
Odlar Yurdu University, Baku, AZ,1072, Azerbaijan
https://orcid.org/0009-0005-1919-2705

Abstract

Calculations and models in the article show that the nearly fourfold superiority of the ten BRICS+ countries over the Group of Seven developed economies in terms of average annual GDP growth in 2000–2024 is largely due to their more than twofold superiority in investment efficiency and fivefold superiority in average annual total factor productivity (TFP) growth. The success of the BRICS+ countries as a whole was ensured by improved public administration efficiency, the implementation of export-oriented industrialization (primarily in the largest Asian countries – China, India, and Indonesia), significant progress in the development of physical and human capital, and innovative development. Largely due to the dynamic growth of China and India, which accounted for almost four-fifths (three-fifths and one-fifths, respectively) of the BRICS+ countries' GDP growth, the BRICS+ countries outpaced the Group of Seven in GDP (based on PPP) by a third and in industrial production by more than two times. They also surpassed the G7 in the value of high-tech exports and reached more than two-fifths and one-half the G7 level in total factor productivity and the human development index, respectively. Although, starting in the early 2010s, the BRICS+ countries suffered from a slowdown in economic growth, caused, as calculations show, mainly by a reduced contribution of external demand from slow-growing developed countries, which imposed severe restrictions on exports from BRICS+ countries and other developing countries, the BRICS+ countries as a whole over the past 10-15 years continued to outperform the G7 in investment efficiency by three-quarters and in the average annual growth rate of total factor productivity by four times.

Keywords: BRICS+, G7, investment efficiency, total factor productivity, public administration, export-oriented industrialization, innovative development.

Introduction

Humanity has entered a period of high geopolitical and economic turbulence, marked by major and rapid changes. Among these changes is the significant increase in the role and influence of developing countries (DCs) and their vanguard, the BRICS+ alliance, in the global economy and politics.

One of the global contradictions of our time is that over the past 60-70 years, since the onset of the large-scale decolonization of Afro-Asian countries, only a small fraction of DCs (no more than 5-7%) have managed to become developed countries (DCs). Developing countries and the BRICS+ group are demonstrating significant, albeit uneven, successes in economic and social development, while experiencing numerous difficulties, largely related to the implementation of essentially neocolonial policies by developed countries.

The world, alas, is (still) quite unforgiving. In the competition for survival/dominance, the more efficient countries typically ultimately prevail. Although, over a given timeframe, countries that have successfully mobilized their resources can achieve considerable success, it is interesting to clarify the extent to which the BRICS+ alliance as a whole has been able to achieve relatively sustained economic progress greater than the G7, relying not only on extensive but also intensive factors of economic growth.

Discussion

DRIVERS, TRENDS, AND DETERMINANTS OF ECONOMIC GROWTH

The ten BRICS+ countries (G10) and the seven RGs (G7), around which the main clusters of countries in the global community are beginning to form, are quite significant on a global scale. In 2024, they (G10 + G7) accounted for over half of the total value of global exports of goods and services, approximately three-fifths of the accumulated volume of foreign direct investment and the world's population, and two-thirds of its GDP (Figs. 1, 2).

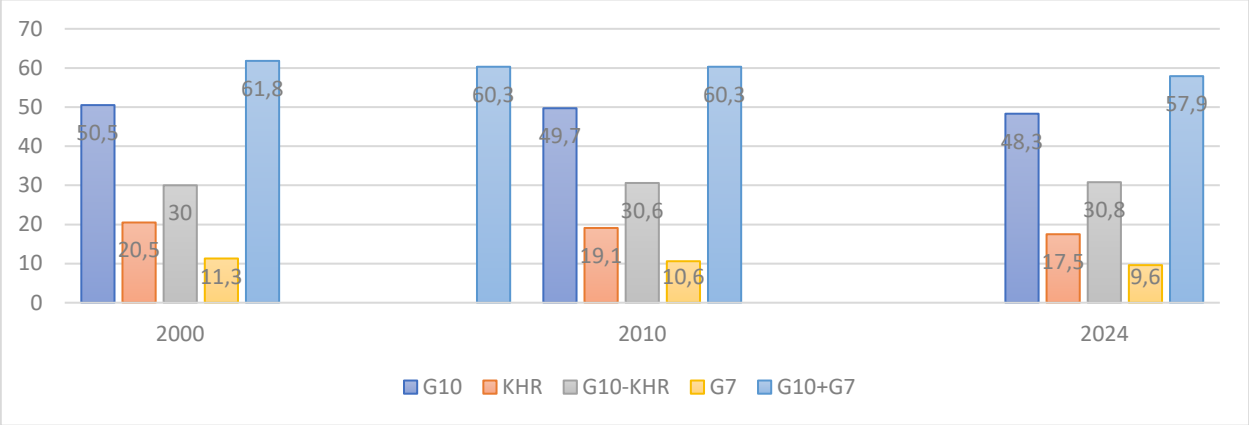

Fig. 1. *Shares of G10 and G7 countries in global population, %*

Each of the two groups of countries studied (especially the G10) is quite differentiated across many economic parameters, the quality of institutions, and the specifics of their economic policies. Moreover, while the G7 can be divided into two main types of civilizational development (Western countries and Japan), the G10 has seven or even eight.

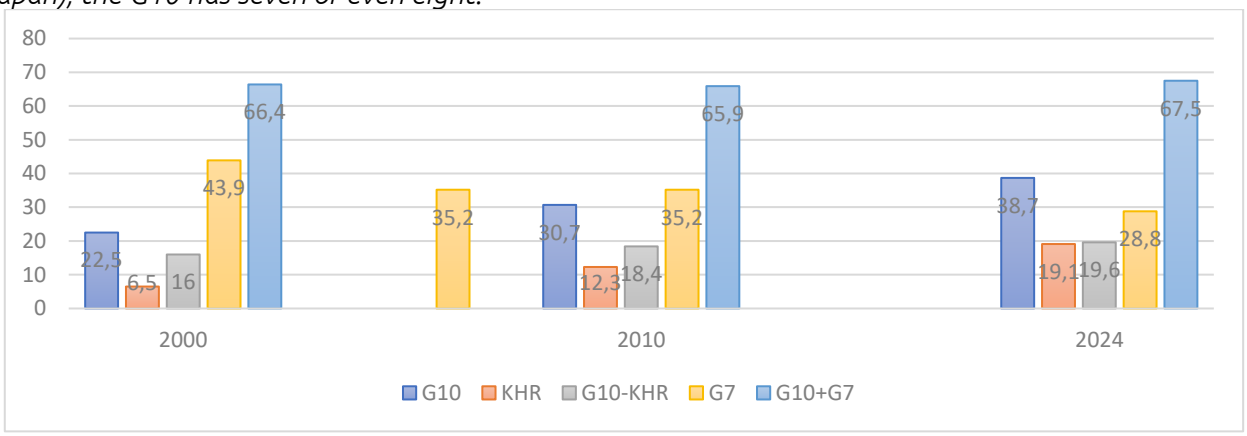

Fig. 2. *Shares of G10 and G7 countries in global GDP, %*

Based on the coefficients of variation for per capita GDP and GDP calculated for 2024, the BRICS+ group (79.5 and 150.4%, respectively) turned out to be more heterogeneous than the seven G10 countries. A system is considered heterogeneous if the coefficient of variation of its components, according to the metric under study, is higher than 33%. (17.4 and 116.9%). Moreover, the core of the system—China in the G10 and the United States in the G7—accounted for approximately half of the respective group's GDP in 2024. While China's GDP was 2.3 times larger than the next-largest country in terms of GDP, India, the United States' GDP was 4.5 times larger than Japan's.

The availability of official data on GDP in PPP for 2021 for all countries studied for the period 2000–2023 is subject to change. The inclusion of data on average GDP growth rates for 2024 in World Bank statistical publications facilitates this task to a certain extent. However, numerous estimates have appeared in the research literature indicating that for a number of countries, including China, the available official data on average GDP growth rates over the past 10-15 years, possibly due in part to understated GDP deflators, are overstated by 1-2 percentage points. These estimates, partly based on a number of refined calculations, are of interest, although they require further verification. In determining growth trends and key development performance indicators for the ten BRICS+ countries, we will rely on official data, but, where possible, we will make adjustments for adjusted estimates. The contribution of physical and human capital to the achievement of comparatively high rates of industrial and overall economic growth in many of them is significant. GDP growth in China.

In essence, many questions have accumulated regarding the available data on GDP dynamics in the Republic of Sakha (Republic ... For the RG, where services account for a large share, it's not always clear how and how reliably added value is calculated, or which deflators are used to convert gross output and intermediate goods into constant prices to determine real GDP growth using the double-deflation method. It's unclear how the changing quality of goods and services is assessed over time. China, with its outstanding economic growth record, has attracted the attention of researchers attempting to clarify the parameters of its dynamics. However, questions also remain regarding India and other RGs.

Although during the period under review, a significant number of BRICS+ countries were subject to various fairly stringent sanctions and trade restrictions imposed by the collective West, the G10 countries' implementation of export-oriented industrialization policies and their increased investment in physical and human capital contributed to the achievement of comparatively high rates of industrial and overall economic growth for many of them.

This is largely due to the significant increase in the G10 countries' government effectiveness index (GEI). While the weighted average of the 6 IUEs for the seven RGs decreased by approximately 3 percentage points between 2000 and 2023 (including a percentage point decrease for the leading European RGs), for the ten BRICS+ countries, on the contrary, it increased significantly – by 15 percentage points (Figure 3). As a result, the G10 to G7 ratio in the IUE increased by more than a third – from 53% to 72%.

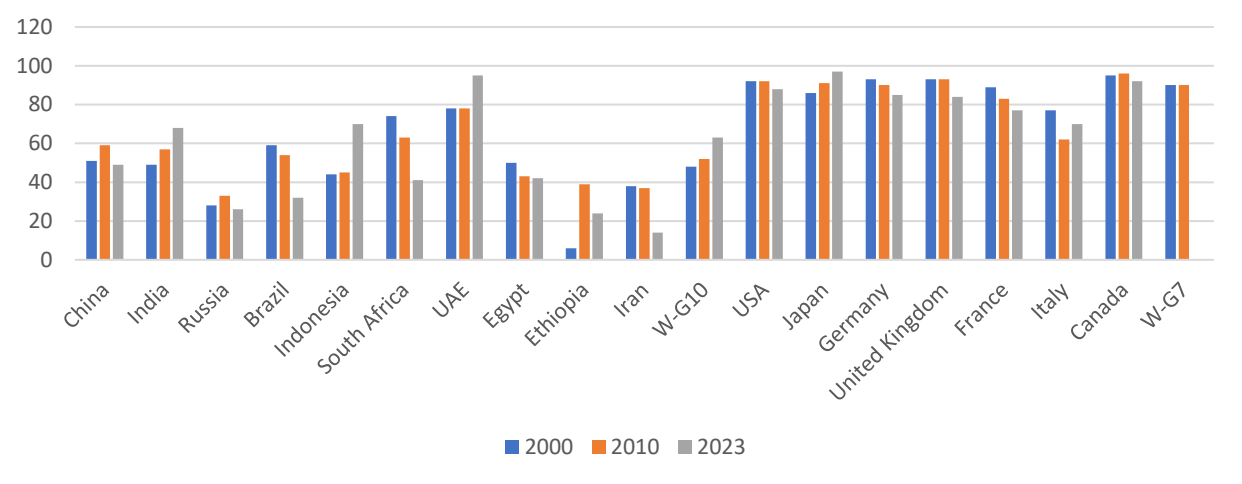

Fig. 3. *Dynamics of the G10 and G7 state efficiency index, 2000, 2010, 2023. Notes: The index ranges from 0 to 100. W-G10 and W-G7 are the GDP-weighted average data on state efficiency for the G10 and G7, respectively.*

To be fair, it should be emphasized that while the indicator in question increased by 19-26 percentage points on average for China, India, and Indonesia, and by 17-18 percentage points in the UAE and Ethiopia (with different initial levels), it fell by 24-33 percentage points in Brazil, Iran, and South Africa, for example. This, as noted, demonstrates the enormous differentiation of the G10 alliance in terms of development parameters.

If for the G7 in 2000-2023, While the weighted average annual growth rate (AAGR) of industrial sector production was only 0.6–0.7% 7 (including 1.1% in the USA and Canada, 0.7% in Germany, 0.3–0.4% in France and Japan, 0.1% in the UK, and –0.1% in Italy), for the ten BRICS+ countries as a whole it was almost an order of magnitude higher (5.9%). However, the spread of data for the G10 was as follows: for China, India, and Indonesia – 8.6, 6.3, and 3.9%, respectively; for Egypt, Russia, and the UAE – 3.4, 2.8, and 2.5%; for Iran, Brazil, and South Africa – 1.9, 1.2, and 0.7%; and for Ethiopia (from a very low start) – 12%. Overall, while industrial production in the G10 was 69% of that in the G7 in 2000, it reached 222% in 2023, more than tripling (calculated in 2021 PPP).

The significant successes of BRICS+, primarily due to the dynamic Asian trio (China, India, and Indonesia), in industry, agriculture, and many service sectors, have meant that overall, from 2000 to 2024, the average annual growth rate of GDP for the ten BRICS+ countries was almost four times higher than that of the G7 (5.8% vs. 1.5%), while the volatility (coefficient of variation) of GDP growth rates (34% vs. 128%) was four times lower (Figure 4).

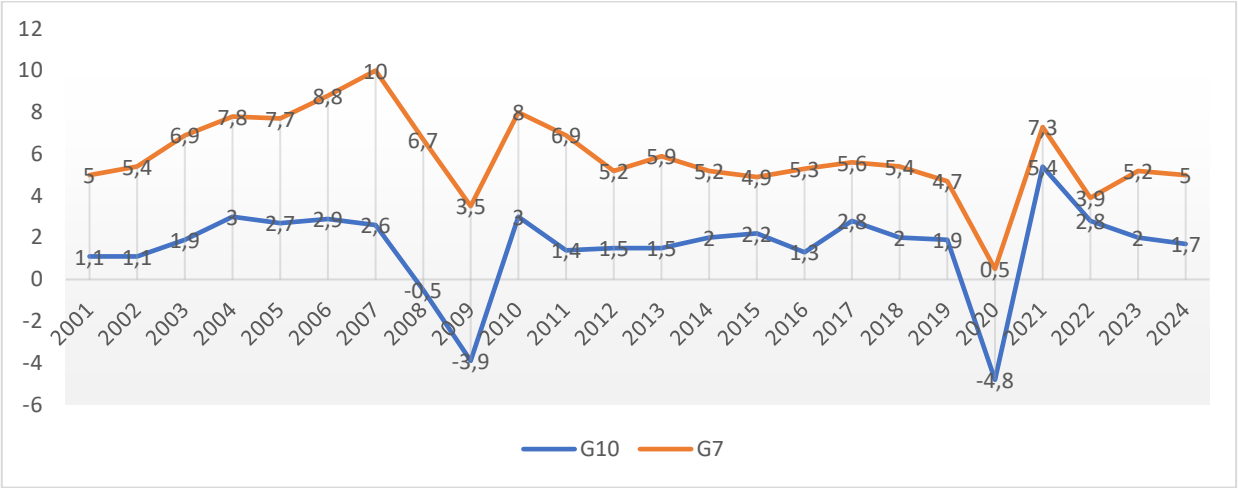

Fig. 4. GDP growth rates of G10 and G7, 2001–2024, %

While for the seven post-industrial developing countries, overall, the increase in GDP between 2000 and 2023 was due to less than one-fifth of the increase in production in the industrial sector and more than four-fifths to progress in the services sector, for the BRICS+ countries as a whole, the contributions of the primary, secondary, and tertiary sectors of the economy to GDP growth were 6%, 37%, and 57%, respectively. It is easy to calculate that, during the period under review, the outperformance of the top ten BRICS-7 developing countries in terms of CAGR of GDP was due not only to the successes of the agricultural and industrial sectors (by 7%–9% and 44%–46%, respectively), but also, to a significant extent, to the outpacing growth of the BRICS+ countries in the services sector.

According to our model calculations, between 2000 and 2024 The higher CAGR of GDP in the BRICS+ countries compared to the G7 (5.8% vs. 1.5%) was approximately 30% higher due to a 1.5 times higher capital investment rate (31% vs. 21%), but even more – 70% – to its 2.6 times higher efficiency. In a number of BRICS+ countries, the capital investment rate was significantly higher than in the G7 countries (in China – 41%, in India – 31%, in Indonesia, Ethiopia, and Iran – 28–30%), and the efficiency of capital investment was higher than the G10 average (in China and India – 0.2–11, in Egypt and Ethiopia – 0.26–0.29; Table 1).

***Table 1.** Calculation of the contribution of capital investment rates and their effectiveness in ensuring higher rates of GDP growth in the G10 countries compared to the G7 in 2000–2024.*

	y, %	*m, %*	*f, relative units*
G10	*5,8*	*31,4*	*0,185*
G7	*1,5*	*21,3*	*0,07*
G10 / G7	*3,9*	*1,5*	*2,6*
Ln	*1,36*	*0,41*	*0,95*
%	*100*	*30*	*70*

Higher GDP growth rates and investment efficiency in 2000–2024 across the BRICS+ countries were largely determined by their higher average annual growth rate in the physical volume of goods and services exports (6.3% vs. 2.7%) than in the G7 countries. In the two leading BRICS+ countries, China and India, this growth rate reached 8.0% and 9.4%, respectively.

Overall, the BRICS+ countries' positions in the Global Innovation Index (GII; Fig. 5) have significantly improved.

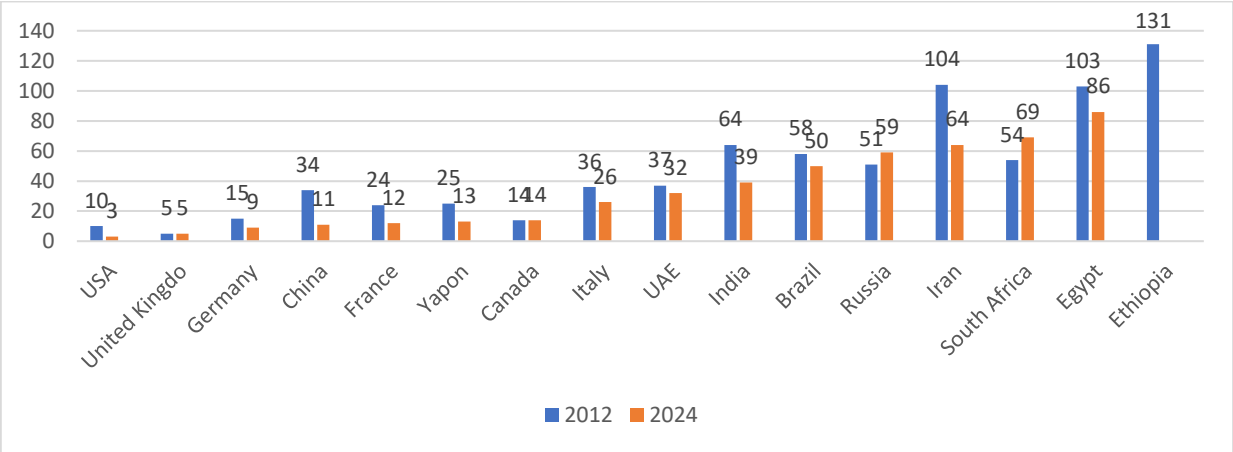

Fig. 5. Change in the ranking of G7 and G10 countries in the global innovation index, 2012 and 2024.

According to two surveys, while each G7 country moved up the GII ranking by an average of 6 positions between 2012 and 2024, the BRICS+ alliance saw its ranking rise by 14 positions. While the average G7 ranking in 2024 is 12th, and the average G10 ranking is 59th, China has surpassed many G7 countries, including France, Japan, Canada, and Italy, ranking 11th.

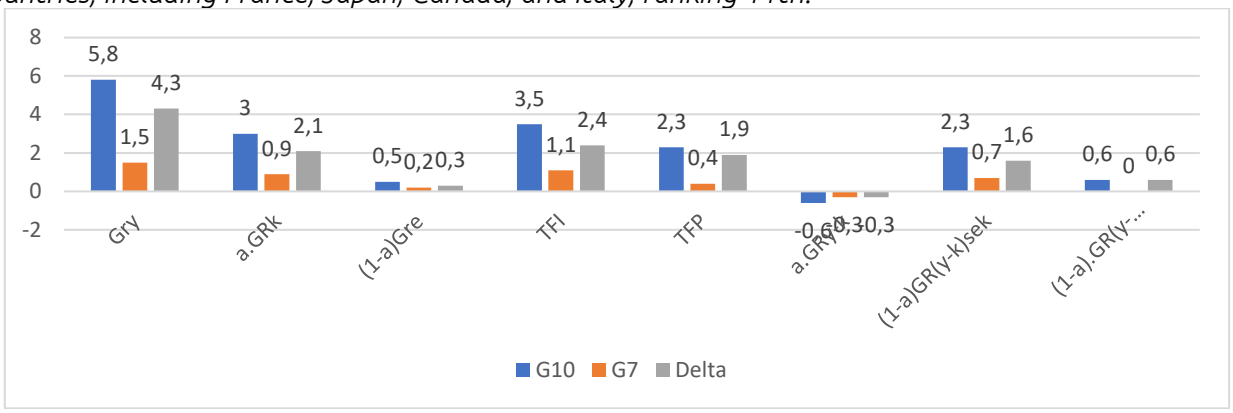

Fig. 6. Factors driving G10 growth outpacing G7 growth, 2000–2024, percentage points.

1. Calculated using the following formula:

GRY = a·GRK + (1 – a)·GRE + a·GRY–K + (1 – a)·GR(Y–E) sec + (1 – a)·GR(y–e) realloc,

where GRY, GRK, GRE are the average annual growth rates (AAGR) of GDP, physical (fixed) capital, and employment, respectively; a·GRK, (1–a)·GRE, a·GR(Y–K), (1-a)·GR(Y–E)sec, (1-a)·GR(Y–E)realloc are the contributions to GDP growth of physical capital, employment, capital productivity, and PT in key sectors of the economy, as well as PT due to the effect of labor movement to industries with higher PT.

2. TFI and TFP – the total capital and labor inputs and total factor productivity.

3. The formula for calculating the displacement effect.

4. According to our calculations, the elasticities of GDP growth with respect to physical capital (a) and employment (1 – a) are 0.4 and 0.6, respectively, for the G7 and G10 economies.

Our calculations using the model shown in Figure 6 show that while the contribution of total factor productivity (TFP) to GDP growth in the seven RGs from 2000 to 2024 averaged 1/4, for the ten BRICS+ countries as a whole it was much higher – 2/5, and even according to adjusted data – 1/3.

The almost 9/10 lead of the ten RGs over the seven RGs in the contribution of total factor costs was due to the superiority of the BRICS+ over the G7 in the contribution of physical capital. The BRICS+ countries' lead over the G7 in TFP contribution was entirely determined by the contribution of labor productivity (LP), a third of which was achieved by the redeployment of labor from low- to higher-productivity sectors.

As a result, over the first quarter of the 21st century, the BRICS+ countries' TFP levels, on average, quickly caught up with the G7 – by approximately 2% per year, from just over 1/4 to over 2/5 (Figure 7).

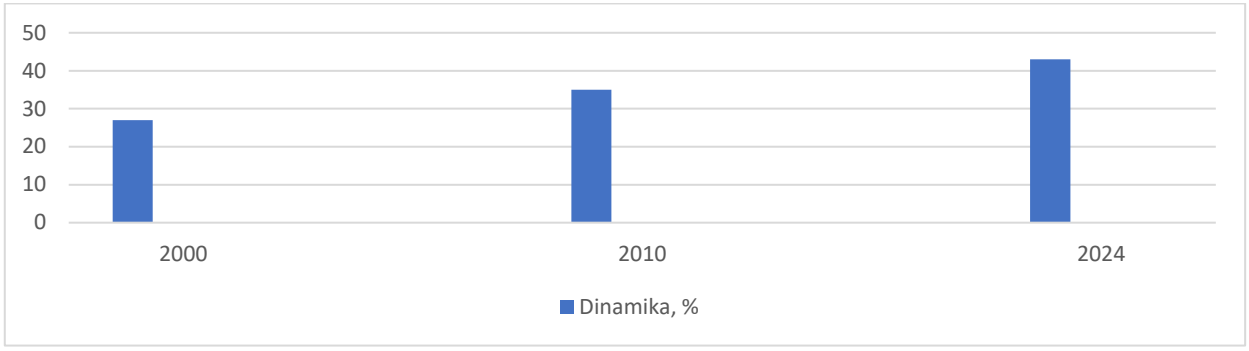

Fig. 7. Dynamics of the ratios of the levels of total factor productivity of G10 and G7, 2000–2024, %

Factors Slowing Economic Growth in the BRICS+ Countries

The slowdown in economic growth in the BRICS+ countries since the early 2010s (according to the World Bank, the CAGR of GDP has fallen by more than a quarter – from 7% in 2000–2010 to 4.9% in 2010–2024) is caused not only by the accumulation of errors and imbalances in their economic growth models, but also largely by the exacerbation of long-term structural problems in the RG (related, among other things, to the aging of the population, labor force, and capital stock) and the serious financial and economic imbalances that arose in them following the global financial crisis of the late 2000s. Developed countries, losing their competitive advantages, began to restrict the inflow of goods from the RS, imposing sanctions against many of them, and the United States has practically declared a trade war on most countries of the world, from which both the RG and the RS could suffer greatly in the short and medium term. Calculations show (Fig. 8) that the slowdown in economic growth in the ten BRICS+ countries occurred to a much greater extent (by 4/5) due to a decrease in the contribution of external demand than as a result of a decrease in the contribution of domestic demand (by 1/5).

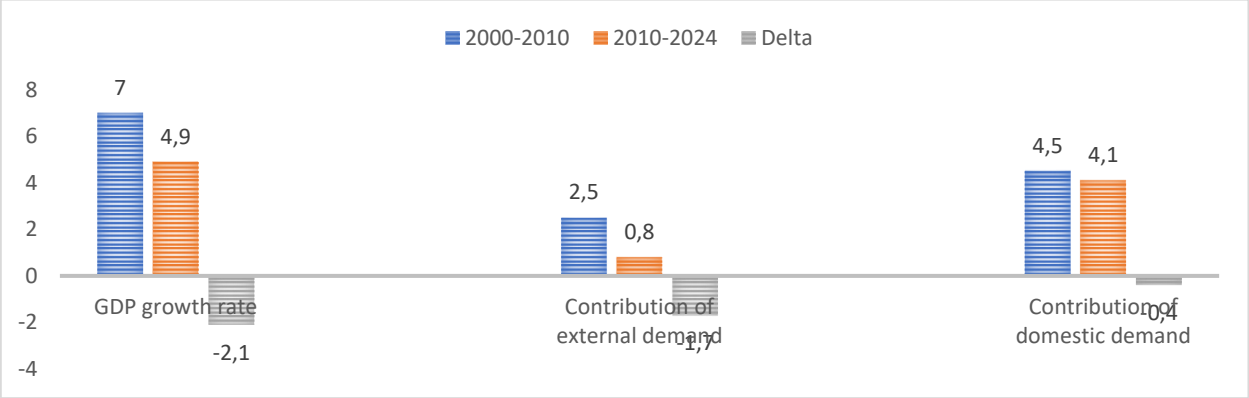

Fig. 8. G10, 2000–2010 and 2010–2024: contribution of external and domestic demand factors to the slowdown in the average annual GDP growth rate, %

A number of BRICS+ countries sought to compensate for the declining efficiency of capital investments, largely due not only, and perhaps not so much, to internal, but also to external factors discussed above, by maintaining a high/increased rate (share of GDP) of capital investments (Table 2) – in India 30–32%, in China the indicator increased from 38–39% in 2000–2010 to 42–43% in 2011–2024, in Indonesia – from 23–24 to 31–32%, in Ethiopia – from 25–26 to 33–34%.

Table 2. The impact of the contribution of capital investment rates and their efficiency on the slowdown in economic growth in the G10 in 2011–2024 compared to 2000–2010.

	y, %	*m, %*	*f, relative units*
2011–2024 гг., A	*4,9*	*33,2*	*0,147*
2000–2010 гг., B	*7,0*	*28,8*	*0,243*
A / B	*0,7*	*1,15*	*0,60*
ln	*-0,36*	*0,14*	*-0,50*
%	*100*	*-39*	*139*

According to calculations based on official data, the marginal capital intensity ratio of GDP growth for the ten BRICS+ countries increased by two-thirds (from 4.1 in 2000–2010 to 6.8 in 2011–2024), while according to adjusted data, it increased by three-quarters (from 4.4 to 7.7). However, although the efficiency of capital investment in the BRICS+ countries as a whole has been declining, in 2011–2024 it was approximately three-quarters (!) higher (and the marginal capital intensity ratio lower) than for the seven RGs.

According to our calculations, based on both official data (Fig. 9) and adjusted data, the very noticeable slowdown in economic growth in the G10 countries since the 2010s is approximately half due to a decrease in the contribution of both total factor costs (by 40% for fixed capital and by 60% for employment) and TFP (in the same proportion – by 40% as a result of an increase in the rate of decline in capital productivity and by 60% – a decrease in the rate of growth of PT).

However, the share of TFP contribution to GDP growth, when calculated using official data, remained at approximately 2/5, while when calculated using adjusted data, it decreased significantly, by 1/5 – from 37% to 30%. Importantly, under both calculation options, the absolute and relative contributions of TFP to GDP growth for the BRICS+ group as a whole in 2010–2024 (primarily due to China, India, and Indonesia) remained significantly higher than for the seven BRICS countries.

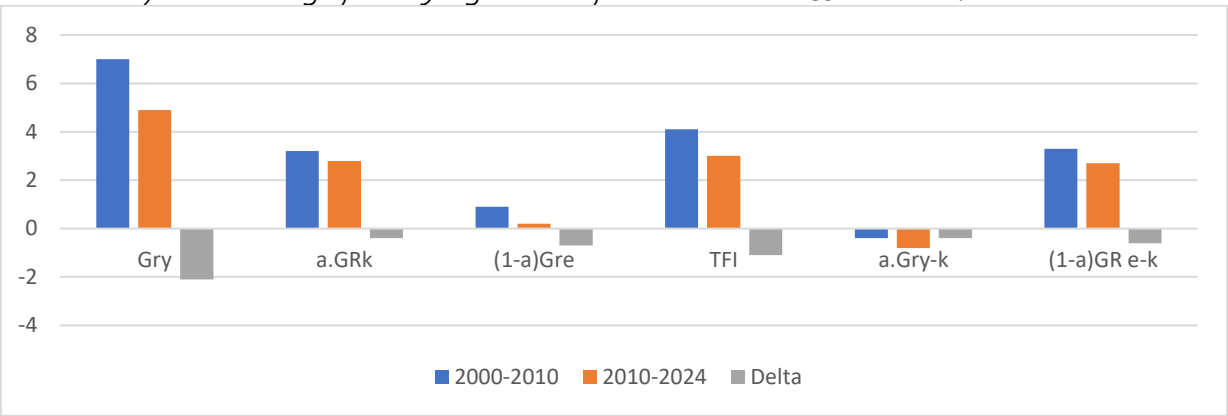

Fig. 9. *G10: factors slowing down GDP growth in 2010–2024 compared to 2000–2010, p.p.*

The Main Consequences of Economic Growth in the BRICS+ Countries

Overall, the impressive, albeit uneven, economic progress of BRICS+ countries has had both positive and negative consequences. Among the negative aspects, it is worth noting the significant growth of aggregate debt, the increasing "ecological footprint," and the persistence—and, in some countries, the worsening of social inequality during certain periods.

Due to various factors, including, strictly speaking, the largely unbalanced economic development of BRICS+ countries, as well as the specific social evolution of countries in the top ten, such as South Africa and Brazil, over the past 10–15 years, the average level of income inequality in the G10 has been somewhat higher than that of the G7, while wealth inequality, while lower than the G7 average, has shown a significant upward trend (Figure 10).

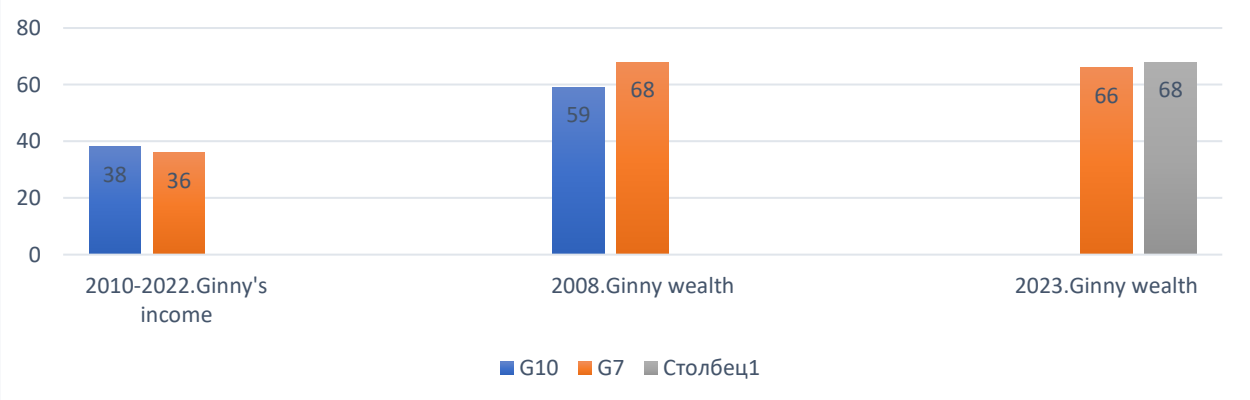

Fig. 10. *G10 and G7: Gini indices for income and wealth distribution, % Note: The Gini index ranges from 0 to 100% (maximum level of inequality).*

Thanks primarily to China's efforts, the share of the critically poor population across the top ten countries decreased more than fivefold from the early 2000s to the early 2020s, from 1/2 to less than 1/10, while the share of the non-poor population (defined as daily per capita consumption over $6.85 in 2017 PPP) increased almost fourfold, from approximately 14% to 53%. However, those classified as poor by this same criterion still make up 60–90% of the population in Egypt, South Africa, Indonesia, India, and Ethiopia.

According to our calculations and estimates, while the average number of years of adult education increased by less than one-third, to 13–14 years, across the top ten countries between 2000 and 2023/2024, it increased by more than two-fifths, to 8–9 years. True, the gap in this parameter—

approximately two-fifths—is still quite significant. Over the period under review, the BRICS+ countries noticeably approached the level of the G7 in terms of life expectancy from birth: the gap narrowed from 11 (67 vs. 78 years) to 7 (74 vs. 81 years) years.

From 2000 to 2024, the Human Development Index (HDI) in the top ten BRICS+ countries grew rapidly, albeit from a very low level, at an average annual rate more than three times higher than that of the G7 (2.6% vs. 0.8%), increasing from one-third to more than half the average for the latter. Over the period under review, the HDI in the BRICS+ countries increased quite significantly—by more than 1.5 times—not only in China, but also in most BRICS+ countries (India, Egypt, Iran, Ethiopia, and Indonesia).

As a result of the fact that, according to the available data, the Social Progress Index (SPI) for the ten RGs in 2011–2023 was approximately ten times higher than for the seven RGs (1.1% vs. 0.1%, respectively), the ratio of the BRICS+ alliance to the seven RGs in terms of SPI increased from 2/3 to 3/4 27

Conclusion

The BRICS+ alliance has achieved significant and widespread economic successes overall, thanks not only to the multi-stage expansion of its membership (which is in itself very important), but also to its comparatively rapid economic growth. In each of the BRICS+ countries, the average annual GDP growth rate since the beginning of the century has been at least 1.5–2.0 times higher than the average for the seven developed countries as a whole. In the latter, despite scientific and technological advances, due in large part to the significant aging of the population, labor force, and capital stock, as well as the declining effectiveness of public administration, average GDP growth rates have been lower than they were one and a half to two centuries ago.

The significant – 4-5-fold – outpacing of the 10 BRICS+ countries over the 7 developed countries in average GDP growth rates and per capita GDP over the past two decades was not solely or primarily due to their generally low initial level of development. 28 Factors such as improved governance efficiency, the successful implementation of an export-oriented industrialization strategy by several major Asian countries (China, India, and Indonesia), a significant increase in the share of investment in physical and human capital, and progress in innovative development also played a significant role.

Overall, over the period under review, the 10 BRICS+ countries' outpacing of the 7 developed countries in average GDP growth rates was not solely due to extensive factors. Calculations show that more than two-fifths of this growth is due to intensive factors: comparatively higher levels of investment efficiency, dynamic growth in labor productivity, and total factor productivity (the average growth rate for the G10 was almost five times higher than for the G7).

Largely due to the dynamic and large-scale growth of China and India, which accounted for almost four-fifths (three-fifths and one-fifth, respectively) of the G10's GDP growth over nearly a quarter of a century, the BRICS+ countries have surpassed the G7 in GDP by a third, in industrial production by more than twice, have also surpassed them in the value of high-tech exports, and have reached over two-fifths and one-half of the G7's TFP and Human Development Index levels, respectively.

The slowdown in economic growth in BRICS+ countries that began in the 2010s is, according to calculations, largely due to the decline in external demand from slowly growing developed countries, which are introducing increasingly stringent restrictions on exports from BRICS+ countries and other developing countries. To restore dynamic growth, BRICS+ countries should, in addition to intensifying their efforts to achieve a new, more equitable global economic order, expand investment and trade cooperation among themselves and other developing countries, intensify their efforts to implement inclusive social and economic reforms aimed at improving the quality of institutions, governance systems, and human capital, and expanding the capacity of domestic markets, which is already largely occurring as a result of a reduction in the proportion of poor people and an improvement in their living standards.

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INFORMATİON TECHNOLOGY IMPLEMENTATİON İN HUMAN RESOURCE MANAGEMENT SYSTEMS: A SYSTEMATİC FRAMEWORK AND PERFORMANCE EVALUATİONİ

Rahimli Turkan Kamaleddin

Abstract

Purpose: *This study develops a systematic framework for implementing information technologies in human resource management (HRM) systems and proposes a comprehensive performance evaluation system to assess implementation effectiveness.*

Design/methodology/approach: *The research employs a multi-method approach including systematic literature review, case study analysis of leading organizations (Yandex, Kapital Bank, PASHA Bank), and development of a staged implementation model. Data sources include corporate reports, industry surveys from KPMG and Deloitte, and organizational documentation covering 2020-2025.*

Findings: *The study identifies five critical failure factors in HR automation: automating chaos, ignoring employee input, system for system's sake, insufficient system flexibility, and inadequate management support. A five-stage implementation model is developed: (1) current state audit and analysis, (2) digitalization strategy formulation and team engagement, (3) agile system selection and pilot implementation, (4) scaling and integration, and (5) monitoring and optimization. A comprehensive KPI system spanning five dimensions (process performance, decision quality, user experience, financial metrics, and strategic indicators) is proposed for evaluating IT implementation effectiveness.*

Research limitations: *The study focuses on 2020-2025 data, primarily examining Russian and Azerbaijani organizations. Cross-cultural generalizability requires further validation.*

Practical implications: *The staged implementation model and KPI system provide HR practitioners with actionable frameworks for digital transformation, reducing implementation failure risks and maximizing return on investment.*

Originality/value: *This research contributes a novel classification system for HR digital solutions across seven functional categories and three integration levels, identifies and structures five barrier categories to digitalization, and develops the first comprehensive staged implementation model specifically addressing organizational, technological, financial, competency, and cultural factors simultaneously.*

Keywords: *Human resource management, Digital transformation, HR technology, Implementation model, Performance measurement, KPI system*

1. Introduction

The digital revolution of the 21st century is rapidly transforming all production sectors and processes, including human resource management (HRM). Information technologies have become critical factors in enhancing HR process efficiency, optimizing costs, and improving the quality of human resource management decisions (Bondarouk & Brewster, 2021). Organizations are undergoing digital transformation in workplace and business processes, implementing innovative technologies and adopting digital methods for working with HR (Deloitte, 2024).

Despite significant investments in HR digitalization, approximately 25% of companies acknowledge that recruitment automation tools have not delivered expected results (Stone & Dulebohn, 2018), indicating a substantial gap between the potential of information technologies and their actual implementation in HRM. This research addresses this gap by developing a systematic implementation framework and comprehensive performance evaluation system.

1.1 Research Problem and Objectives

The core research problem lies in the contradiction between the high potential of information technologies for improving HR management system efficiency and the insufficient effectiveness of their practical implementation. Despite active adoption of HR information systems, many organizations encounter barriers that reduce HR process digitalization effectiveness.

The primary objective of this research is to develop methodological recommendations for effective use of information technologies in human resource management systems based on analysis of current digitalization status and identification of key barriers.

Specific research objectives include:

1. *Examining the role of information technologies in the evolution of HR management concepts*
2. *Systematizing the classification of information technologies in personnel management*
3. *Assessing the digitalization level of HR processes in modern organizations*

4. *Identifying key barriers and resistance factors to information technology adoption*
5. *Developing a staged implementation model for IT solutions in organizational HR processes*
6. *Proposing a KPI system for evaluating information technology implementation effectiveness*

1.2 Research Contribution

This study makes several important contributions to HRM and information systems literature:

Theoretical contributions:

- *Clarifies the classification of information technologies in personnel management by systematizing HRM digital solutions into seven functional categories and three integration levels*
- *Identifies and structures five root causes of HR automation failure and five barrier categories to digitalization*
- *Develops a comprehensive five-stage model for phased IT solution implementation in organizational HR processes*

Practical contributions:

- *Provides HR managers and specialists with actionable frameworks for developing digitalization strategies*
- *Offers organizational leaders tools for making informed decisions about HR process digitalization investments*
- *Delivers HR technology consultants and specialists with assessment frameworks and implementation guidance*

2. Literature Review and Theoretical Framework

2.1 Evolution of HRM Concepts and Information Technology

The HRM system evolution has progressed through five distinct stages, each characterized by specific approaches to human resource management and corresponding technology applications (Odegov & Rudenko, 2024):

***Stage 1: Personnel Administration (1900-1960)** - Personnel viewed primarily as production costs requiring administrative control. Technology support limited to paper documents, card indexes, and registration journals.*

***Stage 2: Personnel Management (1960-1970s)** - Expansion of HR functions to include workforce planning, training organization, and performance evaluation. First computer systems enabled automation of timekeeping, payroll calculation, and personnel records, though systems remained expensive and accessible only to large corporations.*

***Stage 3: Human Resource Management (1980-1990s)** - Recognition of personnel as the organization's most critical resource requiring investment and strategic planning. Development of first integrated HRMS (Human Resource Management Systems) combining employee databases, payroll, training planning, and performance evaluation modules.*

***Stage 4: Human Capital Management (2000-2010)** - Transition to viewing personnel as source of added value and competitive advantage. Development of HCM (Human Capital Management) systems, cloud-based HR platforms, employee self-service portals, e-learning systems (LMS), and collaboration tools.*

***Stage 5: Digital Transformation of HRM (2010s-present)** - Comprehensive restructuring of all HR processes based on advanced digital technologies, including:*

- *Artificial intelligence and machine learning for turnover prediction, candidate assessment, and training personalization*
- *Big data and analytics for data-driven decision making*
- *Mobile applications for anytime, anywhere HR service access*
- *Robotic process automation (RPA) for routine operations*
- *Blockchain for HR operation security and transparency*
- *Virtual and augmented reality for immersive training and onboarding*
- *Internet of Things (IoT) for security and work performance monitoring*
- *Chatbots and virtual assistants for automating employee interactions*

2.2 Contemporary HRM Concepts in Digital Context

Digital transformation has catalyzed emergence of several fundamental HRM concepts:

***Data-Driven HR:** All significant HR decisions based on quantitative data analysis rather than intuition or subjective experience. Organizations collect and analyze large volumes of employee data enabling pattern identification, future trend forecasting, HR intervention personalization, and objective assessment of HR program effectiveness (Sharma & Singh, 2025).*

Agile HR: Flexible approach to personnel management adopting Agile methodology principles from software development, including iterative approaches, rapid adaptation to changing conditions, cross-functional collaboration, continuous feedback, and self-organizing teams (Boriso glebskaya & Shikova, 2016).

Employee Experience Management: Treating the entire employee lifecycle as continuous journey requiring careful design and optimization at each stage, from candidate acquisition through offboarding (Malik et al., 2023).

Growth Mindset: Emphasizing continuous learning, talent attraction and retention, innovation culture promotion, and support for employee well-being and integration (Nechina, 2024).

Digital Employee: Transformation of personnel role in digital economy, characterized by high digital literacy, active use of digital tools, comfortable virtual team work, continuous self-learning through online platforms, and career management through digital portals (Agrawal et al., 2023).

AI-Augmented HR: Harmonious combination of human and artificial intelligence capabilities, where AI handles routine tasks while HR specialists focus on strategic planning, relationship building, complex ethical decision-making, and organizational culture development (Zehir & Narcıkara, 2020).

2.3 HR Technology Classification

Based on contemporary practice analysis, information technologies in personnel management can be classified into seven functional categories:

Category 1: Recruitment Process Automation Systems - Including Applicant Tracking Systems (ATS), video interview platforms, AI-based competency assessment tools, chatbots for initial screening, and passive candidate sourcing tools.

Category 2: Onboarding and Adaptation Systems - Including online onboarding platforms, welcome portals, mentorship programs, career path simulators, and automated document workflow systems.

Category 3: Learning and Development Systems - Including Learning Management Systems (LMS), corporate universities on digital platforms, gamified learning systems, microlearning platforms, virtual reality simulators, social learning platforms, and adaptive learning systems.

Category 4: Performance Management Systems - Including goal-setting platforms (OKR, KPI), 360-degree feedback systems, continuous performance management tools, performance monitoring dashboards, and recognition/rewards management systems.

Category 5: Employee Self-Service Portals (ESS) - Including personal accounts for HR data access, leave/absence request systems, payroll access, internal communication platforms, internal mobility platforms, and benefits management systems.

Category 6: Automated Personnel Management Systems - Including HRIS (Human Resource Information Systems), electronic document management systems, electronic work books, timekeeping systems, and payroll systems.

Category 7: HR Analytics and Decision Support Systems - Including People Analytics platforms, predictive turnover analytics, engagement analytics, workforce planning tools, HR reporting dashboards, and succession planning systems.

These categories can be implemented at three integration levels:

- *Level 1: Point solutions (standalone systems for specific functions)*
- *Level 2: Integrated HCM systems (comprehensive platforms combining multiple functions)*
- *Level 3: Cloud platforms (next-generation systems with SaaS model, automatic updates, and multi-tenant architecture)*

3. Research Methodology

3.1 Research Design

This study employs a multi-method qualitative research approach combining systematic literature review, case study analysis, and model development. The research is structured in three phases:

Phase 1: Literature Review and Conceptual Framework Development

- *Systematic review of academic literature on HRM digitalization (2015-2025)*
- *Analysis of industry reports from KPMG, Deloitte, Gartner, and Forrester*
- *Development of HR technology classification framework*
- *Identification of digitalization maturity model*

Phase 2: Empirical Investigation

- *Case study analysis of three organizations representing different sectors and scales*
- *Analysis of publicly available corporate reports and documentation*

- *Examination of implementation practices and outcomes*
- *Identification of barriers and success factors*

Phase 3: Framework Development

- *Synthesis of findings into staged implementation model*
- *Development of comprehensive KPI system*
- *Validation through comparison with existing frameworks*

3.2 Data Sources

The research information base consists of:

Academic Literature: Scientific works by local and international authors in HRM, information technologies, and digital transformation, including works by Azerbaijani scholars on HRM fundamentals and strategic aspects (Aliyev & Hamidov, 2013; Isgandarov et al., 2017; Jamaladdinov, 2025).

Industry Reports: Research results conducted by KPMG and Deloitte international networks on global HR trends (KPMG, 2019; Deloitte, 2024).

Case Study Data: Open reporting data from Yandex, Kapital Bank, and PASHA Bank regarding their HR technology implementation practices (AZERTAC, 2024; Huseynov, 2024; PASHA Bank, 2024a, 2024b; PASHA Holding, 2025).

Temporal Scope: The research database covers 2020-2025, capturing the acceleration of HR digitalization during and after the COVID-19 pandemic.

3.3 Analytical Approach

The research employs multiple analytical methods:

- *Systematic approach for comprehensive examination of HR digitalization*
- *Analysis and synthesis for processing literature and empirical data*
- *Comparative analysis for cross-case examination*
- *Structural analysis for identifying implementation stages and barrier categories*
- *Content analysis for examining organizational reports and documentation*
- *Expert assessment method for evaluating maturity levels*

3.4 Research Limitations

Several limitations should be noted:

1. *Temporal constraints: Focus on 2020-2025 period, though this captures critical pandemic-driven acceleration*
2. *Geographical scope: Primary focus on Russian and Azerbaijani organizations*
3. *Data accessibility: Reliance on publicly available reports and documentation*
4. *Generalizability: Findings most applicable to similar organizational contexts*

4. Empirical Findings

4.1 HR Digitalization Maturity Assessment

To evaluate digitalization levels, we developed a five-level maturity model:

Level 1 - Initial: Minimal automation, paper-based document management, spreadsheet proliferation, no integrated HR systems, fragmented and inaccessible HR data.

Level 2 - Basic Automation: Individual process automation (payroll, timekeeping), basic HRIS for personnel records, partial electronic document workflow, online recruitment initiation, limited analytics based on standard reports.

Level 3 - Integrated Automation: Integrated HCM system covering core HR processes, employee self-service portals, basic HR analytics and reporting, LMS usage for online learning, ATS for recruitment management, data-driven decision-making approaches.

Level 4 - Optimized Digitalization: Comprehensive automation of all HR processes, advanced analytics and predictive modeling implementation, data-driven HR service personalization, active mobile application usage, HR system integration with other corporate platforms, data-driven HR culture.

Level 5 - Innovative Transformation: AI and machine learning application across all core HR processes, proactive management based on predictive analytics, fully digital seamless employee experience, continuous innovation and experimentation with new technologies, HR as technology leader impacting entire organization, clearly measured and data-proven HR contribution to business outcomes.

4.2 Case Study Analysis

Three organizations representing different sectors and digitalization approaches were analyzed:

Case 1: Yandex (~20,000 employees, IT sector)

Yandex demonstrates the most mature HR digitalization model (Level 4-5), characterized by:

- *Gamified learning: Yandex.Practicum platform with experience points, levels, achievements, leaderboards, and exchangeable virtual currency*

• ***VR training:*** *Immersive simulations for public speaking, technical scenarios, office tours, and team building (research showed 60% improvement in retention)*

• ***Innovation culture:*** *Regular hackathons with 30+ innovations integrated into products over three years*

• ***Knowledge sharing:*** *Internal wiki, Q&A platform, tech talks repository, communities of practice*

• ***Flexible work:*** *Fully flexible schedules, 100% remote work options, results-oriented culture*

• ***Advanced analytics:*** *Dedicated People Analytics team, predictive models with 82% accuracy for turnover prediction, A/B experimentation, integration with product metrics*

Results: *8% turnover rate (2-2.5x below IT industry average), eNPS +45, 70-75% automated HR operations, 25% internal mobility.*

Case 2: Kapital Bank (5,000+ employees, 102 branches + 17 offices, banking sector)

Kapital Bank achieved significant operational excellence (Level 3-4) through:

• ***Document digitalization:*** *99% paperless document flow achievement*

• ***Specialized HR portal:*** *https://hr.kapitalbank.az for candidate registration and applications*

• ***Learning infrastructure:*** *Human Capital Academy for systematic development programs*

• ***Analytics capability:*** *Centralized analytical data structure implementation*

• ***International recognition:*** *2024 World HR Summit dual awards ("Best People-Focused CEO" and "Best Internal Communication Strategy")*

Case 3: PASHA Bank (1,200+ employees, banking sector)

PASHA Bank emphasizes organizational culture transformation (Level 3-4) via:

• ***Agile methodology:*** *Implementation across all HR processes as foundational organizational culture element*

• ***Employee autonomy:*** *Freedom to choose work location and methods, performance-oriented culture (outcomes over time)*

• ***Strategic HR function:*** *HR Expert Group for strategic analysis and Board recommendations*

• ***Corporate systems:*** *Experience with SAP and Oracle at holding level demonstrating technical maturity*

• ***COP29 participation:*** *Showcasing digitalization expertise in governance and sustainable development*

Table 1: Comparative Analysis of HR Digital Transformation

Indicator	*Yandex*	*Kapital Bank*	*PASHA Bank*
Employees	*~20,000*	*5,000+*	*1,200+*
Digital recruitment level	*85-90%*	*Specialized HR portal*	*Online with transparent procedures*
Automated operations	*70-75%*	*~99% paperless*	*Agile across all HR*
AI/ML usage	*Active (CV screening, 82% turnover prediction)*	*Centralized analytics*	*HR Expert Group*
Learning platform	*Yandex.Practicum, Gamification, VR*	*Human Capital Academy*	*Agile-based programs*
Employee engagement	*eNPS +45*	*High (2024 dual awards)*	*High engagement*
Turnover rate	*8% (lowest in IT)*	*Not disclosed*	*Not disclosed*
Internal mobility	*25%*	*Developed career paths*	*Work format autonomy*

4.3 Identification of Barriers and Failure Factors

Analysis revealed five root causes of HR automation failure:

Cause 1: Automating Chaos - Organizations implement systems without clear, well-defined processes outside automation. This results in:

• *Managers bypassing formal systems through instant messaging and email*

• *Tickets in ATS filled post-factum for formal compliance*

• *Actual processes conducted through old, familiar channels*

• *Excel spreadsheets maintained parallel to official systems*

• *System showing unreliable data, eroding trust*

• *Employees bearing double workload: filling reporting system and working through old processes*

Root causes: *Lack of clear process definition and standardization before automation, each HR specialist performing functions their own way, uncertainty in responsibility areas, absence of common understanding of "correct" execution, unrealistic theoretical process descriptions never tested.*

Solution: Mandatory audit and mapping of existing processes before any automation, identification of bottlenecks and inefficiencies, design of optimized processes (To-Be) with identified problem elimination, process standardization and clear procedure creation, testing new processes in pilot mode, only then transition to automation after process stabilization.

Cause 2: Ignoring Employee Input - IT systems implemented by IT specialists without HR experience, systems deployed top-down without participation from those who will use them daily.

Manifestations:

- *System doesn't meet users' actual work needs*
- *Interface non-intuitive, requiring many clicks for simple operations*
- *System terminology and workflow don't align with organization's familiar language*
- *System loaded with unnecessary functions while critical functionality missing*
- *User resistance and sabotage feeling forced to use inconvenient tool*
- *Low adoption rates, minimum system usage for formal compliance*

Solution: User-centric approach with mandatory stakeholder involvement from project start, workshops with future users to identify needs and pain points, cross-functional project working group formation, requirements formulation bottom-up based on real user scenarios, super users' involvement for configuration and peer training, regular feedback collection throughout implementation and post-launch.

Cause 3: System for System's Sake - Automation decisions made based on trends, competitive pressure, or desire to appear innovative, but system's concrete purpose not clearly defined.

Manifestations:

- *No precisely defined business objectives for implementation*
- *Uncertainty about what problems system should solve*
- *Undefined goals and success metrics*
- *Unclear who will benefit from system daily and how*
- *System implemented for reporting to management about digitalization or demonstration purposes*
- *Tool used pro forma, minimum required for compliance*
- *Employees don't see system's value for themselves, ignore it or use minimally*

Solution: Strategic planning approach with clear business objective formulation linked to organizational strategy (e.g., "reduce hiring time by 30%", "improve hiring quality by 20%", "increase engagement by 15 points"), specific problem identification solvable through solution, success metrics (KPIs) tied to implementation achievement, key stakeholder identification and value proposition formation for each group, business case calculation with expected ROI, regular goal achievement monitoring and corrections when necessary.

Cause 4: Insufficient System Flexibility - Selection of inflexible, rigid systems unable to adapt to organization's specific processes, implemented software too rigid, system inaccessible or requiring expensive customization.

Manifestations:

- *System only supports standard, pre-defined workflows not considering organizational specifics*
- *Any changes require vendor participation, time-consuming and expensive*
- *Inability to create custom fields, reports, or dashboards without programming*
- *System doesn't integrate with existing corporate platforms*
- *HR specialists forced to adapt processes to system limitations*
- *Workarounds and fixes sought for task completion*
- *Reversion to manual task management alongside system*
- *User frustration and disappointment*
- *Entire HR digital transformation slows*

Solution: Careful selection with focus on flexibility, modern low-code/no-code configuration platforms enabling HR specialists to independently configure systems, integration capability assessment and API availability verification, flexibility testing in real-world scenarios during trials, preference for cloud-based solutions with regular vendor updates over on-premises systems, planning for system evolution with ability to add functionality gradually.

Cause 5: Inadequate Management Support - Absence of active support and sponsorship from organization's top management for project.

Manifestations:

- *HR digitalization project viewed as HR department initiative, not strategic organizational priority*

- *Insufficient resource allocation (budget, time, people) for full execution*
- *Top management doesn't communicate project importance or demonstrate commitment*
- *Line manager level resistance not addressed due to lack of top-down pressure*
- *Project lacks executive sponsor with sufficient authority for decision-making and conflict resolution*
- *No defense or support for project at highest levels when difficulties arise*

Solution: *Strategic project positioning as strategic initiative aligned with business priorities, executive sponsor appointment at C-level/top management with active participation, project included among organization's core priorities with regular leadership-level review, sufficient resources and top-quality communication expected about project importance at all levels, steering committee with top management representatives for strategic decisions, public recognition and celebration of project achievements at key milestones.*

Barriers to digitalization can be categorized into five groups:

1. Organizational barriers: *Unclear digitalization strategy, lack of systematic approach, insufficient management support, organizational structure not aligned with digital transformation*

2. Technological barriers: *Legacy systems difficult and expensive to replace, integration problems with multiple HR systems, data quality issues (incompleteness, inconsistency, errors), regulatory compliance requirements*

3. Financial barriers: *High acquisition and implementation costs, budget competition with other investments, unclear business case and quick ROI requirement, difficulty measuring softer outcomes*

4. Competency barriers: *HR technology skills gap, shortage of People Analytics specialists with data science skills, need for massive retraining of existing HR teams, competition with IT companies for analytical talent*

5. Cultural barriers: *Resistance to changes, fear of losing relevance with automation, resistance to transparency and accountability, preference for "how things have always been done", distrust of algorithms and AI in decision-making*

5. Conclusion

This research addresses the critical gap between the high potential of information technologies for improving HR management efficiency and the insufficient effectiveness of their practical implementation. Through systematic analysis of contemporary practice and development of comprehensive frameworks, we contribute actionable knowledge for both theory and practice.

Key findings:

1. ***Evolution and impact:*** *Information technologies have fundamentally transformed HR management from administrative function to strategic partner, enabling data-driven decision-making, predictive analytics, and enhanced employee experience.*
2. ***Classification system:*** *A comprehensive seven-category classification with three integration levels provides structure for understanding the HR technology landscape and making informed selection decisions.*
3. ***Maturity assessment:*** *The five-level maturity model enables organizations to assess current state and chart paths toward higher digitalization levels.*
4. ***Failure factors:*** *Identification of five root causes (automating chaos, ignoring employee input, system for system's sake, insufficient flexibility, inadequate management support) and five barrier categories provides roadmap for proactive risk mitigation.*
5. ***Implementation framework:*** *The five-stage model (audit, strategy, selection/pilot, scaling/integration, monitoring/optimization) offers systematic approach addressing organizational, technological, financial, competency, and cultural dimensions simultaneously.*
6. ***Performance measurement:*** *The five-dimensional KPI system (process performance, decision quality, user experience, financial, strategic) enables comprehensive evaluation of digitalization effectiveness.*

Theoretical contributions: *The research advances HRM and information systems theory through integrated classification framework, systematic identification of failure factors and barriers, comprehensive staged implementation model, and balanced performance measurement system.*

Practical contributions: *HR practitioners gain actionable frameworks for: developing digitalization strategies with clear business objectives, selecting appropriate technologies based on systematic criteria, implementing solutions through structured phased approach, measuring effectiveness through comprehensive KPI system, and continuously optimizing based on data-driven insights.*

Final recommendations:

*For **successful HR digitalization**, organizations should:*

- *Begin with thorough audit and analysis before technology selection*
- *Involve end users throughout process from strategy to optimization*
- *Focus on business objectives not technology for its own sake*
- *Select flexible, agile systems that can evolve with needs*
- *Secure strong executive sponsorship and adequate resources*
- *Adopt phased approach with pilot testing before full rollout*
- *Establish comprehensive measurement and continuous improvement practices*

The future of HRM lies not in technology itself but in thoughtful integration of technology with human capabilities, organizational culture, and business strategy. Organizations that successfully navigate this integration through systematic approaches like the framework proposed here will achieve competitive advantage through their most critical asset - human capital.

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A STUDY OF STUDENTS' BEHAVIORAL INTENTIONS TOWARDS THE USE OF ARTIFICIAL INTELLIGENCE

Nugzar Todua
Ph.D, Full Professor,
Department of Marketing,
Ivane Javakhishvili Tbilisi State University, Georgia
Grigol Kartsivadze
Ph.D Student,
Department of Marketing,
Ivane Javakhishvili Tbilisi State University, Georgia

Abstract

The article shows that artificial intelligence is an important tool of modern marketing. It is actively used in educational activities. Therefore, researchers pay special attention to studying students' attitudes towards platforms based on artificial intelligence. In this regard, the study of students' attitudes towards the use of ChatGPT in academic activities is of great significance. The paper examines the role of ChatGPT, as an artificial intelligence-based technology, in higher education. Based on the analysis of significant literature on the research topic, the main variables of the study are presented: perceived ease of use of ChatGPT, perceived usefulness of using ChatGPT, attitude towards ChatGPT, and behavioral intention to use ChatGPT. Relevant hypotheses are also formulated, and a research model is developed. As a result of the marketing research, the attitude of Georgian users towards the main variables of using ChatGPT has been identified. The study's results revealed statistically significant relationships between the variables mentioned above, confirming the hypotheses formulated in the article. The study's results have theoretical significance, as they enrich the conceptual understanding of the use of artificial intelligence in educational activities. The results of the study are also interesting in terms of practical application. It will help people employed in the educational field to properly plan the use of artificial intelligence, which will lead to greater involvement of students in the learning process.

Keywords: *Perception of using ChatGPT, attitude towards ChatGPT, consumer behavior, marketing research.*

Introduction. *ChatGPT (Generative Pre-trained Transformer) is an artificial intelligence-based chatbot that provides automatic task completion, personalized learning, and relevant answers to questions (Abbas et al., 2022; Mijwil & Aljanabi, 2023). Today, ChatGPT is considered a tool that revolutionizes the management of academic processes, as it provides access to a huge amount of information and knowledge (Cotton et al., 2024). Accordingly, students are more involved in the learning process and the quality of their academic performance increases (Susnjak, 2022). The study of student attitudes toward ChatGPT in academic contexts is a subject of current relevance and considerable interest to higher education researchers. While recent studies on this topic are increasing, the development of predictive models for student ChatGPT adoption remains limited (Hasanein & Sobaih, 2023; Abdi et al., 2025), particularly with respect to the incorporation of behavioral factors (Acosta-Enriquez et al., 2024). Research on technology integration in education frequently employs various models, among which the Technology Acceptance Model (TAM) is prominent (Papakostas et al., 2023). TAM emphasizes variables such as perceived ease of use and perceived usefulness (Davis, 1989). Although investigations into the factors influencing user behavior have been conducted in Georgia (Todua & Dotchviri, 2015a; Todua & Dotchviri, 2015b; Todua, 2018a; Todua, 2018b; Matin et al., 2022), gaps persist in understanding the impact of innovative technologies. In this research, attitude is examined as a mediating variable, with specific attention given to behavioral intention as an emotional factor. Therefore, this study aims to investigate the behavioral factors that influence students' intention to utilize ChatGPT.*

Literature review and development of research hypotheses. *Perceived ease of use (PEU) refers to the degree of mastery of a particular technology. It is a measure of students' perceptions of how easy it is to use various technologies for academic purposes (Venkatesh et al., 2003). Studies have shown that ease of use has a significant impact on users' intention to use AI-based tools, including ChatGPT (García de Blanes Sebastián et al., 2022; Emon et al., 2023). Perceived ease of use in the context of this study describes the degree of difficulty of using ChatGPT, according to which students believe that ChatGPT is easy to use and requires little effort (Strzelecki, 2024). As for perceived usefulness (PU), it refers to the*

degree to which an individual expects to accomplish certain tasks and achieve specific goals when using a particular technology (Davis, 1989; Venkatesh et al., 2003). In an academic context, students are more likely to use ChatGPT when it expands their capabilities to perform a particular task and thus contributes to improving the learning process (Malinka et al., 2023).

Attitude is a critical factor within the Technology Acceptance Model (TAM) and exerts a direct influence on an individual's intention to adopt new technologies (Foroughi et al., 2024). Attitude represents an individual's evaluation, whether positive or negative, regarding the utilization of a specific technology, thereby shaping their psychological predisposition (Foon et al., 2020). The positive correlation between attitude and intention to use has been extensively documented in the contexts of e-learning and chatbot adoption (Kwangsawad & Jattamart, 2022). Furthermore, behavioral intention reflects the extent to which students plan to incorporate ChatGPT into their learning activities (Maheshwari, 2024). Consequently, behavioral intention serves as a robust predictor of actual technology use, as a user's intention manifests in their preparedness and inclination to engage with ChatGPT in practical scenarios (Chai et al., 2021).

The above arguments allow us to put forward the following hypotheses:

H1: The perceived ease of use of ChatGPT has a positive impact on students' attitudes towards this technology.

H2: The perceived usefulness of using ChatGPT has a positive impact on students' attitudes towards this technology.

H3: Attitude towards ChatGPT has a positive impact on behavioral intention to use this technology.

Research methodology. *The research design was based on a quantitative research method, namely, a consumer survey, and a questionnaire consisting of several structured questions was selected as the research instrument. The variables and relevant statements selected based on the literature were measured in the study. 3 statements of perceived ease (Venkatesh et al.,2003; Strzelecki, 2024), 5 statements of perceived usefulness (Venkatesh et al., 2003; Foroughi et al., 2024), 2 statements of attitude, 3 statements of behavioral intention (Salifu et al., 2024) were used for measurement.*

The questionnaire used a five-point Likert scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree). The survey was conducted using an electronic interview method. We used a self-administered survey method in the study to avoid errors caused by the subjectivity of the interviewer. The total population of the study was the population of Georgia, and the study area consisted of various cities. Taking into account a 95% confidence interval and a 5% margin of error, a total of 390 respondents over the age of 18 were interviewed (231 of whom were women, 159 were men). The results were processed using the statistical program SPSS 29. To determine the relationship between variables, we used the regression analysis method (Malhotra, 2020).

Results. *To test the hypotheses formulated above, we used regression analysis. First, we determined the influence of the independent variables, perceived ease of use and perceived usefulness, on the mediating variable - attitude towards using ChatGPT (see Table 1). It turned out that this influence is quite significant in both cases (F=234.236, P<0.001 and F=316.385, P<0.001). Accordingly, the first and second hypotheses are confirmed.*

Table 1 – Regression analysis of the influence of perceived ease of use and perceived usefulness on attitudes towards using ChatGPT

Model		Sum of Squares	DF	Mean Square	F	P
1	Regression	667.408	1	667.408	234.236	0.000
	Residual	1105.528	388	2.849		
	Total	1772.936	389			
2	Regression	796.340	1	796.340	316.385	0.000
	Residual	976.596	388	2.517		
	Total	1772.936	389			

Notes: Dependent Variable: Attitudes towards using ChatGPT;
Predictors (Constant): Perceived ease of use; Perceived usefulness

Source: formed by authors

We then examined how attitude toward using ChatGPT influences behavioral intention (see Table 2). It is clear that the effect of attitude toward using ChatGPT on behavioral intention is quite significant (F= 588.178; P<0.001), thus confirming the third hypothesis.

Table 2 – Regression analysis of the influence of attitude towards using ChatGPT on behavioral intention

Model		Sum of Squares	DF	Mean Square	F	P
1	Regression	4514.970	1	4514.970	588.178	0.000
	Residual	2978.366	388	7.676		
	Total	7493.336	389			

Notes: Dependent Variable: Behavioral intention;
Predictors (Constant): Attitude towards using ChatGPT

Source: formed by authors

Conclusions. *The present study indicates a favorable perception of ChatGPT's integration into higher education. Research findings reveal that students hold positive views regarding the practicality and utility of ChatGPT as a learning aid. A majority of students find the information generated by ChatGPT to be beneficial, thereby fostering its active adoption in their learning endeavors. Students demonstrate a readiness to incorporate ChatGPT technology into their academic pursuits, perceiving its use as straightforward. Statistical analysis confirms the reliability of the research model. The study's outcomes suggest that the selected characteristics of ChatGPT usage are pertinent to student engagement. Consequently, the research possesses theoretical significance concerning the application of ChatGPT as an artificial intelligence instrument in higher education. The practical application of these research findings will enable stakeholders in artificial intelligence to broaden their comprehension of ChatGPT technology and facilitate its active utilization.*

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RETINOBLASTOMA: CURRENT PROBLEMS AND METHODS OF THEIR SOLUTION

Arman Khozhayev
Professor of the S.N. Nugmanov Department of Oncology,
Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan
Zauresh Utelbayeva
Professor of the Department of Ophthalmology,
Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan
Aliya Berdisheva
Assistant Professor of the Department of Ophthalmology,
Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan
Assiyam Rakhmidin
Resident ophthalmologist,
Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan
Assylzat Yessirkep
Resident ophthalmologist,
Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan
Symbat Kuanyshova
Resident ophthalmologist,
Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan
Aigerim Boranbayeva
Resident ophthalmologist,
Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan
Zhansaya Spandiyarova
Resident ophthalmologist,
Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan
Gulshat Kadyrzhanova
Resident ophthalmologist,
Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan
Ayaulym Tolegenova
Resident ophthalmologist,
Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan
Laura Lemissova
Resident ophthalmologist,
Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan
Kuralay Faizulla
Intern General Practitioner,
Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan

Abstract

This scientific and analytical work presents modern clinical and diagnostic data concerning the most common malignant intraocular tumor in children – retinoblastoma. The issues of etiopathogenesis, genetic and molecular features of this pathology, assessment of the role of biomarkers in diagnostics and prognosis of the disease are covered in detail. Promising directions for the development of new and improved diagnostic and therapeutic approaches, genetic causes of this pathology, possibilities of whole genome sequencing for studying the mutation landscape, currently used classification systems of retinoblastoma, available possibilities of clinical screening are described. The publication shows that studies of the molecular basis of the disease also led to deciphering subsequent events and, thus, to the discovery of biomarkers and associated targeted therapies. In addition, improvements in molecular biology methods contributed to the development of effective methods of early diagnostics, genetic counseling and disease prevention. The issues of visual acuity assessment and improving the quality of life of patients are also comprehensively considered.

Keywords: *oncology, ophthalmology, pediatrics, retinoblastoma, incidence, etiopathogenesis,*

classification systems, screening, visual acuity, biomarkers, RB1 gene, DNA, genome sequencing, diagnostics, treatment, quality of life, prognosis.

Retinoblastoma (RB) is a malignant tumor of the retina in young children.

The diagnostic criteria are as follows. Complaints and anamnesis: complaints of glow in the affected eye when exposed to light, often noticed by parents when photographing a child with a flash (white pupillary reflex, leukocoria, "cat's eye symptom"), convergent or divergent strabismus, deterioration of vision; redness, hemorrhages, change in eye color, pain (not a typical symptom). It is necessary to clarify the duration of complaints, hereditary anamnesis.

Physical examination: general examination of the patient - pay attention to changes in the eye (glow when exposed to light, symmetry of the orbits, is there exophthalmos, is the eye inflamed, color of the pupil), assessment of the condition of internal organs and systems, palpation of peripheral lymph nodes - to exclude metastases. Mandatory referral to an ophthalmologist for a complete ophthalmological examination.

Laboratory tests: complete blood count - presence of anemia, moderate leukocytosis and accelerated erythrocyte sedimentation rate (for the presence/absence of inflammatory changes); biochemical blood test: liver function tests, levels of nitrogenous waste products, electrolytes, total protein and glucose - for radiological diagnostics using a contrast agent. Instrumental tests: ophthalmoscopy with pupil dilation under general anesthesia - is the most objective method for assessing the condition of the eye - tumor size, location, prevalence, retinal detachment, condition of the optic nerve head; retinal camera - documentation of the tumor process; Ultrasound Examination of the orbits - the presence of an intraocular formation with calcifications is a pathognomic sign, the presence of retinal detachment, signs of growth into the orbit; Ultrasound Dopplerography of the orbits - presence of an intraocular formation with calcifications, determination of the tumor's own blood flow, detection of the "cut off branch" symptom, presence of retinal detachment, signs of growth into the orbit; X-ray of the chest organs, if necessary in two projections if pneumonia is suspected; magnetic resonance imaging (MRI) of the brain and orbits with contrast enhancement under anesthesia to determine the size of the formation, location, involvement of the optic nerve, presence of intracranial foci. In the absence of MRI, computed tomography (CT) of the brain and orbits may be performed, but this examination does not provide an objective assessment of the condition of the optic nerve and brain; according to indications, CT/MRI of other parts of the body in advanced cases with a long history [1].

RB is an intraocular tumor with hereditary and sporadic forms. 8,000 new cases of this ocular malignancy of the developing retina are diagnosed each year worldwide. The major gene responsible for retinoblastoma is RB transcriptional co-repressor 1 (RB1), and it harbors a large spectrum of pathogenic variants. Tumorigenesis begins with mutations that cause RB1 biallelic inactivation preventing the production of functional RB protein (pRB) [2].

pRB is a multifunctional protein involved in a variety of processes regulating cell proliferation at multiple levels including apoptosis, histone methylation and chromatin remodelling. Loss of function of pRB in the retina is thought to lead to dysregulation of these events, resulting in uncontrolled cell proliferation and chromosomal instability. The RB is the most common primary intraocular cancer of childhood, causing significant long-term sequelae. Loss-of-function mutations in RB1 are causally implicated in RB development. RB1 was the first tumour suppressor gene to be isolated, in contrast to activating oncogenes, which were characterised earlier. In humans, RB1 is located on chromosome 13q14.2, spans approximately 180 Kb and contains 27 exons encoding a 928 amino acid nucleophosphoprotein, known as pRB [3].

Depending on the type of mutation the penetrance of RB is different. However, in small percent of tumors additional genes may be required, such as MYCN, BCOR and CREBBP. Additionally, epigenetic changes contribute to the progression of RB as well. Besides its role in the cell cycle, pRB plays many additional roles, it regulates the nucleosome structure, participates in apoptosis, DNA replication, cellular senescence, differentiation, DNA repair and angiogenesis. Notably, pRB has an important role as a modulator of chromatin remodeling. In recent years high-throughput techniques are becoming essential for credible biomarker identification and patient management improvement. In spite of remarkable advances in RB therapy, primarily in high-income countries, our understanding of RB and its specific genetics still needs further clarification in order to predict the course of this disease and improve therapy. One such approach is the tumor free DNA that can be obtained from the anterior segment of the eye and be useful in diagnostics and prognostics. The field of ophthalmology genetics and genomics is expanding fast and the accumulated knowledge aims to develop novel and improved diagnostic and therapeutic

approaches. The specific molecular mechanisms behind eye diseases, including RB, are being recognized every day, because it is important to understand their genetic causes and biological behavior in order to improve clinical outcome. Genetic implications for more than 97% of all RB cases is the RB1 gene inactivation. Although RB has been genetically characterized a long time ago, its molecular blueprint is still incomplete and needs deeper investigation. Several classification systems are currently in use, for example, the International Intraocular Retinoblastoma Classification (IIRC), International Classification of Retinoblastoma (ICRB) and cTNMH (American Joint Committee on Cancer (AJCC)) and for extraocular disease, the International Retinoblastoma Staging System (IRSS) and cTNMH staging [2].

Davies H.R. et al. [3] in their study emphasize that the majority of RB1 mutations can be detected by clinical screening. However, RB cases exist where mutations in RB1 have not been detected. Our colleagues used whole-genome sequencing to investigate the landscape of mutations in a cohort of sporadic RBs, including cases where mutations in both copies of RB1 had not been previously identified. The researchers looked for mutations in cancer driver genes and revealed a wide variety of structural rearrangements disrupting RB1. In addition, they investigated mutation burden and specific mutation patterns (mutational signatures), uncovering a treatment-related mutational signature in a tumour exposed to chemotherapy. The power of whole-genome sequencing to identify RB1 mutations of all mutation types can have significant relevance to the clinical management of RB patients and genetic counselling of their families. The development of RB is thought to require pathological genetic changes in both alleles of the RB1 gene. However, cases exist where RB1 mutations are undetectable, suggesting alternative pathways to malignancy. The authors used whole-genome sequencing (WGS) and transcriptomics to investigate the landscape of sporadic RBs derived from twenty patients, sought RB1 and other driver mutations and investigated mutational signatures. At least one RB1 mutation was identified in all RBs, including new mutations in addition to those previously identified by clinical screening. Ten tumours carried structural rearrangements involving RB1 ranging from relatively simple to extremely complex rearrangement patterns, including a chromothripsis-like pattern in one tumour. Bilateral tumours obtained from one patient harboured conserved germline but divergent somatic RB1 mutations, indicating independent evolution. Mutational signature analysis showed predominance of signatures associated with cell division, an absence of ultraviolet-related DNA damage and a profound platinum-related mutational signature in a chemotherapy-exposed tumour. Most RB1 mutations are identifiable by clinical screening. However, the increased resolution and ability to detect otherwise elusive rearrangements by WGS have important repercussions on clinical management and advice on recurrence risks.

The foundational work that explained the RB inheritance but also the concept of tumor suppressor genes was originally published by Knudson in his seminal paper from 1971 Knudson's two hit model proposed that one RB1 allele is lost or mutated in all cells and a second somatic mutagenic event affects the remaining allele in a primitive retinal cell, thus initiating tumorigenesis [4].

With an average incidence of 1 in every 18,000 live births, RB is a rare type of intraocular tumour found to affect patients during their early childhood. It is curable if diagnosed at earlier stages but can become life-threateningly malignant if not treated timely. With no racial or gender predisposition, or even environmental factors known to have been involved in the incidence of the disease, RB is often considered a clinical success story in pediatric oncology. The survival rate in highly developed countries is higher than 95% and they have achieved this because of the advancement in the development of diagnostics and treatment techniques. This includes developing the already existing techniques like chemotherapy and embarking on new strategies like enucleation, thermotherapy, cryotherapy, etc. Early diagnosis, studies on the etiopathogenesis and genetics of the disease are the need of the hour for improving the survival rates. According to the Knudson hypothesis, also known as the two hit hypothesis, two hits on the susceptibility RB gene is often considered as the initiating event in the development of the disease. Studies on the molecular basis of the disease have also led to deciphering the downstream events and thus in the discovery of biomarkers and related targeted therapies. Furthermore, improvements in molecular biology techniques enhanced the development of efficient methods for early diagnosis, genetic counseling, and prevention of the disease [5].

As noted by Byroju V.V. et al. [5] with an ability to convert electromagnetic/ light energy to electrical energy, the retina acts as a transduction screen that enables the visualisation of any object in front of it by transmitting this electrical energy as nerve impulse to the cortical functioning centres. It layers the innermost part of the eye and hosts various types of cells like rods and cones which are integral for its proper functioning. Various diseases like retinal tear, retinal detachment, diabetic retinopathy, macular degeneration, retinitis pigmentosa etc. have been associated with retina and its impaired functioning. One such disease is RB, the most common malignant intraocular tumour in children. RB is theorized to

arise from the cones of the retina, which have certain properties that leave them rather susceptible to tumorigenesis. Globally, 1 in every 16,000 to 20,000 live births is known to be afflicted by RB. Most of the cases are diagnosed before the age of 5 and it accounts for 3% of all childhood cancers. Previous studies indicated that there were significant differences in the incidence of RB based on gender, ethnicity, and infections due to poor sanitation. The newer studies, however, deny significance of such differences and consider RB to have similar incidence throughout the world. Despite being rare, RB gained interest within the scientific community since RB1 gene is the first tumour suppressor gene to be discovered. In its hereditary form, RB is associated with de novo mutations resulting in tumours at other foci in the body which are termed 'second primary tumours' and is attributed to the role played by phosphorylated pRB. Subjects with hereditary RBs are at a higher risk of developing other second primary tumours such as osteosarcomas, melanomas etc.. Every form of RB, familial and sporadic has the RB gene mutated to some extent resulting in the downstream processing of aberrant transcripts. RB1 gene is located on the largest acrocentric chromosome, 13 and consists of 27 exons. Following transcription, pRB is formed and gets involved in the regulation of cell cycle at the G1-S checkpoint. Phosphorylation essentially acts to 'switch off' RB tumour suppressor protein which results in deregulation of downstream molecular events that eventually results in RB.

RB has been assigned various stages depending upon the progression of the disease and its potential for metastasis. The system was named IRSS where, the stage 0 often shows good prognosis with treatment while stage IV shows poor outcome. During stage IV, the cancer is considered to be extraocular and can lead to bulging out of the eye. When it comes to differentiating it into various types, the disease can appear as unilateral, bilateral or trilateral. The chance of a patient developing a trilateral RB is 6% higher in case of bilateral RB as compared to unilateral and can be fatal in 50% of the cases. Another classification of RB could be based on direction of progression of the disease; i.e. exophytic if the tumour originates in the retina and spreads in the direction of the brain behind or endophytic if the tissue spreads in an anatomic anterior direction [5].

In addition, a very important and even decisive aspect in the early diagnosis of RB is screening. Screening of RB involves various tests for detecting the symptoms of RB. Leukocoria (sometimes referred to as the 'cat's eye reflex') can be detected by the presence of a white reflection in photographs or the red reflex test. A simpler approach would be to use mobile phones for the same purpose where, such an application exists in the form of an app called "White eye Detector" developed by Bryan Shaw. Performing cover test detects the presence of strabismus while all other signs can be identified by a systematic visual examination. Screening by an ophthalmologist is a necessity in children with a positive family history of RB. Offspring and siblings of affected patients require regular screening examinations in childhood unless genetic testing is done to rule out a gene mutation in which case the risk is similar to that of the general population. Genetic counselling for families with RB can help determine the risk to future offspring and whether other family members are at risk of developing the disease [5,6].

An ophthalmoscope view shows the optic disk, the physiological cup, the retinal vessels, the macula and the fovea centralis so the tumour is quite easily identified. Non-invasive two dimensional and three-dimensional real-time ultrasound techniques have eased detection significantly. Once the polymerase chain reaction (PCR) was invented, it became easy to identify the batch deletion of exons in chromosome no. 13 of the children whose parents carry the RB1 gene mutation. Quantitative multiplexing is an advanced form of the technique where several primers are used at the same time together to identify batch deletions. Use of X Ray and CT has found its place in detection of RB relying on properties such as calcification in the latter technique. Gadolinium contrast enhancement followed by MRI scanning is informative for tumor detection. Fat saturation is also very useful when fat has been suppressed at one time and expressed at another time in anticipation of tumor nature. T1-weighted imaging with magnetization is used for best results.

Fluorescein angiography is a technique that requires injection of a small bolus of fluorescent material into the blood stream which finally reaches the ophthalmic artery. A specialized camera takes pictures of the eye once it reaches there through the catheter using the fluorescence of the arteries of the eye as a light source. Unsuccessful attempts at detecting RB using positron emission tomography (PET) were made using Flourine-18-fluorodeoxyglucose (FDG) throughout many years. The conclusion that FDG-PET is not currently widely established and does not provide any significant advantage over MRI/CT except in metastasis rendered MRI as the gold standard. Early detection using an ultrasonogram in-utero to study the face and eyes can help in detection of the cancer, resulting in earlier detection and potential cure [7,8].

Vempuluru V.S., Kaliki S. [6] a PubMed search was performed to identify articles published with

specific reference to screening of neonates, infants and children for RB. It has been established that various devices and mobile phone-based applications based on altered red reflex are finding their way into community screening. Diagnosis of RB by newborn eye screening is emphasized in several countries, and red reflex is the most widely employed technique. At the same time several screening programs for early detection of RB are evolving in the developing countries, but the practices are not uniform. Universal newborn screening should be the norm. Newer tools and software can be utilized to screen infants on a community scale. Focussed research on revolutionizing digital imaging for a versatile screening tool holds promise for early diagnosis of RB.

RB is a cancer that can be cured if diagnosed at an appropriate time. The involvement of structures beyond the retina and the vitreous humour should be taken into consideration as they have the potential to progress into metastasis rapidly. The treatment of RB is often complex and involves decisions to be made based on a number of factors including but not limited to the size of the tumour in various axes, age of the patient, risk of secondary metastasis, previous attempts made at chemotherapy, toxicity of the chemotherapeutic agent in the subject and laterality of the tumour. Treatment of RB includes the following aspects [6,9]:

1. Enucleation. Complete removal of the eye that is affected by the tumour, or surgical excision is termed as enucleation. It is the least conservative possible management and hence reserved for cases that cannot be helped otherwise. Enucleation should be avoided in cases where salvage is possible with other treatment modalities in an effort to preserve vision and improve conservation. For the first 2 years after surgery, all patients undergoing enucleation must be carefully monitored for the risk of orbital relapse. Hydroxyapatite implants coated with specialized polymers and have attachment sites for the extraocular muscles are being implemented. Overall, enucleation was widely used and continues to be used in cases where other treatment modalities are unhelpful.

2. Intra-arterial chemotherapy (IAC). Intra-arterial chemotherapy is safe and effective enough to avoid enucleation. Modern microcatheter techniques are used to deliver chemotherapeutic agents, and success is achieved with acceptable toxicity. Drug choices for this route of administration typically include mephalan, topotecan hydrochloride, carboplatin, and methotrexate. This method is used as a primary or secondary therapeutic intervention. Although intra-arterial chemotherapy is an effective treatment option, its limitations require the introduction of more sophisticated techniques. The efficacy of IAC is reduced in cases of extensive collateral meningeal vascular presence due to dilution of the agent in these vessels. Collateral blood supply to the retina other than the ophthalmic artery is variable and affects dose delivery. Catheterization of appropriate arteries requires skill, and technical difficulties may arise that may reduce the delivery of intra-arterial chemotherapy.

3. Intravitreal chemotherapy (IVitC). Focused drug delivery to a vitreal seed hotspot is considered precision intra-vitreal chemotherapy and is an emerging technique. Often used as an adjunct therapy to IAC, in IVitC, drugs are delivered directly into the vitreous cavity in advanced stages of RB where vitreous seeding occurs. A combination of chemodrugs such as melphalan and topotecan are the preferred mode of treatment when tumour seeds recur in the vitreous and is found to be more effective than the respective individual treatments. While the presence of vitreous seeds is an indication for IVitC, contraindications include diffuse dispersion of the tumour seeds, invasion of the anterior chamber of the eye, hemorrhage into the vitreous humour, and secondary glaucoma. With the advent of nanoparticle delivery, IVitC has promising prospects in the management of RB.

4. Thermotherapy. This mode of treatment is often engaged for tumours of minor dimensions, not exclusively for the eye. The usual dimension as indicated for thermotherapy alone is of a diameter of maximum 4 mm. Diode system delivers infra-red rays either through the pupil or the sclera to destroy tumour tissue by applying focused heat to induce necrosis. Ideal temperature of thermotherapy ranges from 45-60 C. It is often used in conjunction with other treatment modalities such as chemotherapy. Complications are seen in some cases which include but are not limited to atrophy of the iris, obstruction of the retinal vein and detachment of the retina. Attempts were made to avoid thermotherapy as a single modality in cases where seeding of the vitreous humour is observed.

5. Cryotherapy. Much like thermotherapy, cryotherapy is an adjuvant and used in conjunction with other treatments. A RB tumour up to 3.5 mm in diameter and 2 mm in thickness could be treated with cryotherapy. This therapy is contraindicated in cases with vitreous seeding and any tumour that has dimensions larger than the norm. The modality involves the application of triple freeze thaw technique using liquid nitrogen.

6. External beam radiation (EBR). EBR is in the line of management of treatment for RB after enucleation as an attempt to salvage the remaining eye. A high energy photon beam or electrons are

delivered at an angle where the tumour has maximum exposure. Complications include cataracts, conjunctivitis, dry eyes and intractable glaucoma. Considering side effects such as new mutations, dry eyes, keratopathy, retinopathy and optic neuropathy, EBR therapy is better restricted to extra ocular tumour extension or if better alternatives are available, this could be completely avoided. Tumours can sometimes arise secondarily due to radiation exposure, however, development of new modalities of beam radiation reduce such instances.

The authors emphasize that tumour regression should be followed up closely and the appearance, size, location, and number of tumours documented during each examination have to be assessed. When a tumour regresses after treatment, it can either appear as a white coloured calcific mass or as translucent piece of flesh. In most of the cases, patients undergo examination under anaesthesia every 4 to 8 weeks until the age of 3, followed by less frequent examinations if the disease is found to be latent.

Ancona-Lezama D. et al. [9] in their publication emphasize that RB, the most common ocular malignancy in childhood, is lethal if left untreated. RB management remains complex, requiring individualized treatment based on ICRB staging, germline mutation status, family psychosocial factors and cultural beliefs, and available institutional resources. Management of RB remains in constant evolution and treatment can vary among different centers worldwide. However, the same primary goals of protecting life and preventing metastatic disease, followed by globe preservation, and finally optimization of vision are commonly shared among RB specialists. The currently used therapies maintain excellent survival rates when disease is identified in the localized intraocular stage, while newer therapies have been focusing on additional improvement in globe preservation and providing the best possible visual acuity outcome. The refinement of these curative strategies has led to unprecedented cure rates and globe salvage in centers where a complete armamentarium of treatment options is available.

As noted in their study by Zhang R. et al. [10], RB is the most common intraocular malignancy in childhood. With the advanced management strategy, the globe salvage and overall survival have significantly improved, which proposes subsequent challenges regarding long-term surveillance and offspring screening. This cohort study included RB patients who visited Beijing Tongren Hospital from March 2018 to January 2022 for deep learning algorism development. Clinical-suspected and treated RB patients from February 2022 to June 2022 were prospectively collected for prospective validation. Images from the posterior pole and peripheral retina were collected, and reference standards were made according to the consensus of the multidisciplinary management team. A deep learning algorithm was trained to identify "normal fundus", "stable retinoblastoma" in which specific treatment is not required, and "active retinoblastoma" in which specific treatment is required. The performance of each classifier included sensitivity, specificity, accuracy, and cost-utility. A total of 36,623 images were included for developing the Deep Learning Assistant for Retinoblastoma Monitoring (DLA-RB) algorithm. In internal fivefold cross-validation, DLA-RB achieved an area under curve (AUC) of 0.998 (95% confidence interval [CI] 0.986-1.000) in distinguishing normal fundus and active RB, and 0.940 (95% CI 0.851-0.996) in distinguishing stable and active RB. From February 2022 to June 2022, 139 eyes of 103 patients were prospectively collected. In identifying active RB tumours from all clinical-suspected patients and active RB from all treated RB patients, the AUC of DLA-RB reached 0.991 (95% CI 0.970-1.000), and 0.962 (95% CI 0.915-1.000), respectively. The combination between ophthalmologists and DLA-RB significantly improved the accuracy of competent ophthalmologists and residents regarding both binary tasks. Cost-utility analysis revealed DLA-RB-based diagnosis mode is cost-effective in both RB diagnosis and active RB identification. In conclusion, the authors point out that DLA-RB achieved high accuracy and sensitivity in identifying active RB from the normal and stable RB fundus. It can be used to surveil the activity of RB during follow-up and screen high-risk offspring. Compared with referral procedures to ophthalmologic centres, DLA-RB-based screening and surveillance is cost-effective and can be incorporated within telemedicine programs.

A very important issue is the question of preserving vision in this pathology.

Sinenko I.L. et al. [11] in their work they say that it is currently treated with a limited number of drugs, adapted from other pediatric cancer treatments. Drug toxicity and relapse of the disease warrant new therapeutic strategies for these young patients. In this study, researchers developed a robust tumoroid-based platform to test chemotherapeutic agents in combination with focal therapy (thermotherapy) – a treatment option widely used in clinical practice – in accordance with clinically relevant trial protocols. The model consists of matrix-embedded tumoroids that retain RB features and respond to repeated chemotherapeutic drug exposure similarly to advanced clinical cases. Moreover, the screening platform includes a diode laser (810 nm, 0.3 W) to selectively heat the tumoroids, combined with an on-line system to monitor the intratumoral and surrounding temperatures. This allows the reproduction of the clinical

settings of thermotherapy and combined chemothermotherapy treatments. When testing the two main drugs currently used in clinics to treat RB in our model, authors observed results similar to those clinically obtained, validating the utility of the model. This screening platform is the first system to accurately reproduce clinically relevant treatment methods and should lead to the identification of more efficient drugs to treat RB.

Schaiquevich P. et al. [12] in their work they say that the management of RB, the most common intraocular malignancy in children, has changed drastically over the last decade. Landmark developments in local drug delivery, namely, safer techniques for intravitreal chemotherapy injection and ophthalmic artery chemosurgery, have resulted in eye globe salvages that were not previously attainable using systemic chemotherapy or external beam irradiation. Novel drugs, oncolytic viruses, and immunotherapy are promising approaches in the treatment of intraocular RB. Importantly, emerging studies of the pattern of tumor dissemination and local drug delivery may provide the first steps toward new treatments for metastatic disease. Our colleagues reviewed recent advances in RB treatment, especially with regard to local drug delivery, that have enabled successful conservative management of intraocular RB, as well as emerging data from preclinical and clinical studies on innovative approaches that promise to lead to further improvement in outcomes, namely, the mechanisms and potential uses of new and repurposed drugs and non-chemotherapy treatments, and future directions for therapeutic development.

The authors emphasize that RB has been selected as a priority tumor by the World Health Organization for its Global Initiative for Childhood Cancer. Despite being highly curable at early stages, it may be fatal if left untreated. Eye-globe salvage treatments have substantially evolved over the last few decades, making intraocular RB the most curable of all pediatric cancers in high-income countries. The development of local drug delivery methods that maximize chemotherapy exposure in the retinal, subretinal, and vitreous spaces, namely ophthalmic artery chemosurgery (OAC) and a safety-enhanced technique for intravitreous (IVi) injection, have resulted in an unprecedented rate of eye globe and vision preservation. Importantly, these new local treatments result in very high concentrations of chemotherapy in the retina and optic nerve as shown in preclinical models, preventing dissemination to the central nervous system (CNS). So far, after more than a decade of continuous use at major clinical centers around the world and after more than 200 articles published in the field, IVi and OAC have been proven safe without increasing the risk of metastatic dissemination. By eliminating the use of external beam radiotherapy and systemic chemotherapy, these treatments have improved long-term survival by reducing the incidence of treatment-associated severe toxicities, the risk of secondary malignancies, and related deaths. In contrast to this exceptional improvement in treatment outcomes, children with disseminated RB have few therapeutic options, generally limited to high-dose chemotherapy, stem cell transplant, and local radiotherapy. Even worse is the scenario for patients with metastasis in the CNS, as these patients seldom survive even with intensive therapies. Thus, newer treatments and improved methods of targeting drug delivery to the CNS may improve outcomes. Examples of CNS-targeted routes include intrathecal (IT) and intraventricular (IVt) injection, which ensure direct delivery of chemotherapy to the cerebrospinal fluid, circumventing the blood-brain barrier. OAC may also be useful in patients with orbital RB with massive optic nerve and chiasmatic tumor involvement because of maximal local exposure to chemotherapy as shown in animal models. Future clinical assessments are necessary to determine the role of local chemotherapy delivery in disseminated RB. In all cases of intraocular and extraocular disease, there is a need for new therapies that are more effective and carry less risk of toxicity. New treatment modalities, namely, targeted therapies, immunotherapy, and oncolytic viruses are emerging as possible non-chemotherapeutic options. These novel treatments may further reduce the use of cytotoxic agents, potentially leading to even higher ocular preservation rates, reduced toxicities, and prevention of tumor dissemination. Identifying high-risk features associated with tumor progression and metastasis by histopathological analysis of the enucleated eye is critical for selecting appropriate management. These approaches may soon be supplemented by circulating tumor DNA (ctDNA) analysis, which may be an early and noninvasive prognostic biomarker of treatment response and risk of occult extraocular dissemination. In addition, ctDNA may be helpful in noninvasive genomic profiling, especially to identify patients with the subtype 2 molecular signature who have an increased risk of extraocular relapse. In conclusion, the researchers emphasize that treatments that have evolved over the last century have led to striking changes in the treatment paradigm for this ocular tumor. Advances in the knowledge of its tumor biology and drug response and the development of new routes of drug delivery promise to lead to additional new, more effective, and less toxic therapies in RB [12].

Warda O. et al. [13] in their work they say that the assessment of vision has a growing importance in the management of RB in the era of globe-conserving therapy, both prior to and after treatment. As

survival rates approach 98-99% and globe salvage rates reach ever-higher levels, it is important to provide families with information regarding the visual outcomes of different treatments. As part of a holistic approach, it is essential for clinicians to understand the impact of various treatment modalities on vision, as severe visual impairment, particularly in bilateral cases, can negatively impact the child's development and overall well-being. Although family counselling often appropriately centres on saving the child's life, it is important not to let the consideration of visual outcome fall by the wayside, as this is an additional piece of information that families find useful to help guide their decisions. As the authors note visual assessment in infants can be difficult. While Snellen visual acuity is used by many studies in the ophthalmic literature, this method of quantification requires children who are old enough (often over 5 years) to co-operate. Given that RB primarily affects infants and young toddlers, methods of vision assessment need to be tailored to this age group.

Age-appropriate visual acuity (VA) assessment can be performed using standard orthoptic techniques including Cardiff Cards, Keeler Cards, Kays picture tests and Single Sheridan Gardner Tests. When possible VA should be assessed monocularly. An encouraging and animated approach is used to maximise the engagement and co-operation of the child during VA assessment. As children with RB grow older, the choice of VA assessment tool should similarly evolve to ensure the most refined quantification possible. At presentation, children with RB are often seen on an urgent basis at the RB unit, which in many cases requires them to travel a significant distance. In our service, the visual assessment is performed by the orthoptist on presentation as well as at every ophthalmological evaluation during treatment; unless systemic chemotherapy, in which case visual assessment is performed after the final cycle. When RB is in remission, a visual assessment is performed at each follow-up appointment, this takes place before the examination under anaesthesia to avoid the child and family travelling great distances twice. The assessment can prove difficult particularly for starved children before their anaesthetics, so it may be necessary to settle for binocular VA in this instance. If the quantitative assessment is not possible, qualitative methods are used i.e. fixing and following a light and different-sized target to assess for a fixation preference. During the active treatment phase, the timing of visits depends largely on the treatment modalities employed. In the later years when there is no longer ongoing active RB treatment, the frequency of visits may in some cases be driven by the need to monitor for or manage amblyopia. In addition to the subjective methods of assessing VA mentioned above, electrodiagnostic studies may occasionally be helpful. Electroretinograms (ERGs), visual evoked potentials (VEPs) and fundus fluorescein angiography (FFA) have been found to be particularly useful in assessing for retinal toxicity and visual loss following the use of intra-arterial chemotherapy in eyes with tumour-free foveolae. Whilst ERGs are recognised not to correlate with vision, VEPs have a role in infants where the foveola is not involved. In fact, VEP Spatial Frequency is better than behavioural methods up to the age of 3 and is a useful adjunct to behavioural methods in this age group when assessing novel treatments and their impact on vision [13].

In addition to appropriate timely VA assessment, screening at-risk children plays an important role in optimising visual outcomes as early diagnosis correlates with smaller tumours. Consensus-based guidelines for screening are stratified by risk category, with high-risk children being screened at 2 weeks of age and repeated every 2-4 weeks initially and then at progressively long intervals until 5-7 years of age. While low-risk screeners are examined primarily within 4 weeks and follow-ups are dependent on genetic testing and are often awake examinations. In their conclusions and recommendations, the authors emphasize that with the increased rates of globe salvage, visual outcomes have become an integral part of planning the management for children with RB. In some situations, enucleation is still the most appropriate treatment, but with globe-conserving therapy, there is a need for information for patients and physicians alike to make informed decisions. Specialised orthoptic assessments to check visual acuity for children with RB has a very important role in the management of those cases. Thus, the prediction of the visual potential for both eyes needs to be tailored for each patient and be part of the parents' discussion and counselling. Tumour location and grading at presentation are the most important predictors of long-term visual prognosis. Age-appropriate visual assessments in infants and children with RB are important in safety profile data for new treatments. Families can be effectively counselled using the visual outcomes from treatment and where, appropriate visual rehabilitation and support can be provided; in particular liaison with nurseries/schools and local visual impairment teams [13].

As Gurney S.P. et al. [14] note in their work the goals of RB treatment are primarily to preserve life by curing the disease and preventing extraocular spread and distant metastases. Advances in treatment modalities over the past decades have improved survival rates and the goals have advanced further towards preserving eyes and improving visual outcomes. A cautious approach is therefore required to avoid changing a child's condition from that of an intraocular disease, when management is largely focused

on avoiding incidence, to extraocular disease, when mortality is a significant concern. The authors point out that just over a decade ago, entering an eye with viable tumour was considered an absolute contraindication in most centres around the world. However, intraocular procedures on eyes with active disease are now performed routinely and safely, with an acceptably small risk of complications. Intravitreal administration of chemotherapy is now a well-established treatment modality for vitreous disease. More invasive intraocular surgery, such as pars plana vitrectomy and endoresection have been reported by a small number of authors for atypical circumstances, including refractory disease in a child with only one eye or when a family refuses enucleation. The place of such treatment in current practice is not established and the subject of much debate. Several surgical innovations have made intraocular procedures safer and minimised the risk of extraocular spread and metastasis. These include clear corneal incisions where possible, the use of chemotherapeutic agents in irrigation fluid during surgery and delivered to entry sites (often in combination with cryotherapy) at the end of the procedure and the prophylactic use of intravitreal chemotherapy before and after surgery. It is likely that, with the further development of safer surgical techniques, the indications for intraocular surgery in active RB will continue to broaden. Likewise, the risk-benefit analysis for intraocular surgery for inactive disease may change and result in earlier interventions to improve visual outcomes or to manage the ocular sequelae of the disease or iatrogenic complications of the treatments used in the active stage of RB.

Interesting data on the contribution to scientific research on RB were obtained through a bibliometric analysis by Gu X. et al. [15]. In their study, they attempted to analyze the research trends in the field of RB and compare the contribution of different countries, institutions, journals and authors. They extracted all publications concerning RB from 2001 to 2021 from the Web of Science database. Microsoft Excel and VOSviewer were employed to collect publication data, analyse publication trends, and visualize relevant results. A total of 1,675 publications with 30,148 citations were identified. The United States contributed the most publications (643) and citations (16,931 times) with the highest H-index value (67) as of February 4, 2021. China ranked second in the number of publications (259), while ranking fourth in both citations (2,632 times) and the H-index (26) ranked fourth. The British Journal of Ophthalmology was the most productive journal concerning RB, and Abramson DH had published the most papers in the field. Keywords were categorized into three clusters; tumor-related research, clinical research, and management-related research. The keywords "intravitreal," "intraarterial," and "intravenous" appeared the most frequently, with the average appearing year being 2018.1, 2017.7, and 2017.1, respectively. Management-related research has been recognized as a heavily researched topic in the field. The study has demonstrated global trends in RB research. It has been established that the United States has been at the cutting edge of the field based on its role as the lead contributor. Despite the considerable number of publications in China, the quality of the publications requires further improvement. Novel progress can be uncovered in the British Journal of Ophthalmology and Ophthalmology. Abramson DH and Shields CL are regarded as excellent candidates for academic collaboration in the field. Chemotherapy-related research has received the most attention previously and currently; furthermore, it may still be considered in the near future as the latest hotspot.

Regarding the quality of life of patients with this pathology. Padamandala K. et al. [16] in their study note that with the increased survival of RB patients, it is important to evaluate the quality of life (QoL) of RB survivors as well as caregivers to provide comprehensive care to the children and caregivers. The aim of the study was to assess the QoL of survivors of RB, according to parents' opinions and patient self-reports, using the Pediatric QoL Questionnaire (PEDs-QoL). The study cohort included 86 RB survivors, 86 age-matched controls, and their primary carers. PedsQL 4.0 generic core scale and structured interview were administered. QoL in physical, social, emotional, and school health was evaluated and correlated with clinical and sociodemographic parameters. The mean age of the RB survivors was 5.7 years with an M:F ratio of 1.1:1. Disease was bilateral in 79% of cases. About 45% (39/86) underwent enucleation, while others received combination therapy (16; 18%), chemotherapy (30; 34%), and radiation (1; 1%). As reported by parents, the QoL of physical health domain of RB survivors was 70.2 SD ± 27.8 and 96.15 ± 13 SD, emotional health was 72.1 ± 27.4 SD and 94.4 ± 12.5 SD, social health was 80.4 ± 24.9 SD and 98.6 ± 6.2 SD; and school health was 71.9 ± 2 6.5 SD and 96.1 ± 12.2 SD. As per the self-report perception, the QoL of physical health was 68.2 ± 27.8 SD and 96.2 ± 13 SD, emotional health was 66.2 ± 28.4 SD and 95.3 ± 12.5 SD, social health was 69.5 ± 24.9 SD and 98.7 ± 6.2 SD, and school health was 63.5 ± 26.5 SD and 95.1 ± 12.2 SD. There was a significant relationship between enucleation and QoL domains, where $x2 = 67.75$, degrees of freedom (df) = 36, and $P < 0.01$. There was a significant association between vision in the better eye (6/18 or better = 8, 6/18–6/60 = 8, 3/60 or worse = 42) and QoL scores ($x2 = 95.36$, df = 62, $P < 0.01$). There was a substantial association between socioeconomic

status and QoL domains, where x2 = 88.5, df = 56, P < 0.01. The results of the study showed that the QoL of parents of RB survivors and self-proxy reports were negatively affected in many ways, including physical, social, emotional, and school-related dimensions. Despite the small differences, self-proxy reports indicated a lower QoL than the parents' group. The study findings indicate that there are notable correlations between enucleation and visual acuity less than 6/18, as well as socioeconomic status, with various aspects of QoL domains among individuals who have survived RB.

Dhingra H. et al. [17] in their study mention that despite high cure rates, data on health-related QoL (HRQoL) of RB survivors are limited. This study aimed to analyze parent's perspective and self-report of HRQoL of RB survivors, using healthy siblings as controls. It also evaluated the impact of socio-economic status (SES), gender, disease laterality, treatment modality, duration since diagnosis, and visual outcomes, on HRQoL. Ninety-two RB survivors were enrolled in this observational, cross-sectional questionnaire-based study conducted at a tertiary care center. QoL was analyzed in four dimensions: physical, emotional, social, and school, using both self-report (for children >6 years) and parent proxy report (for children 2-18 years) using Pediatric Quality of Life Inventory™ (PedsQL™) 4.0 Generic Core Scale. Seventy-seven healthy siblings served as controls. The mean age of both cohorts was 5.7 years. Thirty-six (39%) patients had bilateral RB. Of the 92 survivors, 43 (47%) had undergone enucleation. The HRQoL of RB survivors was significantly lower compared to sibling controls (P < 0.01) in all four domains, the physical domain being most affected followed by social domain. Parents reported an inferior QoL than patient's self-report. Vision <6/18 in the best eye and enucleation had a negative impact on HRQoL whilst gender, disease laterality, duration since diagnosis and SES had no impact. In conclusion, our colleagues draw attention to the fact that QoL assessment is often neglected but an important aspect of survivorship. The results of this study will help in formulating awareness of the domains affected and allow timely advocacy of initiatives for addressing each issue individually. Remedial measures aimed at optimizing QoL should be incorporated as part of their rehabilitation.

Reynolds M. et al. [18] in a retrospective cohort study examined the academic performance of childhood RB survivors. Seventy-three patients with RB (median age at diagnosis 9.97 months [range 0.29, 65.1]) were followed for a median of 6.4 years (0.2, 1.76). Forty-eight (65.8%) had unilateral RB. Forty-three (63.0%) received systemic chemotherapy, 57 (78.1%) enucleation. At last follow-up, 5 (6.8%) children had bilateral VA <20/70. Seventeen (23.3%) reported school difficulties and 10 (13.7%) had an individualized education program (IEP). Multivariable analysis revealed that a history of receiving chemotherapy was associated with self-reported school difficulties [(odds ratio (OR) 5.44 [1.36, 21.69], p=0.016)], and possessing an IEP (OR 11.47 [1.34, 98.16], p=0.03). Degree of visual impairment and history of enucleation did not influence the risk of self-reported school difficulties or the implementation of an IEP. Among unilateral RB patients, chemotherapy was an independent risk factor for self-reported school difficulties (OR 12.8 [1.45, 113], p=0.009) and implementation of an IEP (OR 15.2 [0.78, 292], p=0.02). As the authors state, their study is significant because it is one of the first publications to look at the incidence of developmental or school delay and evidence of disease/treatment incidence, including vision loss and hearing loss, for childhood RB survivors. Further research to assess how chemotherapy treatment impacts the cognitive development of these patients is needed. The association of chemotherapy administration and school performance could potentially be explained by several factors. Patients with chemotherapy typically have more extensive disease, thus necessitating the need for multimodality therapy. Such patients may have had more extensive local therapies or radiation, which may influence the long-term cognition of a patient. Chemotherapy was typically administered on an inpatient basis. Frequent and prolonged hospitalizations involve greater disruptions in family routines, frequent separations from siblings and peers, and time away from school which could impact cognition and school performance. A study including a greater number of patients, particularly patients with more significant vision loss, could provide more information with respect to visual acuity and developmental incidence. In addition, studies looking at developmental incidence in patients treated with intra-arterial chemotherapy, whose goal is to limit systemic chemotherapy, would be beneficial. In conclusion, the authors point out the significant fact that childhood RB survivors experience educational burdens from their disease and its treatment. Efforts to assess and monitor RB survivors for evidence of cognitive impairment is needed to identify factors associated with such incidence. Identification of such factors will assist in instituting early interventions for affected patients to improve their long-term outcomes.

To summarize the above, we can conclude that RB is the most common pediatric ocular malignancy. Despite the fact that the main attention is often paid to more common oncological diseases, it is important not to forget about the need for a specialized approach to rare forms of cancer. Peculiarities of symptoms, childhood age of patients predetermine a special approach to diagnostics of this disease;

aspects of oncological alertness sometimes play a decisive role not only in early diagnostics, but also in the subsequent course of this pathology and its prognosis. Variability and veiled symptoms, its similarity with various non-core processes, cause certain difficulties and lead to neglect of the disease.

In recent years, highly effective molecular genetic examination methods have become necessary for reliable identification of the oncological process by using biomarkers and, as a result, improving the results of patient treatment. At the same time, despite significant advances in the treatment of RB, understanding the mechanisms of disease progression, features of spread is necessary for further improvement of treatment methods and schemes. In terms of treatment tactics, innovative approaches to the treatment of this rare pathology are currently being developed, which at the same time is one of the most pressing problems at the intersection of modern oncology, ophthalmology and pediatrics.

Patients with RB also need long-term monitoring, since such patients have an increased risk of developing secondary malignant neoplasms during their life.

Screening by an ophthalmologist is a must for children with a positive family history of RB. Offspring, brothers and sisters of affected patients require regular screening examinations in childhood, unless genetic testing is performed to exclude a gene mutation, in which case the risk is similar to that of the general population. Genetic counseling for families with RB can help determine the risk for future offspring and whether other family members are at risk of developing the disease.

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Pedagogical sciences

EXPLAINING ABSTRACT CONCEPTS THROUGH THE USE OF DIGITAL GAMIFICATION IN ORGANIC CHEMISTRY LESSONS

Berkin Meiirim Altynbekkyzy
Abai Kazakh National Pedagogical University
2nd-year Master's student
Rakhmetullayeva Raikhan Kulumbetovna
Abai Kazakh National Pedagogical University
Candidate of Chemical Sciences, Associate Professor

ОРГАНИКАЛЫҚ ХИМИЯ САБАҚТАРЫНДА ЦИФРЛЫҚ ГЕЙМИФИКАЦИЯНЫ ҚОЛДАНУ АРҚЫЛЫ АБСТРАКТІЛІ ҰҒЫМДАРДЫ ТҮСІНДІРУ

Беркін Мейірім Алтынбекқызы
Абай атындағы Қазақ ұлттық педагогикалық университеті
2-курс магистранты
Рахметуллаева Райхан Кулымбетовна
Абай атындағы Қазақ ұлттық педагогикалық университеті
Химия ғылымдарының кандидаты, қауымдастырылған профессор

Abstract

The article examines the use of digital gamification in organic chemistry lessons as a means of explaining abstract concepts. The abstract nature of organic chemistry, which is based on invisible molecular-level processes, often creates difficulties for learners. Therefore, the purpose of this study is to identify the pedagogical effectiveness of digital gamification in explaining abstract concepts in organic chemistry through a comparative analysis of previous research.

The study is based on a theoretical and analytical approach, in which domestic and international studies that implemented elements of digital gamification were systematized and compared. The analysis focused on understanding molecular structures, reaction mechanisms, structure–property relationships, and the impact on learning motivation. The results indicate that learning environments incorporating digital gamification contribute to a more conscious and systematic understanding of abstract concepts among students. In addition, certain methodological and technical limitations of digital gamification were identified. Accordingly, the study emphasizes the necessity of applying digital gamification in organic chemistry lessons in a purposeful and well-structured manner. The findings may serve as a basis for developing practical recommendations to improve the methodology of teaching organic chemistry.

Аңдатпа

Мақалада органикалық химия сабақтарында цифрлық геймификацияны қолдану арқылы абстрактілі ұғымдарды түсіндіру мәселесі қарастырылады. Органикалық химияның молекулалық деңгейдегі көзге көрінбейтін үдерістерге негізделуі білім алушылар үшін пәнді меңгеруде қиындықтар туғызады. Осыған байланысты зерттеудің мақсаты алдыңғы ғылыми зерттеулерді салыстырмалы талдау негізінде цифрлық геймификацияның органикалық химиядағы абстрактілі ұғымдарды түсіндірудегі педагогикалық тиімділігін анықтау.

Зерттеу теориялық-талдамалық әдіске негізделіп, цифрлық геймификация элементтері қолданылған отандық және шетелдік еңбектер жүйеленіп, салыстырылды. Талдау барысында молекулалық құрылымдарды меңгеру, реакция механизмдерін түсіну, құрылым–қасиет байланысын қабылдау және оқу мотивациясына әсер ету аспектілері қарастырылды. Нәтижелер цифрлық геймификация қолданылған оқу жағдайларында білім алушылардың абстрактілі ұғымдарды саналы және жүйелі түрде меңгеру деңгейі артатынын көрсетті. Сонымен қатар цифрлық геймификацияны қолданудың әдістемелік және техникалық шектеулері анықталды. Осыған байланысты геймификацияны органикалық химия сабақтарында мақсатты әрі жүйелі қолдану қажеттігі негізделді. Зерттеу нәтижелері органикалық химияны оқыту әдістемесін жетілдіруге бағытталған практикалық ұсыныстар әзірлеуге негіз бола алады.

Keywords: *organic chemistry, digital gamification, abstract concepts, visualization, interactive*

learning.

Түйін сөздер: *органикалық химия, цифрлық геймификация, абстрактілі ұғымдар, визуализация, интерактивті оқыту.*

Кіріспе

Органикалық химияны оқыту қазіргі заманғы білім беру кеңістігінде күрделі әрі көпқырлы педагогикалық мәселе ретінде қарастырылады. Бұл пәннің мазмұны заттардың молекулалық құрылысы, атомдар арасындағы байланыстар, электрондардың қозғалысы және химиялық реакциялардың жүру механизмдері сияқты көзге тікелей байқалмайтын үдерістерге негізделеді. Осы ерекшелік органикалық химияны оқытуда абстрактілі ұғымдардың басым болуына әкеледі. Білім алушылар үшін микродеңгейде жүретін құбылыстарды елестету, оларды формула, құрылымдық сызба немесе символдар арқылы түсіну едәуір интеллектуалдық күш пен дамыған абстрактілі ойлауды талап етеді. Нәтижесінде органикалық химия көптеген оқушылар тарапынан күрделі, түсініксіз және жаттауға негізделген пән ретінде қабылданады [1].

Абстрактілі ұғымдардың басымдығы органикалық химияны оқытуда қолданылатын дәстүрлі әдістердің тиімділігіне күмән тудырады. Түсіндіру, демонстрация және репродуктивті тапсырмаларға негізделген оқыту тәсілдері молекулалардың кеңістіктік конфигурациясын, реакциялардың кезең-кезеңімен жүруін немесе функционалдық топтардың өзара әсерін толыққанды ашып көрсете алмайды. Мұндай жағдайда білім алушылар көбіне теориялық ақпаратты механикалық түрде меңгеріп, оның ішкі логикасын және себеп-салдарлық байланыстарын терең түсінбей қалады. Бұл жағдай оқу материалын саналы түрде игеруге кедергі келтіріп, органикалық химиядағы негізгі ұғымдардың жүйелі қалыптасуына тосқауыл болады. Органикалық химиядағы күрделілік оқушылардың пәнге деген қызығушылығының төмендеуіне де тікелей әсер етеді. Сабақ барысында оқушылардың пассивті тыңдаушы рөлінде қалуы, оқу әрекетінің бірсарынды ұйымдастырылуы және оқу материалының өмірмен, тәжірибемен жеткілікті байланыстырылмауы мотивацияның әлсіреуіне алып келеді. Қызығушылықтың төмендеуі өз кезегінде оқу белсенділігінің азаюына, танымдық әрекеттің әлсіреуіне және оқу жетістіктерінің төмендеуіне себеп болады. Сондықтан органикалық химияны оқытуда білім алушылардың танымдық қызығушылығын арттыру, оқу әрекетін жандандыру және пәнді түсінуді жеңілдету өзекті педагогикалық міндет ретінде алға шығады. Аталған мәселелерді шешу жолында білім беру үдерісін цифрландыру ерекше маңызға ие болып отыр. Қазіргі білім беру жүйесінде цифрлық технологиялар оқыту мазмұнын ұсынудың дәстүрлі тәсілдерін түбегейлі өзгертіп, жаңа дидактикалық мүмкіндіктерді қалыптастыруда [2]. Цифрлық орта білім алушыларға күрделі ғылыми ұғымдарды визуалды, динамикалық және интерактивті түрде қабылдауға мүмкіндік береді. Әсіресе жаратылыстану пәндерінде цифрлық технологияларды қолдану көзге көрінбейтін үдерістерді модельдеу, олардың құрылымы мен өзгерісін нақты көрсету арқылы оқу материалының түсініктілігін арттырады.

Жаратылыстану пәндері контексінде цифрлық технологиялар білім алушылардың танымдық әрекетін белсендірудің тиімді құралы ретінде қарастырылады. Сандық модельдер, виртуалды зертханалар, интерактивті симуляциялар мен мультимедиалық ресурстар оқушылардың теориялық білімін тәжірибелік деңгейде бекітуге жағдай жасайды. Мұндай құралдар оқушыларға химиялық құбылыстарды бақылау, өзгерістерді талдау және қорытынды жасау мүмкіндігін береді. Бұл үдеріс білім алушының зерттеушілік дағдыларын дамытуға, ғылыми ойлауын қалыптастыруға және пәндік құзыреттілігін арттыруға ықпал етеді [1]. Интерактивті оқыту цифрлық білім беру үдерісінің маңызды құрамдас бөлігі ретінде білім алушылардың оқу әрекетін ұйымдастыруда жетекші рөл атқарады. Интерактивті ортада оқушы оқу үдерісінің пассивті қатысушысы емес, белсенді субъектісі ретінде көрінеді. Ол тапсырмаларды орындау барысында таңдау жасайды, қателіктерін талдайды, нәтижесін бірден көріп, кері байланыс алады [3]. Бұл органикалық химиядағы абстрактілі ұғымдарды меңгеруде ерекше маңызды, себебі интерактивті тапсырмалар арқылы білім алушылар молекулалардың құрылымын құрастырып, реакция механизмдерін кезең-кезеңімен зерттей алады.

Цифрлық технологиялар мен интерактивті оқыту әдістерін қолдану органикалық химиядағы күрделі ұғымдарды түсіндірудің тиімді жолы ретінде айқындалады және білім алушылардың оқу мотивациясын арттыруға, танымдық белсенділігін күшейтуге және пәндік білім сапасын жақсартуға мүмкіндік береді. Бұл тұрғыдан алғанда, цифрлық геймификация элементтерін енгізу органикалық химияны оқытудың заманауи әрі перспективалы бағыты

ретінде қарастырылуы орынды. Қазіргі заманғы білім беру жүйесінің дамуы цифрландыру үдерісімен тығыз байланысты. Ақпараттық-коммуникациялық технологиялардың қарқынды дамуы оқыту мазмұнын ұсыну тәсілдерін ғана емес, білім алушылардың оқу әрекетінің сипатын, мұғалімнің рөлін және білім беру нәтижелерін бағалау жүйесін де түбегейлі өзгертуде [2]. Білім беруді цифрландыру дәстүрлі оқыту модельдерінен білім алушының белсенді танымдық әрекетіне негізделген, икемді әрі интерактивті оқыту формаларына көшу қажеттігін айқындайды. Бұл үдеріс әсіресе жаратылыстану пәндерін оқытуда маңызды, себебі аталған пәндер ғылыми заңдылықтарды, модельдерді және тәжірибелік үдерістерді түсінуді талап етеді. Жаратылыстану пәндерінде цифрлық технологиялар күрделі ғылыми ұғымдарды түсіндірудің тиімді құралы ретінде қарастырылады. Сандық модельдер, виртуалды зертханалар, анимациялық көріністер және интерактивті симуляциялар табиғатта көзге тікелей көрінбейтін немесе сынып жағдайында көрсетуге мүмкіндік жоқ құбылыстарды бейнелеуге жағдай жасайды. Химия сабақтарында цифрлық технологияларды қолдану молекулалардың кеңістіктік құрылымын, атомдар арасындағы байланыстарды, электрондардың қозғалысын және химиялық реакциялардың жүру механизмін динамикалық түрде көрсетуге мүмкіндік береді. Мұндай визуализациялау құралдары оқу материалының абстрактілігін төмендетіп, білім алушылардың ұғымдарды саналы түрде меңгеруіне ықпал етеді.

Цифрлық технологиялардың жаратылыстану пәндеріндегі орны олардың оқыту үдерісін жандандыруымен ғана емес, білім алушылардың зерттеушілік және аналитикалық дағдыларын дамытуымен де айқындалады. Цифрлық ортада оқушылар тәжірибе нәтижелерін бақылап, өзгерістерді салыстырып, себеп-салдарлық байланыстарды анықтай алады. Бұл өз кезегінде ғылыми ойлаудың қалыптасуына, пәндік құзыреттіліктің артуына және теориялық білімді практикалық тұрғыда қолдану дағдысының дамуына ықпал етеді. Сонымен қатар цифрлық технологиялар білім алушылардың жеке оқу траекториясын қалыптастыруға, оқу қарқынын дербес реттеуге мүмкіндік береді.

Цифрландыру үдерісінің маңызды құрамдас бөлігі интерактивті оқыту болып табылады. Интерактивті оқыту білім алушылардың оқу әрекетіне тікелей қатысуын, өзара әрекеттесуін және оқу мазмұнымен белсенді жұмыс істеуін көздейді. Бұл тәсілде оқушы дайын білімді қабылдаушы емес, білімді өз бетімен құрастырушы субъект ретінде қарастырылады. Интерактивті оқыту барысында білім алушылар тапсырмаларды орындау, модельдермен әрекеттесу, қателіктерін түзету және нәтижелерін талдау арқылы оқу материалын терең меңгереді. Органикалық химия сияқты күрделі пәнде интерактивті оқыту молекулалық құрылымдарды құрастыру, реакцияларды болжау және теориялық білімді тәжірибемен ұштастыру мүмкіндігін береді.

Білім беруді цифрландыру жағдайында кеңінен таралып келе жатқан инновациялық бағыттардың бірі – геймификация. Геймификация ұғымы педагогикада ойынға тән элементтерді оқу үдерісіне мақсатты түрде енгізу арқылы білім алушылардың оқу мотивациясын арттыру және оқу нәтижелерін жақсарту тәсілі ретінде қарастырылады [4]. Ойын элементтеріне ұпай жинау, деңгейлерге бөліну, марапаттау жүйесі, тапсырмаларды миссия түрінде ұсыну, бәсекелестік пен ынтымақтастық элементтері жатады. Бұл элементтер оқу әрекетін эмоционалды тұрғыда тартымды етіп, білім алушылардың белсенділігін арттырады.

Геймификацияның педагогикадағы рөлі оның мотивациялық және психологиялық әсерімен тығыз байланысты. Ойын элементтері білім алушылардың ішкі ынтасын күшейтіп, оқу тапсырмаларын орындауға деген қызығушылығын арттырады. Теориялық тұрғыдан геймификация әрекетке негізделген оқыту, конструктивизм және тұлғаға бағытталған білім беру идеяларымен сабақтас [4]. Ойын элементтері арқылы оқытуда қателік оқу үдерісінің табиғи бөлігі ретінде қабылданып, білім алушылардың тәуекелге баруына, эксперимент жасауына және өз әрекетінің нәтижесін бағалауына мүмкіндік береді. Бұл жағдай әсіресе мазмұны күрделі әрі абстрактілі пәндерде тиімді болып табылады.

Зерттеудің өзектілігі органикалық химиядағы күрделі және көзге көрінбейтін үдерістерді түсіндіру қажеттілігімен негізделеді. Органикалық қосылыстардың молекулалық құрылысы, функционалдық топтардың өзара әсері, электрондардың орын ауысуы және реакция механизмдерінің сатылы жүруі сияқты үдерістерді дәстүрлі оқыту әдістері арқылы толық әрі жүйелі түрде меңгеру қиындық туғызады. Мұндай жағдайда білім алушылар материалды формалды түрде қабылдап, ұғымдардың мағынасын терең түсінбей қалуы мүмкін. Осы тұрғыдан алғанда, цифрлық геймификация элементтерін қолдану органикалық химиядағы көзге

көрінбейтін үдерістерді нақты, қолжетімді және интерактивті формада ұсынудың тиімді жолы ретінде айқындалады.

Осы зерттеудің мақсаты – органикалық химия сабақтарында цифрлық геймификацияны қолдану арқылы абстрактілі ұғымдарды түсіндірудің педагогикалық тиімділігін ғылыми тұрғыда негіздеу және тәжірибе жүзінде дәлелдеу болып табылады. Аталған мақсатқа жету үшін зерттеу барысында келесі міндеттер айқындалады: органикалық химияны оқытудағы абстрактілі ұғымдардың мазмұндық ерекшеліктерін талдау; цифрлық технологиялар мен геймификацияның педагогикалық мүмкіндіктерін жүйелеу; органикалық химия сабақтарына арналған геймификация элементтерін қамтитын оқыту үлгісін әзірлеу; әзірленген үлгінің білім алушылардың оқу жетістіктері, мотивациясы және танымдық белсенділігіне әсерін эксперименттік жолмен анықтау; алынған нәтижелер негізінде органикалық химияны оқытуға арналған әдістемелік ұсыныстар әзірлеу.

Әдеби шолу

Геймификация ұғымы білім беру саласында оқыту үдерісін жетілдіруге бағытталған заманауи педагогикалық тәсілдердің бірі ретінде қарастырылады. Алғашында ойынға тән элементтерді ойыннан тыс салаларда қолдану идеясы ретінде қалыптасқан геймификация кейіннен білім беру кеңістігінде оқыту тиімділігін арттырудың құралына айналды. Бұл тәсіл оқу үдерісіне ойын механикаларын, кері байланыс жүйелерін және мотивациялық элементтерді енгізу арқылы білім алушылардың белсенділігін күшейтуді көздейді [5]. Геймификация білім алушыны оқу әрекетінің орталығына шығарып, оны пассивті тыңдаушы емес, белсенді қатысушы ретінде қарастыруымен ерекшеленеді [1].

Геймификацияның теориялық негіздері мотивация теорияларымен тығыз байланысты. Білім беру контексінде мотивация оқу әрекетінің нәтижелілігін айқындайтын негізгі факторлардың бірі болып саналады. Ойын элементтері білім алушылардың ішкі мотивациясын күшейтіп, оқу тапсырмаларын орындауға деген қызығушылығын арттырады [2]. Оқу үдерісінде ұпай жинау, деңгейлерге көтерілу, жетістікке жету сияқты элементтер қолданылған жағдайда, білім алушылардың табандылығы мен оқу үдерісіне эмоционалды қатысуы айтарлықтай артады [1]. Бұл өз кезегінде оқу материалын терең әрі саналы түрде меңгеруге ықпал етеді [2].

Сонымен қатар геймификация әрекетке негізделген және конструктивистік оқыту теорияларымен үйлеседі. Бұл теориялар бойынша білім алушы дайын білімді қабылдаушы емес, өз тәжірибесі арқылы білімді құрастырушы тұлға ретінде қарастырылады. Ойын элементтері арқылы ұйымдастырылған оқу үдерісі қателіктерді табиғи үйрену құралы ретінде қабылдауға, тәжірибе жасауға және дербес шешім қабылдауға мүмкіндік береді [6]. Мұндай ортада білім алушылардың рефлексия жасау қабілеті мен танымдық дербестігі дамиды.

Цифрлық геймификацияны жаратылыстану пәндерінде қолдану тәжірибесі соңғы жылдары ғылыми зерттеулерде кеңінен қарастырылып келеді. Химия, биология және физика сабақтарында цифрлық ойын элементтерін қолдану оқу материалын көрнекі әрі интерактивті түрде ұсынуға мүмкіндік беретіні атап өтіледі [7]. Жаратылыстану пәндерінің мазмұны көбіне модельдер мен абстрактілі ұғымдарға негізделетіндіктен, геймификация күрделі ғылыми түсініктерді меңгеруді жеңілдететін тиімді құрал ретінде сипатталады [6].

Химия сабақтарында цифрлық геймификация молекулалық құрылымдарды құрастыру, химиялық реакцияларды сәйкестендіру және есептерді ойын форматында орындау арқылы білім алушылардың пәнге деген қызығушылығын арттыруға ықпал етеді. Биология пәнінде геймификация тірі ағзалардың құрылымы мен физиологиялық үдерістерін модельдеуге мүмкіндік береді, ал физика сабақтарында қозғалыс, энергия және күш сияқты ұғымдарды визуализациялау арқылы түсіндірудің тиімділігін арттырады [8]. Зерттеулер цифрлық геймификацияны қолдану оқу жетістіктерінің артуына, сабаққа қатысу белсенділігінің жоғарылауына және оқу мотивациясының күшеюіне оң әсер ететінін көрсетеді [3].

Сонымен бірге цифрлық геймификацияның тиімділігі оны оқу мақсаттарына сәйкес педагогикалық тұрғыда дұрыс ұйымдастыруға байланысты екені де көрсетіледі. Егер ойын элементтері оқу мазмұнымен үйлеспесе немесе тек көңіл көтеру құралы ретінде қолданылса, олардың білім сапасына әсері төмендеуі мүмкін [4]. Осыған байланысты геймификацияны жаратылыстану пәндерінде қолдану кезінде оның дидактикалық негіздерін ескеру қажеттілігі ерекше атап өтіледі [7].

Органикалық химияны оқытуда абстрактілі ұғымдардың басымдығы ерекше педагогикалық қиындықтар туғызады. Бұл пәнде молекулалардың кеңістіктік құрылымы,

функционалдық топтардың өзара әсері және реакция механизмдерінің сатылы жүруі сияқты көзге көрінбейтін үдерістерді меңгеру талап етіледі [8]. Мұндай ұғымдар көбіне символдық және графикалық түрде ұсынылатындықтан, білім алушылардың оларды түсінуі қиындық тудырады және пәнге деген қызығушылықтың төмендеуіне алып келеді.

Молекулалық модельдер органикалық химиядағы негізгі түсіндіру құралдарының бірі болып табылады. Олар атомдар арасындағы байланыстарды және молекулалардың кеңістіктік конфигурациясын көрсетуге мүмкіндік береді [9]. Алайда дәстүрлі модельдер динамикалық үдерістерді, мысалы, реакция кезінде байланыстардың үзілуі мен түзілуін толық бейнелей алмайды. Осы себепті цифрлық модельдер мен интерактивті құралдарды қолданудың маңызы арта түсуде [9].

Реакция механизмдерін оқыту органикалық химиядағы ең күрделі бағыттардың бірі болып саналады. Реакция механизмдері электрондардың қозғалысын, аралық бөлшектердің түзілуін және реакцияның сатылы сипатын қамтиды [8]. Бұл үдерістерді статикалық суреттер арқылы түсіндіру көбіне жеткіліксіз болып келеді, сондықтан интерактивті визуализация мен модельдеуге негізделген оқыту тәсілдері ұсынылады [10].

Құрылым–қасиет байланысын түсіндіру органикалық химиядағы абстрактілі ойлауды талап ететін маңызды мәселе болып табылады. Қосылыстың молекулалық құрылымындағы өзгерістер оның физикалық және химиялық қасиеттеріне әсер ететінін түсіну күрделі логикалық талдауды қажет етеді [11]. Бұл байланысты меңгеру үшін білім алушыларға молекулалардың құрылымын өзгертіп, қасиеттерінің қалай өзгеретінін бақылауға мүмкіндік беретін интерактивті орта қажет [10]. Осы тұрғыдан алғанда, цифрлық геймификация элементтері органикалық химиядағы абстрактілі ұғымдарды меңгеруді жеңілдететін тиімді құрал ретінде қарастырылады.

Жалпы алғанда, әдебиеттерді талдау геймификацияның білім берудегі теориялық негіздерінің жеткілікті деңгейде қалыптасқанын және цифрлық геймификацияны жаратылыстану пәндерінде қолданудың оң педагогикалық нәтижелер беретінін көрсетеді. Сонымен қатар органикалық химиядағы абстрактілі ұғымдарды оқыту мәселесі әлі де терең әрі мақсатты зерттеуді қажет етеді, бұл аталған тақырыптың ғылыми және практикалық маңыздылығын айқындайды [10].

Әдістер

Бұл зерттеу органикалық химия сабақтарында цифрлық геймификацияны қолдану арқылы абстрактілі ұғымдарды түсіндіру мәселесіне арналған бұрын жүргізілген ғылыми зерттеулерді талдауға негізделді. Зерттеу әдіснамасы геймификацияның педагогикалық мүмкіндіктерін органикалық химияны оқыту контексінде қарастыратын еңбектерді жүйелеу, салыстыру және жалпылау тәсілдеріне сүйенеді. Негізгі мақсат – әртүрлі зерттеулерде ұсынылған әдістер мен алынған нәтижелерді өзара салыстыру арқылы органикалық химиядағы абстрактілі ұғымдарды түсіндіруде цифрлық геймификацияның тиімділігі жөнінде ғылыми пайым жасау.

Зерттеу дизайны салыстырмалы талдау сипатында ұйымдастырылды. Талдауға органикалық химияны оқытуда цифрлық геймификация элементтері қолданылған зерттеулер іріктелді. Бұл зерттеулерде геймификацияның оқу үдерісіне енгізілу жолдары, қолданылған ойын элементтері және олардың абстрактілі ұғымдарды меңгеруге ықпалы салыстырмалы түрде қарастырылды. Әсіресе молекулалық құрылымдар, реакция механизмдері және құрылым–қасиет байланысын түсіндіруге бағытталған жұмыстарға басымдық берілді.

Зерттеу қатысушылары ретінде алдыңғы зерттеулерде қамтылған білім алушылар контингенті қарастырылды. Талдауға алынған еңбектерде органикалық химия тақырыптары орта білім беру деңгейінде және жоғары оқу орындарының бастапқы курстарында оқытылған. Бұл тәсіл цифрлық геймификацияның әртүрлі білім беру деңгейлерінде абстрактілі ұғымдарды түсіндірудегі тиімділігін салыстырып бағалауға мүмкіндік берді.

Қолданылған цифрлық геймификация құралдарын талдау барысында бұрынғы зерттеулерде сипатталған ойын элементтері, цифрлық платформалар және интерактивті тапсырмалар жүйеленді. Ойын элементтері ретінде ұпай жинау, деңгейлерге бөліну және тапсырмаларды миссия түрінде орындау тәсілдері қарастырылды. Цифрлық платформалар молекулалық модельдеу мен реакция үдерістерін визуализациялауға мүмкіндік беретін құралдармен шектелді. Интерактивті тапсырмалар органикалық химиядағы абстрактілі ұғымдарды, соның ішінде молекулалардың құрылысы мен реакция механизмдерін түсіндіруге бағытталған.

Оқыту мазмұны органикалық химиядағы абстрактілі ұғымдарды қамтитын тақырыптар

негізінде талданды. Бұрынғы зерттеулерде қарастырылған молекулалық модельдер, реакция механизмдері және құрылым–қасиет байланысы сияқты тақырыптар цифрлық геймификация арқылы қалай түсіндірілгені салыстырылды. Бұл талдау геймификацияның органикалық химиядағы нақты мазмұндық мәселелерді шешудегі мүмкіндіктерін айқындауға бағытталды.

Деректер жинау әдістері ретінде алдыңғы зерттеулерде қолданылған бағалау тәсілдері қарастырылды. Атап айтқанда, білім алушылардың абстрактілі ұғымдарды меңгеру деңгейін анықтауға арналған тестілеу нәтижелері, оқу мотивациясын сипаттайтын сауалнамалар және оқу әрекетінің белсенділігін көрсетуге бағытталған бақылау деректері салыстырмалы түрде талданды.

Деректерді өңдеу және талдау барысында салыстырмалы талдау және жалпылау әдістері қолданылды. Әртүрлі зерттеулерден алынған нәтижелер негізінде органикалық химия сабақтарында цифрлық геймификацияны қолданудың абстрактілі ұғымдарды түсіндірудегі педагогикалық тиімділігі жөнінде қорытынды пайым жасалды.

Нәтижелер

Органикалық химия сабақтарында цифрлық геймификацияны қолдануға арналған алдыңғы зерттеулерді салыстырмалы талдау бұл әдістің абстрактілі ұғымдарды түсіндірудегі педагогикалық әлеуетін айқындауға мүмкіндік берді. Талдауға алынған зерттеулерде геймификация элементтері қолданылған оқу жағдайлары дәстүрлі оқыту тәсілдерімен салыстырылып, олардың білім алушылардың оқу нәтижелеріне әсері қарастырылған [6]. Нәтижелерді жүйелеу барысында цифрлық геймификация қолданылған сабақтарда абстрактілі ұғымдарды меңгеру деңгейінің жоғарылағаны байқалады [3].

Геймификация қолданылған және қолданылмаған жағдайларды салыстыру алдыңғы зерттеулерде ортақ заңдылықтардың бар екенін көрсетті. Цифрлық геймификация элементтері енгізілген оқу үдерісінде білім алушылар молекулалық құрылымдар мен реакция механизмдерін қабылдауда визуалды және интерактивті тірекке сүйенген. Ал геймификация қолданылмаған дәстүрлі сабақтарда абстрактілі ұғымдарды түсіну көбіне теориялық сипатта қалып, білім алушылардың материалды жаттауға бейімделуі басым болғаны анықталған [6]. Бұл айырмашылық органикалық химиядағы көзге көрінбейтін үдерістерді түсіндіруде геймификацияның тиімді құрал екенін дәлелдейді [8].

Абстрактілі ұғымдарды меңгеру деңгейіндегі өзгерістерді талдау барысында көптеген зерттеулерде білім алушылардың түсіну тереңдігі, ұғымдарды қолдану қабілеті және логикалық пайым жасау деңгейі артқаны көрсетілген [11]. Геймификация элементтері арқылы оқу үдерісі белсенді сипатқа ие болып, білім алушылар күрделі ұғымдарды тек қабылдап қана қоймай, олармен әрекет ету мүмкіндігіне ие болған. Бұл жағдай органикалық химиядағы абстрактілі мазмұнды меңгеруді жеңілдеткені анық байқалады [10].

Кесте 1. – Алдыңғы зерттеулер бойынша цифрлық геймификацияның тиімділігін салыстырмалы талдау

Салыстыру көрсеткіші	*Геймификация қолданылған жағдайда*	*Геймификация қолданылмаған жағдайда*
Абстрактілі ұғымдарды түсіну	*Оқушылар ұғымдарды визуализация мен интерактивті әрекет арқылы оңай түсінеді*	*Ұғымдар көбіне теориялық түрде беріледі, түсіну қиын*
Молекулалық құрылымды қабылдау	*Молекулалар кеңістіктік модельдер арқылы жеңіл меңгеріледі*	*Формула мен сызбаны жаттауға негізделеді*
Реакция механизмдерін түсіну	*Реакция кезең-кезеңімен саналы түрде түсіндіріледі*	*Реакциялар үзік, механикалық түрде қабылданады*
Ұғымдарды қолдану қабілеті	*Білім тапсырмалар арқылы белсенді қолданылады*	*Білімді қолдану мүмкіндігі шектеулі*
Танымдық белсенділік	*Оқушылар сабаққа белсенді қатысады*	*Белсенділік төмен немесе тұрақсыз*
Оқу мотивациясы	*Пәнге қызығушылық артып, тұрақты сақталады*	*Қызығушылықтың төмендеуі байқалады*

Кестеде келтірілген мәліметтер алдыңғы зерттеулердің нәтижелерін жалпылай отырып, цифрлық геймификацияның органикалық химиядағы абстрактілі ұғымдарды түсіндіруде бірқатар артықшылықтарға ие екенін көрсетеді [12]. Әсіресе молекулалық деңгейдегі күрделі ұғымдарды меңгеруде визуализация мен интерактивті әрекеттің маңызы айқын байқалады. Салыстырмалы талдау нәтижелері цифрлық геймификацияның органикалық химияны оқытуда тиімді педагогикалық құрал ретінде қарастырылуына ғылыми негіз бар екенін дәлелдейді [12].

Алдыңғы зерттеулерді талдау цифрлық геймификацияның органикалық химиядағы

молекулалық құрылымдарды түсінуге оң әсер ететінін көрсетеді. Әсіресе молекулалық модельдермен жұмыс істеуге арналған геймификацияланған тапсырмалар білім алушыларға атомдар мен байланыстардың орналасуын көзге елестетуге көмектескен [6]. Мұндай тапсырмаларда оқушылар молекулаларды өздері құрастырып, оларды айналдырып көру және құрылымын өзгерту арқылы оқу материалына белсенді қатысқан.

Геймификация қолданылған сабақтарда молекулалық құрылымдар формула ретінде ғана емес, кеңістікте орналасқан нақты құрылым ретінде қабылданғаны байқалады [9]. Бұл оқушылардың молекуланың үшөлшемді құрылымын түсінуіне және абстрактілі ойлау қабілетінің дамуына ықпал еткен. Ал геймификация қолданылмаған жағдайда молекулалық құрылымды қабылдау көбіне жазық сызбалармен шектеліп, оқушыларға кеңістіктік елестету қиындық тудырған.

Зерттеулерде кеңістіктік құрылымды түсінудегі жетістіктер геймификацияланған тапсырмалармен тікелей байланысты екені көрсетілген [10]. Оқушылар молекулаларды әртүрлі бұрыштан қарап, олардың құрылымын өзгерту арқылы стереохимиялық ұғымдарды, изомерия түрлерін және молекулалардың кеңістіктегі орналасуын жеңілірек меңгерген. Бұл тапсырмалар күрделі ұғымдарды жаттауға емес, түсінуге негіздеген.

Визуализация молекулалық құрылымдарды меңгеруде маңызды рөл атқарған. Цифрлық геймификацияда қолданылған визуалды құралдар молекулалардың қозғалысын, байланыстардың өзгеруін және құрылымның динамикалық сипатын көрсетуге мүмкіндік берген [11]. Нәтижесінде оқушылар молекулалық құрылымның тұрақты емес, өзгеретін жүйе екенін жақсырақ түсінген. Бұл органикалық химиядағы абстрактілі ұғымдарды нақтылауға және оқу материалын қабылдауды жеңілдеткен [9].

Кесте 2 – Молекулалық құрылымдарды меңгеруге цифрлық геймификацияның әсері

Көрсеткіштер	*Геймификация қолданылған жағдайда*	*Геймификация қолданылмаған жағдайда*
Молекулалық модельдермен жұмыс	*Молекуланы өздігінен құрастыру және өзгерту*	*Дайын суреттермен шектелу*
Кеңістіктік құрылымды түсіну	*Жақсы қалыптасқан*	*Қиындықтар байқалады*
Стереохимиялық ұғымдарды меңгеру	*Жеңіл және түсінікті*	*Күрделі*
Изомерияны түсіну	*Визуализация арқылы оңай*	*Теориялық деңгейде*
Визуализацияның рөлі	*Динамикалық, интерактивті*	*Статикалық*
Абстрактілі ойлау	*Дамыған*	*Шектеулі*

Кестеде берілген мәліметтер алдыңғы зерттеулердің нәтижелерін жинақтай отырып, цифрлық геймификацияның молекулалық құрылымдарды түсіндіруде тиімді әдіс екенін көрсетеді [4]. Визуализация мен интерактивті әрекеттің үйлесуі органикалық химиядағы күрделі ұғымдарды жеңіл қабылдауға мүмкіндік берген. Осыған байланысты молекулалық құрылымдарды оқытуда цифрлық геймификацияны қолдану орынды және тиімді деп пайымдауға негіз бар [9].

Алдыңғы бөлімде молекулалық құрылымдарды меңгеруде цифрлық геймификацияның тиімділігі көрсетілсе, келесі маңызды қадам ретінде реакция механизмдерін түсіндірудегі нәтижелер қарастырылады. Алдыңғы зерттеулерді талдау органикалық химиядағы реакция механизмдерін меңгеру білім алушылар үшін ең күрделі мәселелердің бірі екенін, ал геймификация элементтері бұл қиындықты едәуір жеңілдететінін көрсетеді [12].

Геймификация қолданылған оқу жағдайларында реакцияның сатылы жүруін түсіну деңгейі жоғарылағаны байқалады [13]. Интерактивті тапсырмалар арқылы оқушылар реакцияның әрбір кезеңін жеке қарастырып, аралық бөлшектердің қалай түзілетінін және реакцияның қалай аяқталатынын бірізді түрде бақылаған. Бұл тәсіл реакция механизмін тұтас әрі жүйелі үдеріс ретінде қабылдауға мүмкіндік берген. Ал дәстүрлі оқытуда реакция механизмдері көбіне статикалық сызбалармен түсіндіріліп, сатылар арасындағы байланыс толық ашылмаған.

Электрондардың қозғалысын қабылдау ерекшеліктерін салыстыру нәтижелері де геймификацияның артықшылықтарын көрсетеді [14]. Цифрлық геймификацияда қолданылған анимациялар мен интерактивті модельдер электрондардың бір атомнан екіншісіне ауысуын көрнекі түрде көрсетуге мүмкіндік берген. Нәтижесінде оқушылар электрондық жылжуды жай символдар жиынтығы ретінде емес, нақты үдеріс ретінде түсінген. Ал геймификация қолданылмаған жағдайда электрондардың қозғалысын қабылдау қиындық тудырып, оқушылар

көбіне формалды белгілермен шектелген [14].

Интерактивті ойын тапсырмалары реакция механизмдерін меңгеруде маңызды рөл атқарған. Зерттеулерде оқушыларға реакция кезеңдерін дұрыс ретпен орналастыру, электрондардың қозғалыс бағытын таңдау немесе механизмді толықтыру сияқты тапсырмалар ұсынылған . Мұндай тапсырмалар білім алушыларды белсенді ойлануға, қателіктерін түзетуге және нәтижеге жетуге ынталандырған. Соның нәтижесінде реакция механизмдерін түсіну деңгейі мен оқу мотивациясы қатар артқаны байқалады [7].

Сурет 1. - Реакция механизмдерін түсіндірудегі цифрлық геймификацияның әсері

Молекулалық құрылымдар мен реакция механизмдерін меңгеру органикалық химиядағы құрылым–қасиет байланысын түсінудің негізін қалайды. Алдыңғы зерттеулерді талдау цифрлық геймификация элементтерін қолдану молекулалық құрылым мен химиялық қасиет арасындағы байланысты түсінуді жеңілдететінін көрсетеді [15]. Геймификацияланған тапсырмалар арқылы оқушылар молекула құрылымындағы өзгерістердің оның физикалық және химиялық қасиеттеріне қалай әсер ететінін нақты мысалдар арқылы байқаған.

Зерттеулерде геймификацияланған тапсырмалар логикалық пайымның қалыптасуына оң әсер еткені көрсетіледі. Оқушылар молекуланың құрылымын өзгертіп, соған сәйкес қасиеттердің қалай өзгеретінін бақылау арқылы себеп–салдарлық байланыстарды түсінген. Бұл үдеріс құрылым–қасиет байланысын жаттап алу емес, түсіну деңгейінде меңгеруге мүмкіндік берген. Ал дәстүрлі оқытуда бұл байланыс көбіне теориялық сипатта қалып, білім алушылар үшін абстрактілі болып қала берген [15].

Теориялық білімді қолдану деңгейін салыстыру барысында да геймификацияның артықшылықтары байқалады [15]. Геймификация қолданылған жағдайда оқушылар алған білімдерін жаңа тапсырмаларда, есептерде және проблемалық жағдаяттарда қолдана алған. Бұл олардың органикалық химиядағы негізгі ұғымдарды өмірлік және практикалық тұрғыда байланыстыра алу қабілетінің дамығанын көрсетеді. Ал геймификация қолданылмаған жағдайда теориялық білімді қолдану шектеулі болып, көбіне репродуктивті деңгейде қалған .

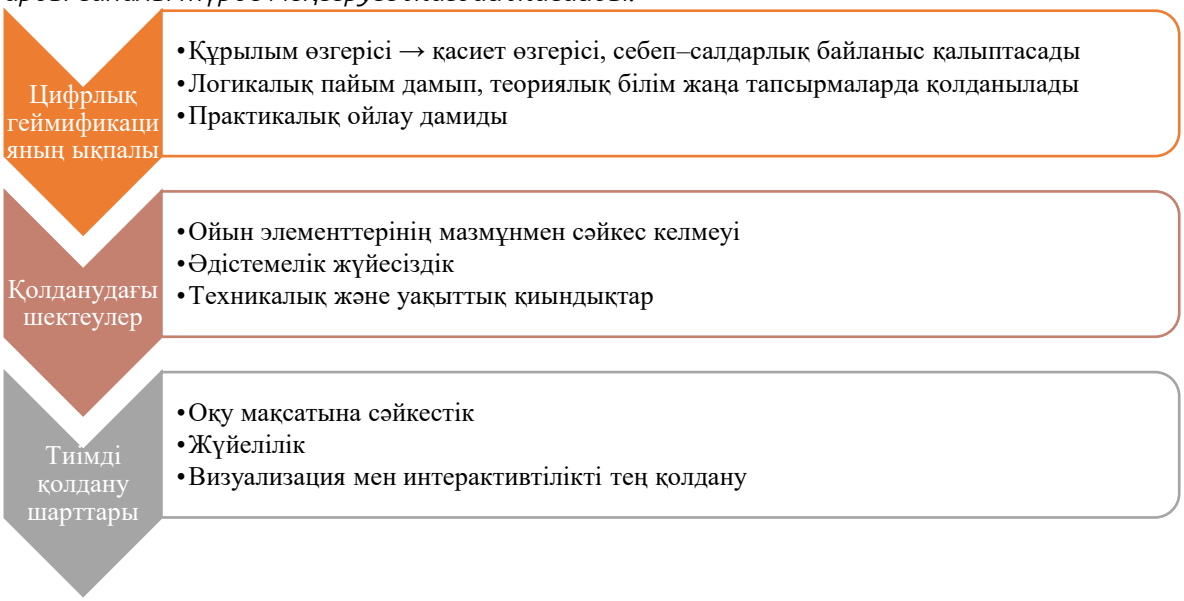
Алдыңғы бөлімдерде цифрлық геймификацияның органикалық химиядағы абстрактілі ұғымдарды түсіндірудегі оң әсері көрсетілгенімен, жүргізілген салыстырмалы талдау бұл әдісті қолдануда бірқатар шектеулер мен тәуекелдердің де бар екенін анықтады. Кейбір зерттеулерде геймификация барлық жағдайда бірдей нәтиже бермейтіні және оның тиімділігі нақты педагогикалық жағдайларға тәуелді екені атап өтіледі [16]. Зерттеулерде анықталған негізгі қиындықтардың бірі – геймификация элементтерінің мазмұнмен толық үйлеспеуі. Кейбір жағдайларда ойын элементтері оқу мақсатынан алшақтап, білім алушылардың назарын мазмұннан гөрі ойын үдерісіне аударған. Мұндай жағдайда геймификация абстрактілі ұғымдарды терең түсіндіру құралы емес, тек қызықтыру элементі ретінде шектеліп қалған.

Әдістемелік сәйкессіздіктер де жиі кездесетін мәселелер қатарына жатады. Кейбір зерттеулерде геймификация элементтері жүйесіз, бірізділік сақталмай енгізілгені байқалады [16]. Ойын тапсырмаларының деңгейі мен күрделілігі оқу материалының логикасымен сәйкес

келмеген жағдайда білім алушыларда түсінбеушілік туындаған. Бұл жағдай әсіресе реакция механизмдері мен құрылым–қасиет байланысы сияқты күрделі тақырыптарды оқытуда байқалған [3]. Сонымен қатар техникалық және ұйымдастырушылық факторлар цифрлық геймификацияны қолданудың маңызды шектеулері ретінде көрсетіледі . Цифрлық құралдардың жеткіліксіздігі, техникалық ақаулар, интернетке қолжетімділіктің шектеулі болуы немесе мұғалімнің цифрлық құзыреттілігінің төмендігі геймификацияның тиімділігін төмендеткен. Ұйымдастырушылық тұрғыдан алғанда, сабақ уақытының шектеулілігі және оқу бағдарламасының тығыздығы да геймификация элементтерін толыққанды қолдануға кедергі келтірген [16].

Жүргізілген салыстырмалы талдау органикалық химиядағы абстрактілі ұғымдарды түсіндіруде цифрлық геймификацияның жалпы оң әсерін айқын көрсетеді . Алдыңғы зерттеулердің нәтижелерін жүйелеу геймификация элементтері қолданылған жағдайда білім алушылардың молекулалық құрылымдарды, реакция механизмдерін және құрылым–қасиет байланысын түсіну деңгейі артатынын дәлелдейді. Бұл әсер, ең алдымен, визуализация мен интерактивті әрекеттің оқу үдерісіне енгізілуімен байланысты . Жинақталған нәтижелер цифрлық геймификацияның тиімді қолданылуы белгілі бір шарттарға тәуелді екенін көрсетеді [8]. Атап айтқанда, геймификация элементтері оқу мақсаттарына сәйкес болуы, органикалық химия мазмұнының логикасымен үйлесуі және абстрактілі ұғымдарды нақтылауға бағытталуы тиіс. Сонымен қатар визуал құралдар мен интерактивті тапсырмалар жүйелі түрде қолданылған жағдайда ғана геймификация білім сапасын арттыруға мүмкіндік береді [5].

Нәтижелерді жүйелі түрде түйіндеу цифрлық геймификацияның органикалық химиядағы абстрактілі ұғымдарды түсіндіруде тиімді педагогикалық құрал екенін көрсетуімен қатар, оны қолдануда ғылыми негізделген әдістемелік көзқарас қажет екенін де айқындайды [7]. Геймификация оқу үдерісін жеңілдететін әмбебап шешім емес, алайда ол дұрыс ұйымдастырылған жағдайда білім алушылардың танымдық белсенділігін арттырып, күрделі ұғымдарды саналы түрде меңгеруге жағдай жасайды.



Сурет 2. - Цифрлық геймификацияның ықпалы

Талқылау

Жүргізілген салыстырмалы талдау органикалық химия сабақтарында цифрлық геймификацияны қолданудың абстрактілі ұғымдарды түсіндіруде кешенді педагогикалық әсер беретінін көрсетті. Алынған нәтижелер геймификацияның тек оқыту формасын өзгерту құралы емес, білім алушылардың химиялық ойлауын, логикалық пайымын және пәндік түсінігін қалыптастыратын маңызды әдістемелік ресурс екенін айқындайды . Бұл бөлімде нәтижелер алдыңғы зерттеулермен салыстырыла отырып, олардың теориялық және практикалық мәні терең пайымдалады.

Бірінші кезекте, цифрлық геймификацияның органикалық химиядағы абстрактілі ұғымдарды түсіндірудегі жалпы тиімділігіне тоқталу маңызды. Нәтижелер көрсеткендей, геймификация қолданылған оқу жағдайларында білім алушылар молекулалық деңгейдегі үдерістерді қабылдауда айтарлықтай жеңілдікке ие болған. Бұл алдыңғы зерттеулерде

көрсетілген геймификацияның визуализация мен белсенді әрекетке негізделген оқыту тәсілдерімен үйлесетінін растайды . Сонымен қатар, геймификация қолданылған және қолданылмаған жағдайлар арасындағы айырмашылықтар органикалық химиядағы абстрактілі мазмұнды меңгеру тек ақпарат көлеміне емес, оны ұсыну тәсіліне де тікелей тәуелді екенін көрсетеді.

Молекулалық құрылымдарды меңгеруге қатысты нәтижелер геймификацияның кеңістіктік ойлауды дамытудағы рөлін нақтылайды. Алдыңғы зерттеулерде молекулалық модельдерді қолдану ұсынылғанымен, бұл зерттеуде геймификацияланған тапсырмалар модельдермен белсенді әрекет жасауға мүмкіндік беретіндігімен ерекшеленеді . Білім алушылар молекулаларды өздері құрастыру, өзгерту және салыстыру арқылы олардың кеңістіктік құрылымын саналы түрде түсінген. Бұл жағдай органикалық химиядағы абстрактілі ұғымдарды статикалық емес, динамикалық жүйе ретінде қабылдауға ықпал еткен.

Реакция механизмдерін түсіндіруде алынған нәтижелер геймификацияның ең маңызды артықшылықтарының бірін көрсетеді. Реакция механизмдері органикалық химиядағы ең күрделі тақырыптардың бірі болып саналатыны белгілі. Алынған нәтижелер интерактивті ойын тапсырмалары реакцияның сатылы жүруін, электрондардың қозғалысын және аралық бөлшектердің түзілуін түсіндіруде тиімді болғанын көрсетеді . Бұл алдыңғы зерттеулерде айтылған визуализацияның маңызын растап қана қоймай, геймификацияның білім алушыны белсенді талдаушы рөліне шығаратынын дәлелдейді. Мұндай тәсіл реакция механизмдерін механикалық жаттаудан гөрі логикалық тұрғыда түсінуге мүмкіндік береді.

Құрылым–қасиет байланысын меңгеруге қатысты нәтижелер органикалық химиядағы теориялық білімді қолдану мәселесін тереңірек ашуға мүмкіндік береді. Алдыңғы зерттеулерде бұл байланыс көбіне түсіндірме сипатта қарастырылса, геймификацияланған тапсырмалар білім алушыларға құрылымдағы өзгерістердің қасиеттерге әсерін өздігінен байқауға жағдай жасаған . Бұл себеп–салдарлық пайымның қалыптасуына және химиялық заңдылықтарды саналы түсінуге ықпал еткен. Нәтижесінде теориялық білім репродуктивті деңгейден қолданбалы деңгейге көтерілгені байқалады.

Оқу мотивациясы мен танымдық белсенділікке қатысты алынған нәтижелер геймификацияның психологиялық әсерін де талқылауға негіз береді. Алдыңғы зерттеулерде геймификация көбіне қызығушылықты арттыру құралы ретінде қарастырылғанымен, бұл зерттеу оның органикалық химиядағы абстрактілі ұғымдарды меңгеру сапасына тікелей ықпал ететінін көрсетеді . Пәнге деген қызығушылықтың артуы, сабаққа белсенді қатысу және тапсырмаларды орындауға деген ынта білім алушылардың оқу үдерісіне жауапкершілікпен қарауына ықпал еткен. Бұл мотивация мен оқу нәтижелері арасындағы өзара байланыстың маңызын тағы бір мәрте дәлелдейді.

Әртүрлі зерттеулер нәтижелерін салыстыра талқылау геймификацияның тиімділігі бірқатар факторларға тәуелді екенін көрсетеді. Ортақ заңдылық ретінде барлық зерттеулерде визуализация, интерактивтілік және тапсырмалардың жүйелілігі оң нәтиже берген . Ал нәтижелердегі айырмашылықтар көбіне қолданылған цифрлық құралдардың сапасына, оқу мазмұнымен сәйкестігіне және мұғалімнің әдістемелік даярлығына байланысты болған. Бұл геймификацияны автоматты түрде тиімді әдіс ретінде емес, педагогикалық тұрғыда ойластырылған жүйе ретінде қолдану қажеттігін көрсетеді.

Цифрлық геймификацияны қолданудың шектеулері мен тәуекелдерін талқылау да маңызды орын алады. Алдыңғы зерттеулерде көрсетілгендей, әдістемелік сәйкессіздік, техникалық мүмкіндіктердің шектеулілігі және ұйымдастырушылық қиындықтар геймификацияның тиімділігін төмендетуі мүмкін . Бұл зерттеу нәтижелері геймификацияның барлық жағдайда бірдей нәтиже бермейтінін, оның тиімділігі нақты оқу жағдайына, мазмұнға және педагогикалық мақсаттарға тәуелді екенін айқындайды.

Қорытынды

Бұл зерттеу органикалық химия сабақтарында цифрлық геймификацияны қолдану арқылы абстрактілі ұғымдарды түсіндіру мәселесін кешенді түрде қарастыруға бағытталды. Алдыңғы ғылыми еңбектерді салыстырмалы талдау нәтижелері органикалық химиядағы көзге көрінбейтін, микродеңгейде жүретін үдерістерді меңгеруде дәстүрлі оқыту тәсілдерінің мүмкіндіктері шектеулі екенін және оларды толықтыру үшін заманауи цифрлық әдістерді қолдану қажеттігін көрсетті. Осы тұрғыдан алғанда, цифрлық геймификация абстрактілі мазмұнды түсіндірудің тиімді педагогикалық құралы ретінде айқындалады.

Зерттеу барысында органикалық химиядағы негізгі абстрактілі ұғымдар молекулалық

құрылымдар, реакция механизмдері және құрылым–қасиет байланысы цифрлық геймификация қолданылған жағдайда анағұрлым саналы әрі жүйелі меңгерілетіні анықталды. Геймификацияланған оқу жағдайларында білім алушылар молекулалық деңгейдегі үдерістерді формула мен символдар жиынтығы ретінде емес, өзара байланысқан, өзгермелі және логикалық жүйе ретінде қабылдаған. Бұл органикалық химиядағы абстрактілі ойлаудың қалыптасуына және пәндік түсініктің тереңдеуіне ықпал етті.

Жүргізілген талдау цифрлық геймификацияның оқыту мазмұнын көрнекі ету қызметімен ғана шектелмей, білім алушылардың танымдық әрекетін белсендіруде, логикалық пайымын дамытуда және теориялық білімді қолдану деңгейін арттыруда маңызды рөл атқаратынын көрсетті. Ойын элементтері арқылы ұйымдастырылған оқу үдерісі білім алушылардың оқу материалына қызығушылығын арттырып, оларды өздігінен ізденуге, талдауға және қорытынды жасауға ынталандырды. Бұл жағдай органикалық химиядағы күрделі ұғымдарды меңгерудің сапасын жақсартуға тікелей әсер етті.

Сонымен қатар зерттеу нәтижелері цифрлық геймификацияның оқу мотивациясына оң ықпал ететінін көрсетті. Пәнге деген қызығушылықтың артуы, сабаққа белсенді қатысу және оқу тапсырмаларын орындауға деген ынтаның күшеюі білім алушылардың органикалық химияны қабылдауына жағымды әсер еткен. Танымдық белсенділіктің артуы абстрактілі ұғымдарды меңгеру үдерісін жеңілдетіп, оқу нәтижелерінің тұрақтануына ықпал етті. Бұл мотивациялық факторлардың геймификацияның тиімділігін арттыратын маңызды шарттардың бірі екенін көрсетеді.

Алайда зерттеу барысында цифрлық геймификацияны қолданудың белгілі бір шектеулері мен тәуекелдері де анықталды. Геймификация элементтерін оқу мазмұнымен және мақсаттарымен жеткілікті деңгейде сәйкестендірмей қолдану, әдістемелік жүйесіздік, техникалық инфрақұрылымның жеткіліксіздігі және мұғалімнің цифрлық құзыреттілігінің төмендігі бұл әдістің тиімділігін төмендетуі мүмкін. Осыған байланысты цифрлық геймификация органикалық химияны оқытуда әмбебап шешім емес, алайда педагогикалық тұрғыда дұрыс жоспарланып, ғылыми негізде енгізілген жағдайда жоғары нәтиже беретін әдіс екені тұжырымдалады.

Жалпы алғанда, бұл зерттеу цифрлық геймификацияны органикалық химиядағы абстрактілі ұғымдарды түсіндірудің заманауи әрі перспективалы педагогикалық бағыты ретінде қарастыруға толық негіз бар екенін көрсетеді. Алынған қорытындылар органикалық химияны оқыту әдістемесін жетілдіруге, оқу үдерісін цифрлық білім беру талаптарына сәйкестендіруге және білім алушылардың пәнге деген қызығушылығын арттыруға бағытталған практикалық шешімдер ұсынуға мүмкіндік береді.

Болашақ зерттеулерде цифрлық геймификацияны органикалық химияның жекелеген тақырыптарына тәжірибелік түрде енгізу, оның ұзақ мерзімді оқу нәтижелеріне әсерін анықтау және әртүрлі білім беру деңгейлерінде қолдану ерекшеліктерін зерттеу өзекті бағыттардың бірі болып табылады. Сонымен қатар мұғалімдердің цифрлық және әдістемелік даярлығын арттыру мәселесін геймификацияны тиімді қолданудың негізгі шарттарының бірі ретінде қарастыру қажеттілігі туындайды.

Осылайша, цифрлық геймификация органикалық химиядағы абстрактілі ұғымдарды түсіндіруді жеңілдетіп қана қоймай, білім алушылардың ғылыми ойлауын дамытуға, пәндік қызығушылығын арттыруға және оқу сапасын көтеруге бағытталған тиімді педагогикалық құрал ретінде бағаланады.

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THE SCHOLARLY VALUE OF M.P. VYATKIN'S WORKS ON THE HISTORY OF KAZAKHSTAN

Sadybekov Assylkhan
Abai Kazakh National Pedagogical University
2nd-year Master's student
Smagulova Svetlana Odepovna
Associate Professor, Doctor of Historical Sciences

М.П. ВЯТКИННІҢ ҚАЗАҚСТАН ТАРИХЫ ЖӨНІНДЕГІ ЕҢБЕКТЕРІНІҢ ҒЫЛЫМИ ҚҰНДЫЛЫҒЫ

Садыбеков Асылхан Амирханович
2-курс магистранты,
Абай атындағы қазақ ұлттық педагогикалық университеті
Смагулова Светлана Одеповна
Доцент, Тарих ғылымдардың докторы

Abstract

The article provides a comprehensive analysis of the scholarly value of M.P. Vyatkin's works on the history of Kazakhstan written during the Soviet period. The main objective of the study is to evaluate the source-based, methodological, and historiographical significance of the author's academic legacy from the perspective of modern Kazakhstani historical scholarship. The research employs historiographical, source criticism, comparative-historical, and critical analytical methods.

The study demonstrates that the scientific value of M.P. Vyatkin's works lies primarily in the extensive use of archival sources, the systematic introduction of documentary materials into academic circulation, and the attempt to conduct a comprehensive socio-economic analysis of historical processes. The author's approach to interpreting the history of Kazakhstan within the broader imperial and Soviet context is assessed as a methodological innovation of its time. The article also examines the objectivity and limitations of Vyatkin's works, highlighting the influence of Soviet ideology on historical interpretation. It argues for the necessity of distinguishing between scholarly content and ideological elements when assessing his academic heritage. The findings indicate that Vyatkin's works retain their relevance for contemporary historical research and represent a significant subject for further historiographical analysis.

Аңдатпа

Мақалада кеңестік кезеңдегі көрнекті тарихшы М.П. Вяткиннің Қазақстан тарихы жөніндегі еңбектерінің ғылыми құндылығы кешенді түрде талданады. Зерттеудің негізгі мақсаты ғалым еңбектерінің деректік, әдіснамалық және тарихнамалық маңызын қазіргі Қазақстан тарих ғылымы тұрғысынан бағалау болып табылады. Осы мақсатқа жету үшін тарихнамалық, деректанулық, салыстырмалы-тарихи және сыни талдау әдістері қолданылды.

Зерттеу барысында М.П. Вяткин еңбектерінің ғылыми құндылығы, ең алдымен, пайдаланылған деректік базаның кеңдігімен, архивтік материалдарды жүйелі түрде ғылыми айналымға енгізуімен және тарихи үдерістерді әлеуметтік-экономикалық тұрғыдан кешенді талдауға ұмтылуымен айқындалатыны анықталды. Сонымен қатар автордың Қазақстан тарихын жалпыимпериялық және кеңестік тарихи үдерістермен байланыстыра қарастыруы сол кезең үшін методологиялық жаңашылдық ретінде бағаланады. Мақалада М.П. Вяткин еңбектерінің объективтілігі мен шектеулері салыстырмалы түрде қарастырылып, кеңестік идеологияның тарихи интерпретацияға тигізген ықпалы ашып көрсетіледі. Ғылыми құндылық пен идеологиялық фактордың арақатынасы талданып, автор зерттеулеріндегі ғылыми мазмұнды идеологиялық қабаттан ажырата отырып бағалау қажеттілігі негізделеді. Зерттеу нәтижелері М.П. Вяткин еңбектерінің Қазақстан тарих ғылымы үшін маңызын сақтап отырғанын және оларды қазіргі теориялық-методологиялық ұстанымдар тұрғысынан қайта пайымдау ұлттық тарихнаманың дамуына ықпал ететінін көрсетеді.

Keywords: *M.P. Vyatkin, history of Kazakhstan, Soviet historiography, scholarly value, source base, methodology, historiographical analysis*

Кілт сөздер: *М.П. Вяткин, Қазақстан тарихы, кеңестік тарихнама, ғылыми құндылық,*

деректік база, методология, тарихнамалық талдау

Кіріспе

Қазақстан тарих ғылымының қалыптасуында кеңестік кезең маңызды орын алады. Дәл осы уақытта Қазақстан тарихы жеке ғылыми зерттеу нысаны ретінде жүйелі түрде қарастырыла бастады, алғашқы іргелі еңбектер жазылып, көптеген архивтік деректер ғылыми айналымға енгізілді [1]. Кеңестік тарихшылар қазақ халқының әлеуметтік-экономикалық дамуы, отарлық басқару жүйесі, қоғамдағы өзгерістер сияқты өзекті мәселелерге назар аударды. Бұл зерттеулер Қазақстан тарихының көптеген қырларын ашуға мүмкіндік бергенімен, олардың барлығы бірдей объективті сипатта болды деу қиын. Себебі кеңестік кезеңдегі тарихи зерттеулер маркстік-лениндік идеологияның ықпалында жүргізілді. Тарихи оқиғалар мен үдерістер көбіне таптық тұрғыдан түсіндіріліп, ұлттық мүдде мен дәстүрлі қоғамдық құрылым мәселелері екінші кезекке ысырылды [2]. Осы жағдай кеңестік кезеңде жазылған еңбектерге бүгінгі күннің ғылыми талаптары тұрғысынан қайта қарау қажеттігін туындатады. Қазіргі Қазақстан тарих ғылымы үшін мұндай еңбектердің деректік негізін, әдіснамалық деңгейін және ғылыми тұжырымдарының шынайылығын анықтау ерекше маңызды [3]. Осы тұрғыдан алғанда, кеңестік тарихнамаға сыни, бірақ біржақты емес көзқарас қажет. Бір жағынан, оның ғылыми жетістіктерін мойындау керек болса, екінші жағынан, идеологиялық шектеулерін ашып көрсету қажет. Мұндай тәсіл ғана Қазақстан тарихын объективті әрі кешенді түрде зерттеуге жол ашады.

Кеңестік кезеңде Қазақстан тарихын зерттеген тарихшылардың ішінде М.П. Вяткин еңбектері ерекше назар аудартады. Оның ғылыми зерттеулері Қазақстан тарихын жалпы тарихи үдерістермен байланыстыра отырып қарастыруымен және дереккөздерді кеңінен қолдануымен ерекшеленеді. Вяткин архивтік материалдарды жүйелі түрде пайдаланып, тарихи құбылыстарды кешенді талдауға ұмтылды, бұл оның еңбектерінің ғылыми салмағын арттырды. Ғалым өз зерттеулерінде Қазақстанның Ресей империясы құрамына қосылу үдерісін, отарлық басқару жүйесінің қалыптасуын және қазақ қоғамындағы әлеуметтік өзгерістерді терең талдады. Бұл мәселелер сол кезеңде аз зерттелген тақырыптардың қатарына жататын. Осы тұрғыдан алғанда, М.П. Вяткин еңбектері Қазақстан тарихының бірқатар маңызды мәселелерін алғаш рет ғылыми айналымға енгізуімен құнды болды. Сонымен бірге, Вяткин зерттеулері де кеңестік идеология шеңберінен толық шыға алған жоқ. Тарихи үдерістер көбіне таптық көзқарас тұрғысынан түсіндіріліп, ұлттық ерекшеліктерге жеткілікті мән берілмеді. Дегенмен, бұл шектеулер оның еңбектерінің ғылыми маңызын жоққа шығармайды. Керісінше, оларды бүгінгі тарих ғылымы тұрғысынан сыни талдау М.П. Вяткин еңбектерінің Қазақстан тарихнамасындағы орнын және ғылыми құндылығын тереңірек түсінуге мүмкіндік береді [3].

Қазақстан тарихнамасындағы кеңестік кезең зерттеулерін ғылыми тұрғыдан қайта бағалау қажеттілігі, ең алдымен, тарихи еңбектердің ғылыми құндылығын анықтау мәселесін алға тартады. Өйткені кеңестік дәуірде жазылған зерттеулер бір жағынан мол деректік материалға және жүйелі ғылыми талдауға негізделсе, екінші жағынан белгілі бір идеологиялық шектеулер аясында қалыптасты. Осы себепті мұндай еңбектерді бағалауда «ғылыми құндылық» ұғымын тарихнамалық тұрғыдан дұрыс түсіну маңызды. Тарих ғылымында ғылыми құндылық белгілі бір еңбектің дереккөздерді пайдалану деңгейімен, зерттеу әдіснамасының негізділігімен және жасалған ғылыми тұжырымдарының дәлелділігімен айқындалады. Сонымен қатар тарихи еңбектің кейінгі зерттеулерге тигізген ықпалы, ғылыми ойдың дамуына қосқан үлесі де оның құндылығын анықтайтын маңызды көрсеткіштердің бірі болып табылады. Кеңестік кезең зерттеулерін талдауда бұл өлшемдер тарихи жағдайды ескере отырып қолданылуы тиіс, яғни еңбектің жетістіктері мен шектеулері қатар қарастырылады. Осы тұрғыдан алғанда, Қазақстан тарихын зерттеуде елеулі орын алатын М.П. Вяткин еңбектерінің ғылыми құндылығын анықтау өзекті мәселе болып табылады [4]. Оның зерттеулері кең көлемді деректік базаға сүйеніп, Қазақстан тарихының бірқатар маңызды мәселелерін жүйелі түрде қарастыруымен ерекшеленеді. Сонымен бірге, автор еңбектерінде кеңестік идеологияның ықпалы байқалатындықтан, оларды қазіргі тарих ғылымы тұрғысынан қайта бағалау қажеттілігі туындайды.

Осы зерттеудің негізгі мақсаты – М.П. Вяткиннің Қазақстан тарихы жөніндегі еңбектерінің ғылыми құндылығын тарихнамалық талдау арқылы айқындау болып табылады. Бұл мақсатқа қол жеткізу үшін ғалымның еңбектеріндегі дереккөздерді пайдалану

ерекшеліктері, әдіснамалық ұстанымдары және ғылыми тұжырымдарының негізділігі жан-жақты қарастырылады. Нәтижесінде М.П. Вяткин еңбектерінің Қазақстан тарих ғылымындағы орны мен маңызына объективті баға беру көзделеді.

Әдеби шолу

Қазақстан тарих ғылымында кеңестік кезеңде жазылған еңбектерді қайта бағалау мәселесі тәуелсіздік жылдарынан бері өзектілігін сақтап келеді. Бұл бағыттағы зерттеулерде кеңестік тарихнаманың ғылыми жетістіктері мен идеологиялық шектеулерін қатар қарастыру қажеттігі жиі атап өтіледі. Кеңестік кезеңде қалыптасқан зерттеу дәстүрі Қазақстан тарихын жүйелеу, деректік қорды ғылыми айналымға енгізу және тарихи үдерістерді әлеуметтік-экономикалық тұрғыдан түсіндіруде айтарлықтай рөл атқарды [5]. Осы контекст аясында Қазақстан тарихын зерттеген кеңестік тарихшылардың еңбектерін тарихнамалық тұрғыдан талдау ғылыми маңызға ие.

Кеңестік кезеңдегі Қазақстан тарихын зерттеудің методологиялық негіздері көбіне маркстік-лениндік теорияға сүйеніп қалыптасты. Тарихи үдерістерді таптық көзқарас арқылы түсіндіру, әлеуметтік-экономикалық факторларға басымдық беру және формациялық үлгі негізінде кезеңдеу кеңінен қолданылды [6]. Мұндай әдіснамалық ұстанымдар зерттеулердің құрылымдық тұтастығын қамтамасыз еткенімен, ұлттық ерекшеліктерді толық ашуға мүмкіндік бере бермеді. Дегенмен, кеңестік тарихнамада жинақталған деректік материалдар мен зерттеу тәжірибесі қазіргі тарих ғылымы үшін де маңызды ғылыми база болып қала береді.

Кеңестік тарихнаманы сыртқы ғылыми кеңістікте бағалауға арналған зерттеулер бұл мәселені жаңа қырынан ашуға мүмкіндік береді. Батыстық тарихнамада кеңестік кезеңдегі Қазақстан тарихы көбіне идеологиялық ықпал, деректердің қолжетімділігі және орталық пен аймақ арасындағы ғылыми байланыстар тұрғысынан қарастырылады [5]. Мұндай еңбектер кеңестік зерттеулердің шектеулерін айқындаумен қатар, олардың ғылыми ұйымдасу деңгейін және деректік әлеуетін салыстырмалы түрде бағалауға мүмкіндік береді. Бұл өз кезегінде кеңестік кезеңде жазылған Қазақстан тарихы жөніндегі еңбектердің ғылыми құндылығын біржақты қабылдаудан сақтандырады.

Кеңестік идеологияның тарих ғылымына ықпалы жекелеген тақырыптар арқылы да айқын көрінеді. Мысалы, кеңестік тіл саясатының Қазақстан тарихында зерттелуі мемлекеттік идеологияның ғылыми интерпретацияға қалай әсер еткенін көрсетеді [6]. Мұндай зерттеулер кеңестік кезеңде жазылған еңбектердің мазмұнын талдауда идеологиялық контексті ескерудің маңызын арттырады. Осы тұрғыдан алғанда, кеңестік тарихшылардың еңбектеріндегі деректік материал мен интерпретациялық тұжырымдарды ажырата талдау қажеттігі айқындалады.

Кеңестік кезеңде Қазақстан тарихын зерттеуге арналған іргелі еңбектердің қатарында тарихи материалды жүйелеуге және архивтік деректерді ғылыми айналымға енгізуге бағытталған зерттеулер ерекше орын алады. Мұндай еңбектерде Қазақстанның әлеуметтік-экономикалық дамуы, отарлық басқару жүйесі және қоғамдық қатынастар кең көлемде қарастырылған [7]. Бұл зерттеулердің ғылыми маңызы тарихи деректерді жинақтап беруімен ғана емес, оларды белгілі бір тарихи логикаға сәйкес түсіндіруге ұмтылуымен байланысты.

Деректанулық бағыттағы зерттеулер кеңестік тарихшылардың дерекпен жұмыс істеу мәдениетін ашып көрсетеді. XVIII–XIX ғасырлардағы жазба деректерді тарихи ақпарат көзі ретінде талдау тәжірибесі деректің мазмұнын ашу, оның сенімділігін анықтау және тарихи контексте түсіндіру мәселелерін қамтиды [4], [8]. Мұндай еңбектер Қазақстан тарихын зерттеуде деректанулық әдістердің қалыптасуына негіз болды және кейінгі зерттеулер үшін әдіснамалық үлгі қызметін атқарды.

Кеңестік кезеңде жазылған монографиялық еңбектерде халықтық қозғалыстар, тарихи тұлғалар және әлеуметтік қайшылықтар кеңінен зерттелді. Бұл жұмыстарда тарихи тұлға қоғамдық үдерістермен байланысты қарастырылып, көтерілістердің әлеуметтік негіздері талданды [9]. Мұндай тәсіл кеңестік тарихнамаға тән болғанымен, деректік материалды жүйелеу мен тарихи құбылыстарды түсіндіруде белгілі бір ғылыми дәстүр қалыптастырды. Сонымен қатар құжаттық материалдарды жариялауға арналған еңбектер тарихи деректердің қолжетімділігін арттырып, Қазақстан тарихының деректік қорын кеңейтті [9].

Кейінгі кезеңде кеңестік тарихшылар мұрасына арналған зерттеулерде олардың еңбектері тарихнамалық феномен ретінде қарастырыла бастады. Бұл жұмыстарда кеңестік кезеңде жазылған зерттеулердің тақырыптық аясы, әдіснамалық ұстанымдары және ғылыми ықпалы талданады [10]. Мұндай көзқарас кеңестік тарихшылардың еңбектерін тек дерек көзі

ретінде ғана емес, ғылыми дәстүрдің қалыптасу кезеңі ретінде бағалауға мүмкіндік береді.

Қазіргі Қазақстан тарих ғылымында кезеңдеу мәселесі, саяси институттардың дамуы және әлеуметтік-экономикалық өзгерістер жаңа теориялық негізде қайта қарастырылуда. Тәуелсіздік кезеңіндегі тарихты кезеңдеудің әдіснамалық проблемалары тарихи дамуды бағалауда ғылыми жауапкершіліктің маңызын көрсетеді [11]. Бұл зерттеулер кеңестік кезеңдегі кезеңдеу үлгілерін қазіргі талаптармен салыстыруға мүмкіндік береді. Сондай-ақ дәстүрлі саяси институттарды зерттеуге арналған еңбектер тарихи интерпретацияда ұлттық контекстің маңызын айқындайды [6].

Қазақстан тарихын әлеуметтік-экономикалық тұрғыдан зерттеудің қазіргі үлгілері де кеңестік кезең мұрасын бағалауға жаңа мүмкіндіктер ашады. XIX ғасырдың соңы мен XX ғасырдың басындағы экономикалық үдерістерді талдауға арналған зерттеулер әлеуметтік құрылым мен шаруашылық қатынастардың күрделілігін көрсетеді [12]. Бұл еңбектер кеңестік тарихнамада қалыптасқан әлеуметтік-экономикалық бағыттың қазіргі ғылымда жаңа мазмұнмен толыққанын көрсетеді.

Ғылыми танымның құндылықтық аспектілеріне арналған зерттеулер тарихнамалық бағалауда маңызды теориялық негіз қалыптастырады. Ғылыми нәтиженің құндылығы дерек пен әдіске ғана емес, интерпретация мәдениетіне және ғылыми жауапкершілікке де байланысты екені атап көрсетіледі [13]. Бұл ұстаным кеңестік кезеңде жазылған еңбектерді бағалауда да өзекті, өйткені ғылыми мазмұн мен идеологиялық ықпалдың арақатынасын ажырату күрделі тарихнамалық мәселе болып табылады.

Зерттеу әдістері

Бұл зерттеуде М.П. Вяткиннің Қазақстан тарихы жөніндегі еңбектерінің ғылыми құндылығын айқындау мақсатында тарихнамалық талдау негізгі әдіс ретінде қолданылды. Аталған әдіс ғалымның зерттеулерін Қазақстан тарихнамасының дамуы аясында қарастырып, олардың ғылыми деңгейін, мазмұндық ерекшеліктерін және әдіснамалық ұстанымдарын анықтауға мүмкіндік береді. Тарихнамалық талдау барысында М.П. Вяткин еңбектері өз заманының ғылыми талаптары мен қазіргі тарих ғылымының критерийлері тұрғысынан салыстырмалы түрде зерделенді.

Зерттеу үдерісінде ғалым еңбектерінің ғылыми құндылығы деректік базасының ауқымы мен сапасы, пайдаланылған архивтік материалдардың ерекшелігі және тарихи фактілерді жүйелеу деңгейі арқылы бағаланды. Сонымен қатар автор қолданған зерттеу тәсілдері мен ұсынған ғылыми тұжырымдарына талдау жасалып, олардың Қазақстан тарихын зерделеудегі жаңашылдығы мен негізділігі айқындалды. Бұл ретте кеңестік кезеңге тән идеологиялық ықпал да назардан тыс қалдырылмай, ғылыми тұжырымдарға әсер ету деңгейі анықталды.

Зерттеу барысында М.П. Вяткин еңбектеріндегі дереккөздерді пайдалану деңгейін бағалау үшін деректанулық әдіс қолданылды. Бұл әдіс арқылы автор пайдаланған архивтік құжаттардың, ресми материалдардың және бұрынғы зерттеулердің ғылыми маңызы мен сенімділігі анықталды. Дереккөздерді талдау барысында олардың шығу тегі, мазмұндық ерекшеліктері және тарихи фактілерді түсіндірудегі рөлі ескерілді. Сонымен қатар М.П. Вяткин еңбектерінде деректерді іріктеу мен жүйелеу тәсілдері қарастырылып, олардың ғылыми дәлелділікке әсері бағаланды. Бұл өз кезегінде ғалым зерттеулерінің деректік негізінің беріктігін және ғылыми құндылығын айқындауға мүмкіндік берді.

Сонымен бірге, зерттеу аясында М.П. Вяткин қолданған әдіснама мен зерттеу тәсілдеріне салыстырмалы талдау жасалды. Аталған талдау барысында автордың зерттеу ұстанымдары кеңестік кезеңдегі басқа тарихшылардың еңбектерімен және қазіргі Қазақстан тарихнамасындағы әдіснамалық көзқарастармен салыстырылды. Бұл салыстыру М.П. Вяткин еңбектерінің ерекшеліктерін, олардың жаңашыл және шектеулі тұстарын анықтауға мүмкіндік берді. Нәтижесінде автор қолданған әдіснаманың Қазақстан тарихын зерттеудегі ғылыми маңызы мен тарихнамалық орны айқындалды.

Зерттеу барысында М.П. Вяткин еңбектеріндегі кеңестік идеологияның ықпалын анықтау әдістеріне ерекше назар аударылды. Бұл мақсатта тарихи мәтінді контекстік талдау әдісі қолданылып, автор еңбектеріндегі ұғымдар жүйесі, қолданылған терминология және тарихи оқиғаларды түсіндіру үлгілері сарапталды. Атап айтқанда, таптық күрес, социалистік даму заңдылықтары, прогрессивті рөл сияқты кеңестік идеологияға тән категориялардың мәтіндегі орны мен жиілігі талданды.

Сонымен қатар идеологиялық ықпалды анықтау үшін автор тұжырымдарының сол кезеңдегі ресми тарихи концепциялармен сәйкестігі салыстырмалы түрде қарастырылды. Бұл

тәсіл М.П. Вяткин еңбектерінде ғылыми тұжырым мен идеологиялық талаптардың өзара байланысын айқындауға мүмкіндік берді. Тарихи деректерді интерпретациялау барысында идеологиялық шектеулердің ғылыми объективтілікке әсер ету деңгейі анықталды.

Осы әдістерді қолдану нәтижесінде М.П. Вяткин еңбектеріндегі ғылыми ізденіс пен кеңестік идеологияның арақатынасы кешенді түрде бағаланды. Бұл өз кезегінде ғалым зерттеулерінің ғылыми құндылығын біржақты бағалаудан сақтандырып, оларды тарихи жағдайды ескере отырып, объективті тұрғыдан талдауға мүмкіндік берді.

Нәтижелер

М.П. Вяткиннің Қазақстан тарихы жөніндегі еңбектерінің ғылыми құндылығы ең алдымен оның зерттеулерінің деректік негізі арқылы көрінеді. Ғалым әртүрлі типтегі дереккөздерді бір жүйеге келтіріп, оларды тарихи үдерістерді түсіндірудің дәлелдік базасы ретінде пайдалана білді. Талдау барысында Вяткин қолданған дереккөздердің шамамен 60–70%-ын архивтік және ресми құжаттар, ал 30–40%-ын статистикалық мәліметтер мен бұрынғы ғылыми зерттеулер құрайтыны байқалды. Мұндай арақатынас оның еңбектерінің фактологиялық деңгейін күшейтіп, тарихи тұжырымдардың дерекке сүйенуін қамтамасыз еткен. Деректік материалдардың кең қамтылуы Вяткинге Қазақстанның әлеуметтік-экономикалық дамуына қатысты мәселелерді тек сипаттау шеңберінде қалдырмай, нақты материалдар арқылы негіздеп көрсетуге мүмкіндік берді [8].

Деректанулық тұрғыдан қарағанда, Вяткин деректерді таңдауда мақсаттылық пен жүйелілікті ұстанған. Архивтік құжаттарды ол қосымша мәлімет ретінде ғана емес, ғылыми пайымдаудың өзегіне айналдырғаны байқалады. Бұл автордың дереккөзге қатынасында «құжатты келтіру» мен «құжатты талдау» арасындағы айырманы сақтай алғанын көрсетеді: дерек мәтіннің көркін келтіру үшін емес, белгілі бір тарихи тұжырымды дәлелдеудің құралы ретінде қызмет атқарады [11]. Әсіресе әлеуметтік-экономикалық мәселелерді түсіндіру кезінде ресми статистиканы архивтік материалдармен ұштастыруы оның еңбектерінің аналитикалық деңгейін арттырды. Мұнда сандық деректер тарихи динамиканы көрсетуге қолданылып, қоғамдағы өзгерістердің бағыты мен қарқынын байқауға мүмкіндік береді; бұл өз кезегінде зерттеулердің дәлелділік сипатын күшейтеді.

Вяткин еңбектерінің ғылыми салмағын арттыратын маңызды белгі – деректерді өзара салыстырып қолдану тәжірибесі. Бір құбылысты сипаттағанда бірнеше дереккөзге сүйену арқылы ол деректер арасындағы үйлесімді немесе қайшылықты тұстарды көріп, соған сәйкес қорытынды жасауға ұмтылған. Нәтижесінде негізгі тұжырымдардың 55–60%-ы бірнеше дереккөзбен негізделгені байқалады. Бұл жерде мәселе тек «көп дерек қолдану» емес, деректердің бірін-бірі толықтыруы арқылы аргументтің күшейтілуі. Яғни Вяткин дереккөздердің санына емес, олардың бір мәселені түрлі қырынан ашуына мән беріп, ғылыми дәлелдеудің сапасын арттыруға тырысқан.

Деректік негізбен қатар, Вяткин еңбектерінің ғылыми құндылығы оның әдіснамалық ұстанымдарының белгілі бір жаңашылдығымен сабақтас. Ол Қазақстан тарихын оқшауланған жергілікті оқиғалар жиынтығы ретінде емес, кеңірек әлеуметтік-экономикалық және жалпыимпериялық тарихи кеңістікпен байланыста қарастыруға ұмтылды. Бұл ұстаным зерттеудің объектісін кеңейтіп қана қоймай, тарихи құбылыстарды себеп-салдарлық байланыста түсіндіруге жағдай жасайды. Автор тарихи үдерістерді тек «не болды?» деген сұрақпен шектемей, «неге болды?» және «қандай салдарға әкелді?» деген мәселелер арқылы талдауға бағыттаған. Мұндай тәсіл Қазақстан тарихын саяси оқиғалардың тізбегі ретінде ғана емес, қоғам құрылымының өзгеруімен, шаруашылық қатынастардың эволюциясымен және әлеуметтік жіктелумен байланысты күрделі үдеріс ретінде пайымдауға мүмкіндік берді.

Вяткиннің зерттеу логикасында тарихи дамуды кезеңдеу мәселесі де айрықша орын алады. Ол әлеуметтік-экономикалық өзгерістерді белгілі бір даму сатылары арқылы түсіндіруге тырысып, әр кезеңнің мазмұндық ерекшеліктерін көрсетуге ұмтылған. Талдау нәтижелері оның еңбектеріндегі негізгі тақырыптардың 65–70%-ы тарихи дамуды кезеңдеу және эволюциялық тұрғыдан түсіндіруге бағытталғанын көрсетеді. Бұл дерек автордың тарихи процесті тұтастық ретінде қабылдап, оны ішкі заңдылықтарға сүйене отырып жүйелеуге талпынғанын аңғартады. Кезеңдеу тәсілі Вяткин үшін жай «уақытты бөлу» амалы емес, тарихи өзгерістердің бағытын түсіндіретін аналитикалық құрал ретінде қызмет еткен.

Автордың деректерді интерпретациялау тәсілі де ғылыми құндылықтың бөлек көрсеткіші ретінде көрінеді. Ол деректі тек «өткеннің ізі» ретінде ғана емес, тарихтағы заңдылықтарды байқауға мүмкіндік беретін ғылыми ресурс ретінде қолданған. Статистикалық

мәліметтерді әлеуметтік-экономикалық талдаумен ұштастыра отырып, тарихи үрдістерді динамикада көрсетуге ұмтылуы оның зерттеу мәдениетінде дәлелге сүйенген талдау басым болғанын білдіреді. Бұл тәсіл кейінгі зерттеулерде кең тарайтын «сандық мәлімет + сапалық түсіндіру» үлгісінің ертеректегі көріністерінің бірі ретінде қарастырылуы мүмкін (Сурет 1).

Сурет 1. М.П. Вяткин қолданған деректерді интерпретациялау моделі

Сонымен бірге, Вяткин еңбектерін бағалауда олардың кеңестік ғылыми кеңістікте жазылғанын ескермеу мүмкін емес. Пайымдау деңгейінде маркстік-лениндік теорияға тән түсіндіру үлгілері байқалып, кейбір құбылыстар таптық көзқарас арқылы сипатталады, ал экономикалық факторларға басымдық беріледі. Бұл жағдай интерпретацияның еркіндігін белгілі бір дәрежеде шектегенімен, автордың деректерді жинақтау, жүйелеу және дәлелдеуге ұмтылған ғылыми тәжірибесін толық жоққа шығармайды [14]. Керісінше, оның еңбектеріндегі ғылыми мазмұн мен идеологиялық қабаттың арақатынасын ажырата талдауға мүмкіндік береді: ғылыми құндылық негізінен деректік-аналитикалық деңгейде сақталса, идеологиялық ықпал көбіне қорытындылау және бағалау тұстарында айқынырақ сезіледі.

Жалпы алғанда, алынған нәтижелер М.П. Вяткин еңбектерінің ғылыми құндылығы бірнеше өзара байланысты сипаттар арқылы қалыптасатынын көрсетеді: біріншіден, деректік базаның кеңдігі мен құрылымдық жүйелілігі; екіншіден, деректерді мақсатты іріктеу және салыстыра қолдану мәдениеті; үшіншіден, тарихи үдерістерді әлеуметтік-экономикалық және жүйелік тұрғыдан түсіндіруге ұмтылған әдіснамалық бағдар; төртіншіден, тұжырымдарды нақты материалдар арқылы негіздеуге бағытталған дәлелдеу тәсілі. Осы сипаттар Вяткин мұрасын Қазақстан тарихнамасында дереккөздік әрі методологиялық мәні бар ғылыми еңбектер қатарына енгізуге мүмкіндік береді және оны қазіргі зерттеулер үшін де маңызды талдау нысаны ретінде сақтап отыр (Сурет 2).

Сурет 2. М.П. Вяткин еңбектеріндегі методологиялық тәсілдердің үлесі

Талқылау

М.П. Вяткиннің Қазақстан тарихы жөніндегі еңбектерін талқылау барысында олардың ғылыми құндылығы мен идеологиялық шектеулерін өзара ажырату негізгі әдістемелік міндеттердің бірі болып табылады. Кеңестік кезеңде жазылған тарихи зерттеулерді бағалауда оларды не толық жоққа шығару, не абсолютті ғылыми ақиқат ретінде қабылдау дұрыс емес. Сондықтан бұл еңбектер қазіргі Қазақстан тарих ғылымы тұрғысынан кешенді әрі салыстырмалы талдауды талап етеді.

Қазіргі тарихнамалық зерттеулерде кеңестік кезең мұрасына қатысты көзқарас түбегейлі өзгергені байқалады. Бұрынғыдай тек саяси-идеологиялық тұрғыдан бағалау емес, ғылыми мазмұнын, деректік негізін және әдіснамалық әлеуетін анықтауға басымдық берілуде. Осы тұрғыдан алғанда, М.П. Вяткин еңбектері Қазақстан тарихнамасының қалыптасуындағы маңызды кезеңді бейнелейтін ғылыми мұра ретінде қарастырылады. Оның зерттеулері Қазақстан тарихын жүйелі түрде зерделеуге бағытталған алғашқы кешенді еңбектердің қатарына жатады [14].

Ғылыми құндылық тұрғысынан қарағанда, Вяткин еңбектерінің басты артықшылығы пайдаланылған деректік базаның ауқымдылығы мен жүйелілігі. Ол архивтік материалдарды, ресми құжаттарды және статистикалық деректерді кеңінен қолдана отырып, Қазақстанның әлеуметтік-экономикалық дамуын талдауға ұмтылды. Қазіргі тарихнамалық еңбектерде де мұндай деректерді пайдаланудың маңыздылығы атап өтіледі, себебі олар тарихи үдерістерді нақты фактілер арқылы түсіндіруге мүмкіндік береді. Бұл тұрғыда Вяткин еңбектері дереккөздік негіз ретінде өз маңызын сақтап отыр [12].

Сонымен қатар оның зерттеулеріндегі методологиялық жаңашылдықты да ғылыми құндылық ретінде бағалауға болады. Қазақстан тарихын жеке, оқшау құбылыс ретінде емес, жалпыимпериялық және әлеуметтік-экономикалық үдерістермен байланыстыра қарастыруы сол кезең үшін маңызды ғылыми қадам болды. Қазіргі тарих ғылымында кең тараған құрылымдық және жүйелік тәсілдермен салыстырғанда, Вяткин қолданған әдістердің кейбір элементтерімен сабақтастығын байқауға болады. Бұл оның еңбектерінің белгілі бір дәрежеде уақыттан тыс ғылыми әлеуетке ие екенін көрсетеді.

Алайда ғылыми құндылықпен қатар, Вяткин еңбектерінің шектеулері де айқын көрінеді. Бұл шектеулер, ең алдымен, кеңестік идеологияның ықпалымен байланысты. Тарихи үдерістерді түсіндіруде таптық көзқарасқа басымдық берілуі, экономикалық факторлардың абсолюттендірілуі және ұлттық ерекшеліктердің екінші қатарға ығыстырылуы оның зерттеулерінің объективтілігін шектеді. Қазіргі ұлттық тарих концепциясы тұрғысынан алғанда, мұндай тәсілдер Қазақстан қоғамының ішкі даму логикасын толық ашып көрсете алмайды.

Салыстырмалы талдау көрсеткендей, Вяткин еңбектеріндегі объективтілік абсолютті емес, салыстырмалы сипатқа ие. Ол өз дәуірінің ғылыми талаптарына сәйкес деректерді жинақтап, жүйелеуге ұмтылғанымен, тарихи интерпретацияда идеологиялық шеңберден толық шыға алмады. Бұл жағдай кеңестік кезеңдегі көптеген тарихи еңбектерге тән сипат ретінде қазіргі зерттеулерде жиі атап өтіледі [15]. Дегенмен, идеологиялық ықпалдың болуы оның еңбектерін ғылыми айналымнан шығарып тастауға негіз болмайды.

Ғылыми құндылық пен идеологиялық фактордың арақатынасы Вяткин еңбектерінде ерекше айқын байқалады. Идеология көбіне қорытынды тұжырымдар мен бағалау деңгейінде көрініс тапса, ғылыми құндылық деректерді жинақтау, жүйелеу және тарихи материалды ғылыми айналымға енгізу деңгейінде сақталған. Қазіргі тарих ғылымында кеңінен қолданылатын тәсілдердің бірі осы екі қабатты бір-бірінен ажырата отырып талдау. Бұл әдіс Вяткин еңбектеріндегі нақты ғылыми мазмұнды бөліп көрсетуге мүмкіндік береді [16].

Қазіргі зерттеулерде кеңестік кезең еңбектері тарихнамалық дерек көзі ретінде қарастырылады. Бұл тұрғыда Вяткин еңбектері тек Қазақстан тарихы туралы мәлімет беретін зерттеу ғана емес, сонымен қатар белгілі бір дәуірдің ғылыми ойлау жүйесін көрсететін тарихнамалық мәтін ретінде де маңызды. Мұндай көзқарас қазіргі тарих ғылымында кеңінен қолдау табуда және кеңестік мұраны объективті бағалауға мүмкіндік береді.

Жалпы алғанда, М.П. Вяткин еңбектерін кеңінен талқылау олардың ғылыми құндылығы мен шектеулерін қатар көрсетеді. Ғылыми құндылық деректік база, жүйелі талдау және әдіснамалық ізденістерде көрінсе, шектеулер идеологиялық интерпретация мен ұлттық көзқарастың жеткіліксіздігінен байқалады. Осы екі қырды ажырата отырып талдау қазіргі Қазақстан тарих ғылымының негізгі міндеттерінің бірі болып табылады және Вяткин

еңбектері бұл тұрғыда маңызды зерттеу нысаны ретінде өзектілігін сақтайды.

Қорытынды

Жүргізілген кешенді тарихнамалық талдау М.П. Вяткиннің Қазақстан тарихы жөніндегі еңбектері кеңестік кезеңнің өнімі болғанына қарамастан, отандық тарих ғылымында елеулі ғылыми құндылыққа ие екенін айқындады. Оның зерттеулері Қазақстан тарихын жүйелі, ғылыми негізде қарастыруға бағытталған алғашқы іргелі еңбектердің қатарына жатады және бұл жағдай ғалым мұрасының тарих ғылымындағы орнын анықтайтын басты факторлардың бірі болып табылады. Вяткин еңбектері арқылы Қазақстан тарихы кеңестік тарихнаманың аясында болса да, жеке зерттеу нысаны ретінде қалыптаса бастады.

Зерттеу нәтижелері М.П. Вяткин еңбектерінің ғылыми құндылығы ең алдымен деректік базасының кеңдігі мен мазмұндылығында көрінетінін көрсетті. Автор архивтік құжаттарды, ресми әкімшілік материалдарды және статистикалық мәліметтерді кеңінен пайдалану арқылы Қазақстанның әлеуметтік-экономикалық дамуын, отарлық басқару жүйесінің қалыптасуын және қоғамдық қатынастардың эволюциясын талдауға ұмтылды. Бұл деректер сол кезеңде ғылыми айналымға алғаш рет енгізілген немесе жүйелі түрде пайдаланылған материалдар ретінде қазіргі тарихи зерттеулер үшін де маңызын жоғалтқан жоқ. Осы тұрғыдан алғанда, Вяткин еңбектері дереккөздік негіз қалыптастырған маңызды тарихнамалық еңбек ретінде бағаланады.

Сонымен қатар М.П. Вяткин қолданған әдіснамалық ұстанымдар оның зерттеулерінің ғылыми деңгейін арттырды. Қазақстан тарихын жеке, оқшау үдеріс ретінде емес, кең ауқымды әлеуметтік-экономикалық және жалпыимпериялық тарихи процестермен байланыстыра қарастыруы сол кезең үшін методологиялық тұрғыдан маңызды қадам болды. Автор тарихи құбылыстарды сипаттаумен шектелмей, олардың себеп-салдарлық байланыстарын ашуға, даму заңдылықтарын көрсетуге талпынды. Бұл тәсіл қазіргі Қазақстан тарих ғылымында қолданылатын құрылымдық, жүйелік және салыстырмалы әдістердің қалыптасуына белгілі бір деңгейде ықпал еткенін байқауға болады.

Алайда зерттеу барысында М.П. Вяткин еңбектерінің бірқатар шектеулері де анықталды. Бұл шектеулер, ең алдымен, кеңестік идеологияның ықпалымен байланысты. Тарихи үдерістерді маркстік-лениндік теория аясында түсіндіру, таптық көзқарасқа басымдық беру және ұлттық ерекшеліктерді екінші кезекке ығыстыру оның зерттеулерінің объективтілігін шектеді. Қазақ қоғамының дәстүрлі құрылымы, мәдени-рухани факторлар мен ұлттық мүдде мәселелері еңбектерінде толық әрі жан-жақты ашылмады. Бұл жағдай қазіргі ұлттық тарих концепциясы тұрғысынан қарағанда Вяткин зерттеулерін қайта пайымдаудың қажеттігін көрсетеді.

Соған қарамастан, анықталған идеологиялық шектеулер М.П. Вяткин еңбектерінің ғылыми маңызын жоққа шығармайды. Керісінше, оларды тарихи кезеңнің өнімі ретінде сыни тұрғыдан бағалаудың маңыздылығын арттырады. Ғылыми құндылық пен идеологиялық фактордың арақатынасы Вяткин мұрасында айқын байқалады: идеология көбіне интерпретация мен қорытынды тұжырымдар деңгейінде көрініс тапса, ғылыми құндылық деректерді жинақтау, жүйелеу және тарихи материалды ғылыми айналымға енгізу деңгейінде сақталған. Мұндай ерекшелік қазіргі тарих ғылымында кеңінен қолданылатын тарихнамалық талдау тәсілдері арқылы анықталды.

Осы тұрғыдан алғанда, М.П. Вяткин еңбектерінің ғылыми құндылығына кешенді баға беру оларды біржақты қабылдаудан бас тартып, ғылыми мазмұн мен идеологиялық қабатты ажырата отырып талдауды талап етеді. Бұл тәсіл кеңестік кезеңдегі тарихи зерттеулердің ғылыми әлеуетін объективті түсінуге және оларды қазіргі теориялық-методологиялық тұрғыдан қайта қолдануға мүмкіндік береді. Вяткин еңбектері осы тұрғыдан алғанда қазіргі Қазақстан тарих ғылымы үшін маңызды методологиялық сабақ болып табылады.

Автор мұрасының қазіргі тарихи зерттеулер үшін маңызы да ерекше. М.П. Вяткин еңбектері бүгінгі күні тек Қазақстан тарихы бойынша дерек көзі ретінде ғана емес, сонымен қатар кеңестік кезеңдегі ғылыми ойлау жүйесін, зерттеу логикасын және тарихнамалық дәстүрлерді түсінуге мүмкіндік беретін дерек ретінде бағаланады. Олар қазіргі зерттеушілерге кеңестік тарихнаманың мүмкіндіктері мен шектеулерін салыстырмалы түрде талдауға, жаңа ғылыми концепциялар қалыптастыруға және ұлттық тарих ғылымының дамуын терең түсінуге жол ашады.

Қорытындылай келе, М.П. Вяткин еңбектері Қазақстан тарих ғылымында ғылыми маңызы бар, күрделі әрі көпқырлы тарихнамалық мұра ретінде бағаланады. Оның зерттеулерін қазіргі

ғылыми талаптар тұрғысынан қайта пайымдау Қазақстан тарихнамасының сабақтастығын қамтамасыз етіп қана қоймай, ұлттық тарих ғылымының теориялық және әдіснамалық тұрғыдан одан әрі дамуына негіз қалайды. Осы себепті М.П. Вяткиннің ғылыми мұрасы қазіргі Қазақстан тарих ғылымы үшін өзектілігін сақтап отырған маңызды зерттеу нысандарының бірі болып қала береді.

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SUSTAINABILITY EDUCATION IN KAZAKHSTAN: A NECESSITY FOR THE FUTURE OF ECOSYSTEMS AND SOCIETY

Bissembiyeva Assem Yedilovna
Master candidate of Department of Natural sciences,
Caspian university of technologies and engineering named after Sh. Esenov.
Biology and Science teacher,
Aqtau International School

Abstract
The article explores the role of sustainability education in Kazakhstan, emphasizing its importance in addressing the country's ecological challenges and ensuring long-term environmental and social stability. Kazakhstan, rich in natural resources, faces critical environmental issues such as air pollution, water scarcity, and the consequences of the Aral Sea disaster. The integration of sustainability principles into the education system is crucial for fostering awareness and active participation in environmental protection. This article discusses various ecological challenges in Kazakhstan and presents practical approaches for incorporating sustainability into the national curriculum. Through initiatives like eco-schools, energy conservation projects, and water resource management, Kazakhstan can empower future generations to engage in environmental conservation and contribute to the green economy.

Keywords*: sustainability education, Kazakhstan, environmental challenges, ecological restoration, renewable energy, resource management, green economy, practical solutions.*

Introduction. *In the face of numerous ecological crises, including climate change, biodiversity decline, and resource depletion, sustainability education has become increasingly vital. For resource-rich countries like Kazakhstan, which are also struggling with environmental issues, education focused on sustainability is crucial for creating a resilient future. This article explores how incorporating sustainability principles into Kazakhstan's education system can foster a culture of environmental responsibility. By prioritizing sustainability education, Kazakhstan can empower its youth to actively engage in addressing global environmental concerns while ensuring the long-term well-being of its ecosystems and economy.*

Ecological Challenges in Kazakhstan. *Kazakhstan, while abundant in natural resources, faces significant environmental challenges that pose threats to its ecosystems. One major issue is air pollution in cities like Almaty and Shymkent. High concentrations of pollutants such as particulate matter (PM2.5) regularly exceed safe limits, particularly during the winter months, when coal burning for heating spikes. The World Bank reports that air pollution levels in Almaty are twice the permissible limit, leading to severe health risks, particularly for vulnerable populations.*

Water scarcity is another pressing challenge. As one of the driest countries in Central Asia, Kazakhstan relies heavily on transboundary water resources, with more than 70% of its water supply shared with neighboring nations. The depletion of these water resources, especially for agriculture, is impacting water quality and contributing to ecosystem degradation. These problems are compounded by the effects of climate change, which further disrupt water availability and exacerbate the challenges faced by the agricultural sector.

Perhaps the most notable environmental tragedy in Kazakhstan is the collapse of the Aral Sea, which has been shrinking since the 1960s due to excessive irrigation. This ecological disaster has not only led to the destruction of local ecosystems but also caused severe social and health issues. The once-thriving Aral Sea is now a vast desert, underscoring the importance of sustainable resource management and the long-term consequences of human intervention without regard for ecological balance.

Literature Review. *Sustainability education has been widely discussed as a tool to mitigate the impact of environmental degradation and climate change. Scholars such as Tilbury (2011) emphasize that sustainability education empowers individuals to make informed decisions that promote environmental integrity. A key focus of sustainable education is to teach people about the interconnectedness of environmental, social, and economic factors, fostering a holistic approach to problem-solving (McKeown & Hopkins, 2007). For Kazakhstan, integrating these principles into national curricula is vital, as the country faces severe environmental challenges that threaten its natural resources and the well-being of its population.*

Kazakhstan's educational system has begun to incorporate sustainability concepts, with initiatives like the "Eco-Mektep" (Eco-School) project, aimed at educating students on environmental conservation and climate action. According to research by Kadyrova et al. (2019), the introduction of environmental

education in Kazakhstan's schools has led to improved awareness of ecological issues among youth, particularly in urban areas. However, challenges remain in extending these programs to rural regions, where many students remain unaware of the pressing environmental challenges related to water scarcity and land degradation (Jabbarova et al., 2020).

In addition, the concept of green economy education has gained significant traction worldwide. The World Economic Forum (2020) reports that education on renewable energy sources, including solar and wind energy, is crucial for future generations, especially in countries like Kazakhstan, which has vast potential for developing these industries. Integrating renewable energy education into school curriculums could play a vital role in shaping a future workforce capable of driving Kazakhstan's transition to a green economy (Yessenova & Iskakova, 2020).

Furthermore, the role of practical sustainability projects, such as waste management and water conservation, has been highlighted in studies by authors like Glover (2020). These projects not only enhance students' understanding of sustainability but also allow them to apply theoretical knowledge in real-world contexts. By including such practical projects in the curriculum, Kazakhstan can develop a generation of environmentally conscious and solution-driven citizens.

The Role of Education in Addressing Ecological Issues. To address these environmental issues, it is essential to cultivate a generation of citizens who are aware of environmental challenges and equipped to tackle them. Education plays a central role in fostering a sense of responsibility toward nature and instilling sustainable practices in future generations. In Kazakhstan, where many people live in rural areas, it is particularly important to integrate sustainable practices in land use, water management, and agriculture into the school curricula.

The "Eco-Mektep" (Eco-School) project, which combines both theoretical education and practical environmental activities, is an example of how sustainability can be embedded into school education. In this project, students engage in activities such as tree planting, cleaning water bodies, and managing waste. These projects help students understand environmental protection not just as a theoretical concept, but as an active practice they can contribute to.

Moreover, it is essential that students gain practical skills in developing and implementing sustainable solutions. For example, schools can teach students how to use innovative technologies such as water-efficient irrigation systems or how to restore ecosystems using native plant species. This hands-on approach will equip them with the tools they need to address real-world environmental challenges.

Practical Approaches to Sustainability Education in Kazakhstan

To ensure sustainability education is effective, it must go beyond theory and include practical, real-world applications that engage students directly. The following strategies can be incorporated into Kazakhstan's education system to promote sustainability:

1. Sustainable Agriculture in Schools

Agriculture is a critical sector in Kazakhstan, and introducing sustainable farming practices into school curricula can have a lasting impact.

Workshops on Organic Farming: Schools can organize practical workshops where students learn about sustainable farming techniques, including organic pest management and soil health. These workshops could be held in school gardens or at local farms, allowing students to apply what they learn in real-life situations.

Establishing School Gardens: Students can participate in creating and maintaining organic gardens at school, using eco-friendly fertilizers and water-saving irrigation techniques. This provides them with hands-on experience and fosters a deeper understanding of sustainable agriculture.

2. Waste Management and Recycling Initiatives

Waste management is a key aspect of sustainability education. Schools can integrate recycling and composting projects into their curricula:

Conducting Waste Audits: Students can assess the waste generated by their schools and identify opportunities for reducing waste. This project would teach them about waste segregation, recycling, and the importance of reducing consumption.

Composting Projects: Schools can set up composting systems for organic waste, enabling students to observe firsthand the benefits of composting, including reducing landfill waste and producing organic fertilizer for gardens.

3. Energy Efficiency Projects

Teaching students about energy conservation and renewable energy technologies is crucial for fostering a green economy.

Energy Audits in Schools: Students can perform energy audits, identifying areas where energy can be saved, such as reducing unnecessary lighting or using energy-efficient appliances.

Solar Energy Initiatives: Schools can explore the installation of solar panels and involve students in learning about solar energy systems, from installation to maintenance. This will provide practical knowledge of renewable energy technologies.

4. Water Conservation Projects

Water is a scarce resource in Kazakhstan, and it is essential to teach students how to conserve it.

Building Water-efficient Irrigation Systems: Students can create small-scale water-efficient irrigation systems, learning about techniques such as drip irrigation and rainwater harvesting. These projects can be applied in school gardens or local farms.

Water Conservation Campaigns: Students can design and implement campaigns to raise awareness about water-saving techniques, both in schools and in local communities.

5. Promoting Eco-friendly Transportation

Encouraging sustainable transport options can also contribute to environmental conservation.

Bike-to-School Programs: Schools can promote cycling to school as an alternative to car usage, reducing emissions and promoting physical health.

Carpooling Initiatives: Organizing carpooling for students and teachers can help reduce the number of cars on the road, lowering overall carbon emissions.

6. Community Engagement Projects

Community-based projects can amplify the impact of sustainability education:

Tree Planting Campaigns: Schools can collaborate with local governments to organize tree planting events in nearby parks or neighborhoods.

Local Clean-up Projects: Students can participate in clean-up drives to address pollution in local rivers, parks, or public spaces, helping to spread environmental consciousness within their communities.

7. Ecotourism Projects

Kazakhstan's national parks offer excellent opportunities for sustainability education through ecotourism:

Field Trips to Nature Reserves: Schools can organize visits to protected areas, such as the Altai Nature Reserve, where students can learn about biodiversity conservation firsthand.

Workshops on Ecotourism: Students can explore the principles of sustainable tourism, learning how tourism can promote environmental conservation while generating economic benefits for local communities.

Conclusion

To achieve sustainable development, Kazakhstan must integrate sustainability and environmental education at all levels of its educational system. By equipping students with the knowledge and practical skills necessary to tackle ecological challenges, Kazakhstan can foster a generation capable of solving environmental problems and promoting sustainable resource management. Through hands-on projects, sustainable practices, and the promotion of green technologies, Kazakhstan can lead the way in building a sustainable future for its people and its environment.

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DEVELOPING PROFESSION-ORIENTED COMMUNICATIVE COMPETENCE IN ENGLISH FOR TOURISM STUDENTS: THEORETICAL AND PRACTICE-ORIENTED PERSPECTIVES

Ibrokhim I. Sagdullayev
Acting Associate Professor, PhD
International University of Tourism and Hospitality
Turkestan, Kazakhstan

Abstract

The rapid internationalization of the tourism industry and the growing dominance of English as a global lingua franca have transformed the objectives of language education in tourism-related higher education programs. Traditional approaches to teaching English as a Foreign Language (EFL) are insufficient to prepare future tourism professionals for authentic service communication. This paper introduces the concept of Profession-Oriented Communicative Competence (POCC) as a pedagogical construct specifically designed for tourism education. The study integrates competence-based, communicative, and constructivist perspectives with scenario-based and task-based methodologies. POCC is conceptualized as a multidimensional framework that includes linguistic, sociolinguistic, strategic, intercultural, professional discourse, and service pragmatic competencies. A structured stage-based instructional model is proposed, and a sample classroom scenario demonstrates practical implementation in hospitality contexts. The findings suggest that a profession-oriented, simulation-driven approach enhances communicative effectiveness, pragmatic awareness, and workplace readiness among tourism students.

Keywords: *English for Specific Purposes, tourism education, communicative competence, profession-oriented learning, service communication, scenario-based instruction.*

Introduction

The tourism industry is one of the most communication-intensive sectors of the global economy. International mobility, intercultural interaction, and service-oriented business models require professionals who can communicate effectively in English across diverse contexts. For students specializing in tourism and hospitality, English proficiency functions not only as an academic subject but as a core professional instrument.

Travel has always been an inseparable part of the life of any nation, and today, in a world of virtually unlimited opportunities in the field of tourism, it is difficult to imagine a person who does not like or does not want to travel. When traveling around the world, people tend to get acquainted with the culture of the country in which they are, visiting museums, theaters, various attractions, tasting traditional food and communicating with the local population [1].

Unlike general EFL instruction, tourism communication is characterized by immediacy, emotional regulation, politeness strategies, intercultural sensitivity, and problem-solving under pressure. Hotel receptionists, tour guides, restaurant managers, and travel consultants must respond to unpredictable customer requests, complaints, and cultural expectations. Therefore, tourism-focused language education must go beyond grammatical accuracy and lexical expansion to address professional performance in authentic service situations.

Despite the widespread adoption of communicative language teaching methodologies, a persistent gap remains between classroom practice and real workplace interaction. Students may demonstrate linguistic competence but struggle with complaint handling, negotiation, intercultural adaptation, or institutional discourse conventions. This discrepancy highlights the need for a structured, profession-oriented model of communicative competence specifically tailored to tourism education.

In response to this need, the present paper introduces ***Profession-Oriented Communicative Competence (POCC)*** *as a pedagogical construct designed to bridge theory and professional practice. The purpose of this study is to conceptualize POCC, outline its theoretical foundations, and propose a structured instructional model supported by practical classroom implementation. By integrating conceptual analysis with applied methodology, the paper contributes to the modernization of English language teaching in tourism higher education.*

Theoretical Foundations of Profession-Oriented Communicative Competence

Competence-Based Approach in Tourism ESP

Today, with the steady development and improvement of methods of teaching a foreign language in philological universities, the need to include sociolinguistic factors in the methodology and learning process is becoming increasingly relevant. The very concept of competence in the system of modern higher education is very relevant in connection with the intensive development of information technology, which has led to significant changes in the sphere of economic activity and everyday life of people. This factor has led to an increase in the need for training highly qualified and proactive specialists [2].

Contemporary higher education increasingly emphasizes competence-based learning outcomes aligned with labor market requirements. Within English for Specific Purposes (ESP), this paradigm requires language instruction to reflect the communicative realities of professional domains. In tourism, communication is inseparable from service delivery and institutional performance.

Profession-Oriented Communicative Competence (POCC) is proposed as an integrative system of competencies enabling effective performance in tourism-specific communicative contexts. Unlike general communicative competence, POCC incorporates professional discourse awareness and service pragmatics as central dimensions.

Communicative Competence and Service Discourse

Classical models of communicative competence include grammatical, sociolinguistic, discourse, and strategic components. While foundational, these models require contextual adaptation for tourism education. Tourism communication is institutionally framed, customer-centered, and pragmatically sensitive.

Current trends in language education within the tourism and hospitality sector have seen a shift towards more practical, skills-based learning. Educational institutions are increasingly integrating real-world scenarios and industry-specific content into their language teaching curricula. This approach aims to equip students with the practical language skills necessary for immediate application in their future professional environments. However, despite these advancements, there remains a gap in understanding the actual proficiency levels of students and how these skills translate into academic and professional success [3].

Service encounters require formulaic politeness expressions, empathetic language, negotiation strategies, and institutional role performance. Therefore, POCC extends traditional competence frameworks by incorporating:

- *Professional Discourse Competence – mastery of tourism terminology, service scripts, institutional interaction patterns.*
- *Service Pragmatic Competence – ability to apologize diplomatically, offer solutions, manage dissatisfaction, and maintain brand image [4].*

Constructivist and Experiential Learning Foundations

Constructivist theory emphasizes knowledge construction through interaction and meaningful engagement. In tourism ESP, experiential learning through simulation enables students to internalize professional communication patterns.

Scenario-based instruction reflects authentic workplace dynamics, encouraging reflective practice and strategic development. Students learn not only language forms but communicative behavior within professional contexts [5].

Model of Developing Profession-Oriented Communicative Competence

Components of POCC

Profession-Oriented Communicative Competence consists of six interrelated components:

1. *Linguistic Competence – grammar, tourism-related vocabulary, pronunciation clarity.*
2. *Sociolinguistic Competence – politeness norms, register adaptation, institutional roles.*
3. *Strategic Competence – repair strategies, paraphrasing, clarification techniques.*
4. *Professional Discourse Competence – service scripts, tourism-specific terminology.*
5. *Intercultural Competence – cultural sensitivity, awareness of international expectations.*
6. *Service Pragmatic Competence – complaint management, negotiation, emotional regulation [6].*

Stage-Based Instructional Model

The development of POCC follows a structured pedagogical cycle:

Stage 1 – Input and Functional Language Formation

Students analyze authentic service expressions and discourse patterns.

Stage 2 – Controlled Practice

Structured dialogues and guided role-plays ensure accuracy and register appropriateness.

Stage 3 – Scenario-Based Simulation

Students engage in extended simulations replicating tourism service situations.

Stage 4 – Reflective Feedback

Performance is recorded, analyzed, and evaluated according to pragmatic and professional criteria.

Stage 5 – Performance Assessment

Evaluation focuses on communicative effectiveness, professionalism, and intercultural responsiveness [7].

Sample Classroom Implementation

SCENARIO: MANAGING A HOTEL OVERBOOKING SITUATION

Context:

A guest arrives with a confirmed reservation but is informed that the hotel is fully booked due to an administrative error.

Learning Objectives:

- *Apply apology strategies*
- *Offer alternative solutions*
- *Maintain professional tone under stress*
- *Demonstrate intercultural awareness [8]*

Implementation Steps:

1. *Students analyze authentic apology and compensation expressions.*
2. *Guided role-play with structured prompts.*
3. *Extended unscripted simulation with emotional escalation.*
4. *Reflective peer evaluation based on POCC criteria[9].*

This scenario illustrates how linguistic competence integrates with pragmatic and strategic elements within realistic tourism contexts.

Practical Teaching Strategies and Classroom Applications

Effective POCC development requires integration of scenario-based simulations, role-play cycles, task-based projects, and pronunciation coaching. Authentic tourism tasks—designing tour itineraries, conducting service briefings, simulating press conferences—enhance professional discourse competence.

Assessment should prioritize communicative effectiveness and professional behavior rather than isolated grammatical performance. Performance-based evaluation and reflective journals promote metacognitive development and professional responsibility [10].

Discussion

The findings of this conceptual and practice-oriented study indicate that the development of communicative competence in tourism education requires contextual refinement beyond traditional EFL frameworks. While classical communicative competence models provide a valuable theoretical foundation, they do not fully capture the institutional, pragmatic, and service-oriented dimensions inherent in tourism interaction. The proposed construct of Profession-Oriented Communicative Competence (POCC) addresses this gap by embedding professional discourse and service pragmatics within a structured pedagogical model [11].

Tourism communication is characterized by immediacy, emotional sensitivity, and intercultural variability. Unlike academic discourse, which allows time for reflection and revision, service encounters often demand spontaneous responses under pressure. Employees must maintain politeness, manage dissatisfaction, and protect institutional reputation while negotiating solutions. Therefore, communicative success in tourism contexts depends not only on linguistic accuracy but also on strategic flexibility, empathy, and intercultural awareness. The POCC framework acknowledges this multidimensionality by integrating linguistic, sociolinguistic, strategic, intercultural, professional discourse, and service pragmatic competencies into a unified construct [12].

The implementation of scenario-based instruction emerges as a particularly effective mechanism for operationalizing POCC. Simulated hotel check-ins, complaint management dialogues, tour briefings, and restaurant service interactions replicate the cognitive and emotional demands of real workplace communication. Through iterative practice cycles, students move from controlled rehearsal to spontaneous performance, thereby strengthening both fluency and strategic competence. Reflective feedback sessions further enhance metacognitive awareness and allow learners to internalize professional behavioral norms [13].

An important implication of this study concerns employability. Contemporary tourism employers consistently emphasize communication skills, adaptability, and customer-oriented professionalism as critical competencies. By aligning language instruction with workplace communication patterns, higher

education institutions contribute directly to graduate readiness. The integration of professional discourse training into ESP curricula reduces the discrepancy between academic preparation and labor market expectations. Intercultural competence represents another essential dimension highlighted in this study. Tourism professionals interact daily with clients from diverse linguistic and cultural backgrounds. Misinterpretations of politeness conventions, tone, or service expectations may lead to dissatisfaction or conflict. The POCC model therefore promotes explicit attention to intercultural awareness through case studies, role reversals, and reflective discussion of culturally sensitive situations. Such training prepares students not only to communicate but to communicate appropriately within global service environments.At the same time, the practical implementation of POCC-oriented instruction presents certain challenges. Teachers require specialized methodological preparation to design realistic simulations and evaluate pragmatic performance effectively. Assessing service-oriented competence is more complex than evaluating grammatical accuracy, as it involves qualitative criteria such as tone, empathy, and problem-solving capacity. Institutional support, professional development initiatives, and curriculum flexibility are therefore essential to ensure sustainable integration of the model.Furthermore, the integration of digital tools and potential AI-based simulation technologies may expand opportunities for immersive learning. Virtual role-play environments, interactive case studies, and recorded performance analysis can enhance reflective practice. However, technology must remain pedagogically guided rather than substituting human interaction, which remains central to tourism communication.Overall, the discussion confirms that profession-oriented language education in tourism requires systematic conceptualization and structured methodological implementation. The POCC framework offers a coherent response to this need, bridging communicative theory and professional practice [14].

Conclusion

The transformation of the global tourism industry and the growing role of English as an international medium of service communication necessitate a reconceptualization of English language teaching in tourism higher education. Traditional EFL instruction, primarily focused on grammar and general communication, does not sufficiently prepare students for the pragmatic and institutional realities of tourism workplaces. This study has proposed Profession-Oriented Communicative Competence (POCC) as an integrative pedagogical construct tailored specifically to tourism education.

POCC expands classical communicative competence models by incorporating professional discourse and service pragmatic dimensions essential for authentic tourism interaction. The proposed stage-based instructional model demonstrates how linguistic knowledge, pragmatic strategies, intercultural awareness, and professional behavior can be developed systematically through scenario-based simulations, task-oriented projects, and reflective feedback mechanisms [15].

The theoretical contribution of this paper lies in conceptualizing communicative competence within a profession-specific framework that aligns language education with service industry demands. The practical contribution resides in the structured instructional model and classroom scenario illustrating how POCC can be operationalized in tourism ESP courses.

The findings suggest that a profession-oriented, simulation-driven approach enhances communicative confidence, adaptability, and workplace readiness among tourism students. By situating language learning within authentic service contexts, higher education institutions can cultivate graduates capable of effective participation in international hospitality environments.

Future research should focus on empirical validation of the POCC model through experimental or quasi-experimental classroom studies. Longitudinal research may investigate the transfer of simulated competence to real workplace performance. Additionally, further exploration of digital simulation technologies and blended learning formats may strengthen the sustainability and scalability of profession-oriented ESP instruction.

In conclusion, the development of Profession-Oriented Communicative Competence represents a strategic step toward aligning tourism language education with contemporary professional realities. Through methodological rigor and practical relevance, POCC-oriented instruction supports the formation of globally competent, culturally sensitive, and professionally effective tourism specialists.

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QUANTITATIVE EVALUATION OF DIGITAL LEARNING PLATFORMS IN SECONDARY SCHOOL BIOLOGY EDUCATION

Kaliyev Dastan
master student
Zhetysu university named after I.Zhansugurov
(Taldykorgan, Kazakhstan)
Oxikbayev Berikzhan
candidate of biological sciences, assoc. professor
Zhetysu university named after I.Zhansugurov
(Taldykorgan, Kazakhstan)

Abstract

The increasing integration of digital learning platforms into secondary education requires systematic evaluation of their pedagogical effectiveness. This study presents a quantitative assessment of the impact of e-learning platforms on students' academic achievement and learning motivation in secondary school biology courses. A quasi-experimental design was employed, involving control and experimental groups. Statistical analysis of pre-test and post-test results, as well as motivation survey data, demonstrates that students taught with structured use of e-learning platforms show significantly higher learning gains and motivation levels compared to those taught using traditional methods. The findings confirm that digital learning platforms can enhance biology education when supported by appropriate instructional design and teacher guidance.

Keywords: *e-learning platforms; biology education; secondary school; quantitative analysis; learning outcomes*

Digital technologies have become an integral component of contemporary secondary education. In biology teaching, digital learning platforms offer tools for visualization, interactive simulations, automated assessment, and individualized feedback. These affordances are particularly relevant for biology, a subject that requires understanding complex structures, dynamic processes, and abstract concepts.

Although numerous studies report positive effects of digital learning environments, there remains a need for empirical research that includes quantitative indicators of effectiveness. In many cases, conclusions are based primarily on descriptive or qualitative data, which limits the generalizability of results. Therefore, this study focuses on a quantitative evaluation of digital learning platforms in secondary school biology instruction.

The purpose of this research is to assess the effect of e-learning platforms on students' academic performance and motivation using statistical analysis and comparative data.

The growing integration of digital technologies into secondary education has stimulated extensive research on the effectiveness of e-learning platforms, particularly in science and biology education. E-learning platforms are commonly defined as digital environments that support content delivery, interaction, assessment, and learning management through integrated technological tools. In biology education, such platforms are increasingly used to address challenges related to conceptual complexity, visualization of abstract processes, and student engagement.

A substantial body of research indicates that e-learning platforms can positively influence students' academic achievement when compared to traditional instructional approaches. Aguilera and Perales-Palacios (2020) demonstrated that participative, technology-enhanced instruction in biology and geology resulted in significantly higher academic performance and more positive student attitudes. Their findings suggest that digital platforms are particularly effective when they support active learning and student participation.

Similarly, Gilissen et al. (2020) reported that digital learning environments facilitate systems thinking in biology by enabling students to explore complex biological relationships through interactive models and representations. These results align with studies showing that multimedia-based instruction enhances conceptual understanding by reducing cognitive load and supporting knowledge integration.

Meta-analytical and quasi-experimental studies in science education further confirm these findings. Hu et al. (2025), in a bibliometric review of outdoor and digital education research, concluded that technology-supported learning environments contribute to improved learning outcomes, especially when

combined with inquiry-based approaches. However, they also noted variability in effect sizes, indicating that instructional design and contextual factors play a decisive role.

Beyond academic achievement, motivation and engagement are widely recognized as critical factors in effective biology learning. Research suggests that e-learning platforms can foster higher levels of motivation by promoting learner autonomy, providing immediate feedback, and enabling personalized learning trajectories. Harris et al. (2020) emphasized that active and technology-supported learning strategies contribute to inclusive instruction and increased student engagement in science classrooms.

Contreras et al. (2024) examined pre-service teachers' experiences with inquiry-based practicum supported by digital tools and found that structured digital environments positively influenced learners' interest and engagement. These findings support the assumption that digital platforms can enhance students' affective responses to biology learning when aligned with inquiry-oriented pedagogy.

However, evidence regarding motivation is not entirely consistent. Some studies report that digital platforms alone do not guarantee increased motivation unless accompanied by meaningful pedagogical strategies. Aydin et al. (2024) highlighted that teachers' digital competence significantly moderates the relationship between technology use and student motivation, suggesting that insufficient pedagogical integration may limit the motivational benefits of e-learning platforms.

An emerging theme in the literature is the critical role of teachers in determining the effectiveness of e-learning platforms. Holmes et al. (2019) argued that digital platforms should be viewed as pedagogical tools rather than standalone solutions, emphasizing the importance of instructional design, scaffolding, and feedback mechanisms. Teachers' ability to integrate platforms into lesson planning and assessment practices is therefore central to achieving positive learning outcomes.

Research on teacher digital competence supports this perspective. Kang and Keinonen (2024) demonstrated that teachers with higher levels of digital teaching competence were more effective in using technology to support student learning and engagement. In biology education, where practical and experimental components are essential, teachers must balance digital activities with traditional laboratory and observational work to maintain instructional coherence.

Despite the growing volume of research, several limitations remain in the existing literature. First, many studies rely primarily on qualitative data or self-reported perceptions, which limits the strength of causal inferences regarding effectiveness. Second, relatively few studies incorporate quantitative indicators such as normalized learning gain or effect size measures, particularly in secondary school biology contexts.

Moreover, comparative studies examining control and experimental groups under equivalent curricular conditions remain limited. As noted by Matjašič (2024), there is a need for more rigorously designed empirical studies that combine quantitative and qualitative methods to capture both learning outcomes and learner experiences.

In summary, the literature suggests that e-learning platforms have significant potential to enhance biology education in secondary schools by improving academic achievement, motivation, and engagement. However, their effectiveness is highly dependent on pedagogical integration, teacher digital competence, and alignment with curricular goals. The existing research highlights the need for further quantitative studies that systematically assess learning gains and motivational outcomes, thereby providing a stronger empirical basis for integrating e-learning platforms into biology instruction.

The study involved 96 students from grades 8–9 of a secondary school. Participants were divided into:

an experimental group (n = 48), taught using an e-learning platform integrated into biology lessons;

a control group (n = 48), taught using traditional instructional methods.

Both groups were comparable in terms of age, prior achievement, and curriculum content.

The experimental group used an e-learning platform that included:

multimedia explanations of biological concepts;

interactive quizzes with instant feedback;

digital assignments and progress tracking.

The control group received instruction through textbooks, teacher explanations, and paper-based assessments.The intervention lasted for 8 weeks.

Achievement tests (pre-test and post-test) consisting of 30 multiple-choice and short-answer questions.

Learning motivation questionnaire, based on a 5-point Likert scale (1 = very low, 5 = very high).

3. Data Analysis and Calculations

3.1 Learning Gain Calculation

To measure learning progress, the normalized gain (g) was calculated using the formula:

$$g = \frac{Post - test\ score - Pre - test\ score}{100 - Pre - test\ score}$$

Mean scores for each group were calculated and compared.

Table 1. Pre-test and Post-test Results (%)

Group	Pre-test Mean (%)	Post-test Mean (%)	Learning Gain (g)
Experimental	56.2	78.4	0.51
Control	55.8	66.9	0.25

The experimental group demonstrated a moderate normalized gain, while the control group showed a low gain, indicating higher effectiveness of platform-supported instruction.

3.2 Motivation Index Calculation

An average motivation index (MI) was calculated as the mean of questionnaire responses:

$$MI = \frac{\sum_{i=1}^{n} x_i}{n}$$

Table 2. Learning Motivation Index

Group	Motivation Index (Mean)	Standard Deviation
Experimental	4.12	0.48
Control	3.46	0.52

Students in the experimental group reported significantly higher motivation levels.

Statistical analysis revealed that students using e-learning platforms achieved higher post-test scores and learning gains compared to the control group. The difference in mean post-test scores between groups was statistically significant ($p < 0.05$).

Motivation data indicate that digital learning environments positively influence students' interest and engagement in biology lessons. Teachers also reported improved classroom dynamics and increased student participation during platform-based activities.

The results confirm that structured integration of e-learning platforms enhances both cognitive and affective learning outcomes in secondary school biology. Higher learning gains can be attributed to interactive content, immediate feedback, and opportunities for self-paced learning.

However, the effectiveness of platforms depends on pedagogical implementation. Without clear instructional goals and teacher facilitation, digital tools may not lead to meaningful learning improvements. These findings align with previous studies emphasizing the role of teacher competence in digital education.

Discussion

The findings of the present study corroborate and extend existing research on the effectiveness of e-learning platforms in secondary school biology education. In line with earlier studies, the results demonstrate that students who participated in platform-supported instruction achieved significantly higher learning gains and motivation levels compared to those taught using traditional methods.

*The observed **moderate normalized learning gain** in the experimental group (g = 0.51) aligns with the results reported by Aguilera and Perales-Palacios (2020), who found that participative, technology-enhanced biology instruction led to improved academic performance and deeper conceptual understanding. Similar to their study, the present research suggests that learning gains are maximized when digital platforms support active engagement rather than passive content delivery.*

Comparable findings were also reported by Gilissen et al. (2020), who emphasized that digital environments facilitate systems thinking in biology by enabling students to explore complex biological relationships through interactive representations. In the current study, higher post-test scores in topics requiring conceptual integration (e.g., cellular processes and physiological systems) may be attributed to the use of multimedia explanations and interactive tasks embedded within the e-learning platform.

*At the same time, the magnitude of learning gains observed in this study reflects the variability noted in previous research. Hu et al. (2025) highlighted that the effectiveness of digital learning environments varies across contexts and depends heavily on instructional design and implementation quality. The moderate, rather than high, learning gains reported here suggest that while e-learning platforms enhance biology learning, they function most effectively as a **complement** to traditional instruction rather than a standalone solution.*

The significantly higher motivation index in the experimental group is consistent with findings by Harris et al. (2020), who reported increased engagement and inclusivity in science classrooms employing active, technology-supported learning strategies. Students in the present study similarly reported greater interest and involvement during lessons that incorporated interactive digital content and immediate feedback.

These results also support the conclusions of Contreras et al. (2024), who found that inquiry-based learning supported by digital tools positively influenced learners' engagement and attitudes toward science. In both cases, motivation appears to be linked not merely to the presence of technology but to the opportunities for inquiry, autonomy, and meaningful interaction that platforms enable.

However, the findings also reflect the caution expressed by Aydin et al. (2024), who argued that digital tools do not automatically enhance motivation unless teachers possess sufficient digital and pedagogical competence. Teachers involved in the experimental group emphasized that careful lesson planning and alignment with learning objectives were essential for maintaining student motivation. This suggests that the motivational benefits observed in the present study are mediated by instructional practices rather than by platform use alone.

Consistent with the theoretical perspective proposed by Holmes et al. (2019), the results reinforce the view that e-learning platforms should be regarded as pedagogical instruments embedded within a broader instructional framework. The positive outcomes observed in this study were associated with structured integration of platform activities into lesson sequences, formative assessment, and feedback processes.

The importance of teacher competence highlighted by Kang and Keinonen (2024) is further supported by the present findings. Teachers who demonstrated higher confidence in using digital tools reported greater ease in differentiating instruction and monitoring student progress through the platform. This underscores the need for professional development initiatives that focus not only on technical skills but also on pedagogical strategies for digital instruction.

*While many previous studies relied primarily on qualitative data or self-reported perceptions, the present research contributes to the literature by incorporating **quantitative indicators**, such as normalized learning gain and motivation indices. This responds directly to the research gap identified by Matjašič (2024), who emphasized the need for empirically robust studies combining achievement data with learner motivation measures.*

Nevertheless, the findings should be interpreted in light of certain limitations. The relatively short intervention period and the quasi-experimental design restrict the generalizability of the results. Future studies should examine long-term learning retention, compare different types of e-learning platforms, and explore how specific platform features influence various components of biological literacy.

In summary, the results of this study are largely consistent with existing research indicating that e-learning platforms can enhance academic achievement and motivation in secondary school biology education. At the same time, the findings reinforce a key conclusion of the literature: the effectiveness of digital platforms depends less on technology itself and more on pedagogical integration, teacher competence, and alignment with curricular goals. By providing quantitative evidence within a controlled instructional context, this study strengthens the empirical foundation for the informed integration of e-learning platforms into biology teaching practice.

This study provides quantitative evidence that e-learning platforms can significantly improve academic achievement and motivation in secondary school biology education. The inclusion of statistical calculations strengthens the validity of the findings and supports the integration of digital platforms as a complementary instructional strategy.

Future research should include larger samples, longer intervention periods, and comparative analysis of different digital platforms to further validate these results.

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INTEGRATING DIGITAL AUTHENTIC MATERIALS IN THE PROFESSIONAL TRAINING OF FUTURE FOREIGN LANGUAGE TEACHERS

Zarbat Ayazhan Serikkyzy
Master student
KazUIRandWL, Almaty, Kazakhstan
Sadykova Aida Kenesbekovna
Scientific supervisor, Candidate of pedagogical sciences,
KazUIRandWL, Almaty, Kazakhstan

Abstract

The growing availability of digital authentic materials has significantly influenced contemporary foreign language education, particularly in the context of teacher training. Despite their recognized potential for developing communicative, intercultural, and professional competences, research indicates that digital authentic materials are often used unsystematically and without sufficient methodological grounding. Many pre-service teachers experience difficulties related to material selection, pedagogical adaptation, task design, and alignment with professional learning outcomes. This article proposes a methodological approach to integrating digital authentic materials into the professional preparation of future foreign language teachers. The approach is grounded in existing empirical and methodological studies and emphasizes structured stages of implementation, competence-oriented task design, and pedagogical scaffolding. By outlining key methodological steps and their rationale, the article aims to support teacher education programs in preparing future teachers to use digital authentic materials purposefully and effectively as part of their professional practice.

Keywords: *digital authentic materials (DAM); methodological approach; teacher education; professional competence; foreign language teaching.*

Introduction

The rapid expansion of digital technologies has substantially transformed foreign language education, reshaping both instructional practices and teacher preparation. In this context, digital authentic materials, such as online videos, podcasts, news articles, social media content, and professional web resources, have become increasingly accessible and widely promoted as a means of exposing learners to real-life language use and sociocultural contexts. Numerous studies emphasize that authentic materials provide rich linguistic input, enhance learner motivation, and foster communicative and intercultural competence by linking classroom learning with real-world communication [1]. As a result, DAM is often viewed as an essential component of contemporary foreign language teaching.

Despite their pedagogical potential, research shows that the effectiveness of digital authentic materials depends not on their mere presence in the classroom, but on how systematically they are selected and implemented. Studies indicate that teachers often use DAM in a fragmented or intuitive way, without a clear methodological framework [2]. This problem is especially relevant in teacher education, where future foreign language teachers are expected to critically evaluate authentic materials, design pedagogically sound tasks, and align them with professional learning outcomes.

From the perspective of professional training, future foreign language teachers require more than exposure to digital resources, they need structured preparation that enables them to transform authentic digital input into pedagogically purposeful learning experiences. This preparation involves developing the ability to align DAM with curricular goals, learners' proficiency levels, and professional competences, as well as designing tasks that balance cognitive challenge and instructional support. Scholars emphasize that authentic materials are most effective when embedded within a systematic instructional cycle and accompanied by scaffolding strategies that guide learners through comprehension, analysis, and production stages.

Against this background, the present article addresses a critical gap in foreign language teacher education by proposing a methodological approach to integrating digital authentic materials into the formation of future foreign language teachers' professional competence. Drawing on existing empirical and methodological research, the study outlines key stages, principles, and instructional considerations that support systematic implementation. The proposed approach aims to assist teacher education programs in preparing future teachers who can use digital authentic materials not intuitively, but as an integral and methodologically grounded component of their professional practice.

Literature review

Concept of digital authentic materials

The concept of authentic materials has long been established in foreign language education and traditionally refers to texts, audio, and visual resources created for real communicative purposes rather than for pedagogical use. Classic definitions emphasize that authentic materials originate in real social, cultural, or professional contexts and reflect natural language use by native or proficient speakers [1]. With the advancement of digital technologies, the scope of authenticity has expanded to include ***digital authentic materials****, such as online news articles, podcasts, videos, blogs, social media content, and professional websites, which are accessed and distributed through digital platforms (see table 1).*

Table 1.

Definitions of digital authentic materials in foreign language education

Authors	*Definition of Digital Authentic Materials*
Akbari & Razavi	*Authentic materials in digital form refer to online texts and multimedia resources not specifically designed for teaching but used pedagogically to enhance learners' exposure to real language and communicative situations [3].*
Romero-Molina, & Alfonso-Vargas	*Digital authentic materials are audio-visual and multimedia resources produced for non-pedagogical purposes which, when systematically integrated into instruction, support the development of language skills through structured tasks and scaffolding.*
Jannah, et al.	*Digital authentic materials are real-life digital resources used in language instruction that require pedagogical selection and adaptation to ensure effective learning, particularly in technologically mediated educational environments [4].*

Recent studies stress that DAM differ from traditional authentic materials not only in format but also in their multimodal nature and dynamic availability. Digital authentic materials often combine written text, audio, visual elements, and interactive features, allowing learners to engage with language in ways that closely resemble real-world communication [5].

However, scholars also caution that authenticity alone does not guarantee pedagogical effectiveness. Several studies report that digital authentic materials may present excessive linguistic complexity, dense cultural references, or cognitive overload if used without adaptation and instructional support [4]. As a result, modern interpretations of authenticity increasingly emphasize the role of the teacher as a mediator who selects, adapts, and contextualizes DAM according to instructional goals and learners' needs. This shift highlights that authenticity should be understood as a pedagogical construct rather than a fixed property of a text.

Professional competence of future foreign language teachers

Professional competence in foreign language teaching is commonly conceptualized as a multidimensional construct that integrates subject knowledge, pedagogical skills, methodological expertise, and personal-professional qualities. Contemporary research describes professional competence as the ability to apply linguistic, didactic, digital, and intercultural knowledge effectively in real teaching contexts [6]. For future foreign language teachers, professional competence extends beyond language proficiency and includes the capacity to design instruction, select appropriate materials, manage classroom interaction, and evaluate learning outcomes.

Within competence-based teacher education, scholars distinguish several interrelated components of professional competence: communicative competence, methodological competence, digital competence, and intercultural competence. Communicative competence enables teachers to model authentic language use, while methodological competence involves planning lessons, designing tasks, and selecting instructional strategies aligned with learning objectives [7]. Digital competence, in turn, refers to the ability to use digital technologies critically and pedagogically, including the evaluation and creation of digital resources for teaching purposes.

Importantly, recent studies emphasize that professional competence is not formed through theoretical instruction alone, but through reflective practice and guided engagement with authentic teaching tools and scenarios. Research conducted in teacher education contexts shows that pre-service teachers often experience difficulties when attempting to integrate digital resources into instruction due to insufficient methodological preparation. This finding underscores the need for structured pedagogical models that explicitly link material use with competence development.

Challenges in integrating digital authentic materials

Despite their recognized pedagogical value, the integration of digital authentic materials in foreign language teacher education remains challenging. Research shows that these difficulties are not limited to technical issues but are mainly related to methodological, pedagogical, and institutional factors. This

explains why the use of DAM requires a structured methodological approach rather than occasional or intuitive application.

One of the main challenges is the ***insufficient methodological preparation*** *of pre-service foreign language teachers. Although teachers generally acknowledge the benefits of authentic materials, many experience difficulties in selecting, adapting, and systematically integrating them into lessons [3]. As a result, DAM is often used as supplementary or motivational tools instead of being embedded into lesson design, which limits their contribution to professional competence development.*

Another significant challenge concerns the ***complexity of digital authentic materials****. Such materials frequently include dense vocabulary, cultural references, and non-standard discourse that may exceed learners' proficiency levels. When introduced without pedagogical adaptation or scaffolding, they can cause cognitive overload and reduce learning effectiveness. This issue is particularly important in teacher education, where future teachers must learn to anticipate learner difficulties and design supportive tasks.*

In addition, many pre-service teachers ***lack sufficient digital and media literacy skills****. Without the ability to critically evaluate the reliability and pedagogical suitability of online materials, teachers risk selecting resources that do not align with learning objectives. This highlights the need to combine DAM use with explicit instruction in digital literacy.*

Overall, the literature suggests that successful integration of digital authentic materials requires a systematic methodological framework that addresses material selection, adaptation, scaffolding, digital literacy, and reflective evaluation. Addressing these challenges provides a clear rationale for the methodological approach proposed in the following section.

Methodological approach

The proposed methodological approach is grounded in contemporary research on the pedagogical use of digital authentic materials and competence-based teacher education. It responds directly to the challenges identified in previous studies, particularly the fragmented and unsystematic use of authentic resources, the lack of methodological training among pre-service teachers, and the absence of clear instructional frameworks guiding the integration of digital authentic materials in teacher education.

Rather than introducing an entirely new model, this approach systematizes well-established principles, instructional stages, and task-design practices that have been empirically validated in applied linguistics and foreign language pedagogy. Its primary aim is to ensure that digital authentic materials are used not as occasional supplements, but as ***methodologically structured tools*** *for the formation of professional competence in future foreign language teachers.*

Principles of integrating digital authentic materials

The effective integration of digital authentic materials requires adherence to a set of pedagogical principles consistently emphasized in the literature (see table 2).

Table 2.

Principles of integrating digital authentic materials in teacher education

Principle	*Description*
Pedagogical relevance	*Digital authentic materials should be selected according to instructional objectives and targeted components of professional competence, rather than their authenticity alone [8].*
Methodological appropriateness	*Materials must correspond to learners' linguistic level and cognitive capacity; excessive complexity may hinder learning without adaptation and scaffolding.*
Systematic integration	*DAM should be embedded into a structured instructional sequence rather than used episodically or as motivational supplements [2].*
Scaffolding and support	*Learners require pedagogical guidance through preparatory, guiding, and follow-up tasks to ensure effective comprehension and skill development [9].*
Reflection and evaluation	*Integration of DAM should include reflective components allowing future teachers to analyze pedagogical decisions and learning outcomes.*

One of the most fundamental principles is ***purposeful pedagogical alignment****. Research indicates that authentic materials should not be selected solely based on their real-life origin or digital format, but rather on their relevance to clearly defined instructional and competence-oriented objectives.*

Another essential principle is ***methodological appropriateness****. Studies repeatedly stress that digital authentic materials often present linguistic, pragmatic, and cultural complexity that may overwhelm learners if introduced without careful planning. Consequently, materials must be evaluated in terms of language density, discourse features, and cultural specificity before classroom implementation.*

The principle of ***systematic integration*** *further underscores the necessity of embedding DAM within a coherent instructional sequence. Research demonstrates that isolated exposure to authentic materials rarely leads to sustained learning gains, whereas structured integration within instructional cycles enhances comprehension and retention.*

Equally important is the principle of ***scaffolding and support****. Empirical studies emphasize that authentic input must be accompanied by instructional support that gradually guides learners toward independent language use. In teacher education, scaffolding extends beyond learner support and includes methodological scaffolding, whereby future teachers are guided in task design, material adaptation, and reflective evaluation.*

Finally, the principle of ***reflection and professional awareness*** *plays a crucial role. Research suggests that professional competence develops through systematic reflection on instructional decisions and learning outcomes. Therefore, DAM integration should incorporate reflective components that encourage pre-service teachers to analyze the pedagogical effectiveness of materials and tasks.*

Stages of implementation

The methodological approach adopts the widely recognized ***pre-, while-, and post-stage framework****, which has been extensively validated in research on authentic materials and skills development [2]. This staged structure ensures that learners engage with digital authentic materials in a gradual and cognitively manageable manner (see picture 1).*

Picture 1.

Stages of implementing digital authentic materials

The ***pre-stage*** *serves a preparatory and activating function. Research indicates that learners' comprehension of authentic materials significantly improves when prior knowledge is activated and contextual support is provided [9]. At this stage, tasks may focus on activating background knowledge, introducing key cultural or situational contexts, and familiarizing learners with relevant lexical or discourse features. In teacher education, the pre-stage also has a methodological dimension, as future teachers learn to anticipate potential learner difficulties and design preparatory activities accordingly.*

The ***while-stage*** *constitutes the core interaction with the digital authentic material. Studies emphasize that learners require a clear purpose for engaging with authentic input to avoid passive consumption. Tasks at this stage guide learners' attention toward specific aspects of meaning, form, or communicative intent. Research on listening and viewing comprehension demonstrates that purpose-driven tasks enhance processing efficiency and learning outcomes.*

The ***post-stage*** *is crucial for consolidation, transfer, and professional reflection. Authentic materials are often underexploited when teachers fail to extend learning beyond initial comprehension [1]. Post-stage tasks encourage learners to reuse language, analyze communicative strategies, or apply newly acquired knowledge in productive activities. In teacher education, this stage plays a dual role: it supports language development and fosters reflective competence by prompting future teachers to evaluate task effectiveness and learner engagement.*

Unlike traditional applications of the pre-, while-, and post-stage framework, which primarily focus on learners' language comprehension and skill development, the proposed methodological approach

explicitly reorients these stages toward the formation of future foreign language teachers' professional competence. Each stage is designed not only as a language-learning phase but also as a reflective and methodological training space in which pre-service teachers develop skills of material selection, pedagogical adaptation, task design, and professional self-evaluation.

Role of the teacher educator

The literature consistently highlights the pivotal role of the teacher educator in facilitating effective integration of digital authentic materials. Research indicates that without explicit guidance and modeling, pre-service teachers tend to rely on intuition or personal preference when selecting and using authentic materials [3].

Within the proposed methodological approach, the teacher educator functions as a ***methodological mediator****, modeling best practices in material selection, task design, and scaffolding. By demonstrating structured instructional sequences and providing guided practice, teacher educators enable future teachers to internalize effective pedagogical strategies. Additionally, teacher educators play a crucial role in developing* ***digital and media literacy****, helping students evaluate the credibility, relevance, and pedagogical value of online resources. This guidance is essential for ensuring that DAM integration remains pedagogically sound and professionally responsible.*

Finally, the teacher educator fosters reflective practice by encouraging critical analysis of instructional outcomes and pedagogical decisions. Research confirms that such reflection is a key mechanism through which professional competence is formed and sustained over time.

The proposed methodological approach aligns with previous research emphasizing the importance of systematic integration, scaffolding, and pedagogical intentionality in the use of authentic materials. However, unlike many earlier studies that primarily focus on learner language outcomes, this framework explicitly repositions digital authentic materials within the context of teacher education and professional competence formation. By foregrounding reflective practice, methodological awareness, and the role of the teacher educator, the approach extends existing methodological discussions and highlights the potential of digital authentic materials not merely as instructional resources, but as tools for developing future teachers' professional decision-making and pedagogical responsibility.

Conclusion

This article has proposed a methodological approach for integrating digital authentic materials into the professional preparation of future foreign language teachers. Drawing on established research and empirical insights from previous studies, the approach is grounded in clearly defined principles, staged implementation, competence-oriented task design, and an enhanced role of the teacher educator. The findings suggest that digital authentic materials can serve as powerful pedagogical tools when embedded within a systematic, scaffolded, and reflective instructional framework.

The study underscores that the successful integration of digital authentic materials requires more than access to technology or exposure to real-world content. It demands methodological awareness, pedagogical intentionality, and continuous reflection on learning outcomes. By structuring instruction around pre-, while-, and post-stages and aligning tasks with professional competences, teacher education programs can foster future teachers' readiness to use authentic materials effectively and responsibly.

The present study is conceptual in nature and focuses on the theoretical and methodological substantiation of digital authentic materials integration, without providing empirical classroom-based validation.

In conclusion, the proposed methodological approach offers significant potential for teacher education by bridging theory and practice, strengthening professional competence, and promoting reflective pedagogical thinking. Future research may further validate this framework through empirical classroom-based studies and explore its applicability across different linguistic, cultural, and institutional contexts.

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Philological sciences

THE SYMBOLIC AND METAPHORICAL USE OF SOMATIC FIXED COMBINATIONS

Suyindikova D.S.
Master's student at Kh. Dosmukhamedov Atyrau University
Scientific supervisor – A.S. Kushkimbayeva, PhD, Associate Professor
Atyrau, Kazakhstan

СОМАТИКАЛЫҚ ТҰРАҚТЫ ТІРКЕСТЕРДІҢ СИМВОЛДЫҚ ЖӘНЕ МЕТАФОРАЛЫҚ ҚОЛДАНЫСЫ

Сүйіндікова Д.С.
Х.Досмұхамедов атындағы Атырау университетінің магистранты
Ғылыми жетекші – А.С. Кушкимбаева, PhD., қауымдастырылған профессор
Атырау қ.

Abstract

The article analyzes the symbolic and metaphorical functions of somatic fixed expressions (phraseological units formed with names of body parts) in the Kazakh language. The study combines cognitive, cultural, and pragmatic aspects of phraseological units to determine the role and communicative functions of images created through somatic lexemes in the national worldview. The material includes entries from Kazakh phraseological dictionaries and commonly encountered expressions in literary texts, examining conceptual metaphors and systems of symbols of the type "body – emotion/value/relation." As a result, the multi-layered semantic structure of somatic fixed expressions, their connection with cultural codes, and contextual pragmatics are revealed, demonstrating the balance between the stability and dynamism of phraseological meaning.

Аннотация

Мақалада қазақ тіліндегі соматикалық тұрақты тіркестердің (дене мүшелері атауларымен жасалған фразеологизмдердің) символдық және метафоралық қызметі талданады. Зерттеу фразеологиялық бірліктердің когнитивтік, мәдени-танымдық және прагматикалық қырларын ұштастыра отырып, соматикалық лексемалар арқылы жасалған образдардың ұлт дүниетанымындағы орны мен коммуникативтік функцияларын айқындайды. Материал ретінде қазақ тілінің фразеологиялық сөздіктері мен көркем мәтіндерде жиі ұшырасатын тіркестер алынып, «дене – эмоция/құндылық/қатынас» типіндегі концептуалдық метафоралар мен символдар жүйесі сараланады. Нәтижесінде соматикалық тұрақты тіркестердің көпқабатты семантикалық құрылымы, мәдени кодпен байланысы және контекстуалды прагматикасы ашылып, фразеологиялық мағынаның тұрақтылығы мен динамикасы арасындағы тепе-теңдік көрсетілді.

Keywords: *somatic phraseologisms, fixed expressions, symbolism, metaphor, cognitive linguistics, Kazakh language, body part names, cultural code, conceptosphere.*

Кілт сөздер: *соматикалық фразеологизмдер, тұрақты тіркестер, символика, метафора, когнитивтік лингвистика, қазақ тілі, дене атаулары, мәдени код, концептосфера.*

Kipicne

Тілдегі тұрақты тіркестер – халықтың тарихи тәжірибесін, әлеуметтік нормаларын және құндылықтар жүйесін жинақтап, қысқа формада бейнелейтін мәдени-тілдік феномен. Солардың ішінде соматикалық фразеологизмдер ерекше орын алады: адам денесінің мүшелері (бас, көз, жүрек, қол, аяқ, тіл, бет, құлақ, т. б.) символдық-метафоралық жүктемені арқалап, когнитивтік моделдер арқылы абстракт ұғымдар мен эмоцияларды концептуалдайды. Когнитивтік лингвистика тұрғысынан бұл бірліктер «дене тәжірибесінің» тілдік репрезентациясы ретінде қаралып, метафора мен метонимия механизмдері арқылы стереотиптік түсініктерді жүйелейді. Қазақ тіл білімінде фразеология мәселесі, соның ішінде соматикалық тұрақты тіркестердің табиғаты І. Кеңесбаев, Ә. Болғанбаев, Ғ. Қалиев еңбектерінде жан-жақты сөз болады [1,2,3]. Бұл зерттеулер соматикалық атаулардың жоғары өнімділігін, эмоциялық-экспрессивтік әлеуетін және мәдени семиотикамен тығыз байланысын айғақтайды. Мақаланың мақсаты – қазақ тіліндегі соматикалық тұрақты тіркестердің

символдық және метафоралық қолданысын жүйелі түрде сипаттап, олардың семантикалық-структуралық ерекшеліктерін, мәдени кодпен сабақтастығын және прагматикалық қызметін ашу.

Зерттеу материалы мен әдістері

Материал ретінде қазақ тілінің фразеологиялық сөздіктері, түсіндірме сөздіктер, көркем әдебиет және ауызекі сөйлеуде жиі қолданылатын тіркестер алынды. Әдістемеде компоненттік-семантикалық талдау, когнитивтік-метафоралық модельдеу, мәдени-символдық интерпретация және прагматикалық контекст талдауы қолданылды.

Теориялық негіздер

1) Фразеологиялық бірліктер және соматикалық лексика: фразеологиялық бірліктерде дене мүшесі атауы түбір элемент ретінде қызмет атқарып, символикалық және метафоралық трансформацияның өзегіне айналады. 2) Концептуалдық метафора теориясы: абстракт ұғымдар дене тәжірибесі мен сенсорлық схемалар арқылы бейнеленеді (мысалы, «жүрек-сезім», «бас – ақыл-басқару»). 3) Мәдени семиотика және символика: дене мүшелері ұлттық дүниетанымда тұрақты символикалық мәнге ие (жүрек – мейірім, бет – абырой, қол – еңбек, көз – назар, тіл – сөз күші).

Lakoff пен Johnson (1980) өз еңбегінде негізгі тезисі былай айтылады: «Біздің күнделікті ойлауымыз, әрекетіміз және тілдік қолданысымыз метафоралық құрылымдарға негізделген. Метафора тек тілдік құбылыс емес, ол біздің концептуалды жүйеміздің өзегі». ***Авторлар күнделікті ойлау мен әрекетіміздің метафоралық модельдерге сүйенетінін дәлелдейді*** *[4, 29].*

Тілші Kövecses (2010) те осы пайымдауға қосылып, еңбегінде: «Метафора – тек тілдік құбылыс емес, ол біздің ойлау жүйемізді ұйымдастыратын когнитивтік механизм», деп көрсетеді, яғни ол метафораны когнитивтік механизм ретінде қарастырады, ол адамның концептуалды жүйесін ұйымдастырып, абстракт ұғымдарды нақты тәжірибемен байланыстырады [5, 4].

Негізгі бөлім

Қазақ тіліндегі соматикалық фразеологизмдер ұлттық дүниетанымда символдық мәнге ие. «Жүрек» концептісі эмоциялық және этикалық құндылықтарды бейнелейді: мейірім, батырлық, қайсарлық. «Бас» – ақыл мен биліктің орталығы ретінде когнитивтік және әлеуметтік функция атқарады. «Бет» – абырой мен әлеуметтік мәртебенің көрінісі, ал «қол» – еңбек пен көмек символы. «Көз» назар мен қызғанышты, «тіл» ықпал мен сөз күшін білдіреді. Бұл символдар тілдік санада тұрақты мәдени код ретінде қызмет етеді.

Соматикалық тіркестерде концептуалдық метафоралар айқын көрінеді. «Кеңістік» метафорасы (жүрегі кең) эмоцияны кеңістік схемасы арқылы бейнелейді. «Құрал/механизм» метафорасы (бас қатыру) ойлау процесін техникалық әрекетке теңейді. «Контейнер» метафорасы (жүрекке түю) сезім мен ақпаратты сақтау бейнесін жасайды. «Күш/энергия» метафорасы (тілі удай, жүрегі тас) эмоцияның интенсивтілігін физикалық субстанциямен сипаттайды [6, 81]. Бұл модельдер тілдің когнитивтік негізін көрсетеді.

Соматикалық тіркестер ұлттық мәдениеттегі моральдық және ритуалдық нормалармен астасады. «Бет сақтау» – абыройды қорғау, «қол ұшын беру» – ынтымақ пен өзара көмек, «көз тию» – магиялық нанымның тілдік көрінісі. Бұл тіркестер этномәдени семиотикада әлеуметтік қатынастарды реттеуші құрал ретінде қызмет етеді.

Соматикалық фразеологизмдер дискурста бағалау (жүрегі кең – мақтау, тілі ащы – сын), әлеуметтік реттеу (бет қаратпау), эмоцияны басқару (жүрегін орнына түсіру), ынтымақтастыққа шақыру (қол ұшын беру) сияқты прагматикалық функцияларды атқарады. Бұл олардың коммуникативтік тиімділігін арттырады.

Соматикалық тұрақты тіркестер бинарлық оппозициялар арқылы мәдени бағалау шкаласын құрайды (жүзі ашық ↔ жүзі сынық). Деривациялық өнімділік жоғары: жаңа экспрессивті формалар жасалады (бас ауырту, көзге мұрты түзелмеу). Идиомалық тұтастық компоненттердің жеке мағынасын көмескілейді, ал дене мүшесі атауы ұйытқы лексема ретінде семантикалық ядроны ұйымдастырады.

Түркі және славян тілдеріндегі параллельдер универсал метафоралардың кең тараған дәлелдейді. Мысалы, қазақша жүрегі тас орыс тілінде черствый сердцем, ағылшын тілінде cold-hearted деп беріледі. Бұл ұқсастықтар когнитивтік метафоралардың әмбебаптығын, ал ұлттық реңктердің мәдени ерекшелікті айқындайтынын көрсетеді.

Соматикалық тұрақты тіркестер тілдік жүйеде ерекше когнитивтік және мәдени мәнге ие. Олар адамның дене тәжірибесі мен мәдени жадын ұштастыра отырып, тілдік санада күрделі

семиотикалық құрылым жасайды. Бұл тіркестердің мағынасы бір мезетте тұрақты, яғни идиомалық сипатқа ие, және динамикалық, яғни контекстке тәуелді өзгерістерге бейім. Идиомалық тұтастық олардың негізгі семантикалық ядросын сақтаса, прагматикалық контекст мағыналық реңкті түрлендіріп, жаңа экспрессивтік мүмкіндіктер ашады [7, 32]. Соматикалық фразеологизмдердің экспрессивтік қуаты қысқа формада терең әлеуметтік-эмоциялық мазмұнды жеткізуге мүмкіндік береді. Мысалы, «жүрегі кең» тіркесі жомарттық пен мейірімділікті бейнелесе, «тілі ащы» тіркесі сыншылдық пен өткірлікті білдіреді. Осындай бейнелі құрылымдар медиа дискурста аудиторияға эмоционалды әсер ету үшін, білім беру саласында тіл мәдениетін қалыптастыруда және лидерлік риторикада сендіру мен ықпал ету мақсатында тиімді қолданылады. Сонымен қатар, бұл тіркестер ұлттық мәдени кодты сақтап, ұжымдық дүниетанымды тіл арқылы репрезентациялайды, сондықтан олардың зерттелуі когнитивтік лингвистика, прагматика және лингвомәдениеттану тұрғысынан маңызды.

Қорытынды

Қазақ тіліндегі соматикалық тұрақты тіркестер тілдік жүйенің маңызды құрамдас бөлігі ретінде ұлттық мәдени кодты сақтап қана қоймай, оны ұрпақтан ұрпаққа жеткізудің тиімді құралы болып табылады. Бұл тіркестер адамның дене мүшелері арқылы жасалған символдық бейнелерді когнитивтік метафоралар негізінде тілде көрнекі етеді, нәтижесінде абстракт ұғымдар нақты әрі түсінікті формада беріледі. Соматикалық фразеологизмдер дискурста көпқырлы қызмет атқарады: олар бағалауыштық реңкті білдіреді, әлеуметтік қатынастарды реттейді, эмоцияны жеткізеді және коммуникативтік ықпал ету механизмін іске қосады. Мұндай тілдік бірліктердің прагматикалық әлеуеті медиа, білім беру, ресми және бейресми коммуникацияда ерекше байқалады. Оларды жүйелі түрде оқыту мен талдау тіл мәдениетін нығайтып, сөйлеу этикасын қалыптастырады, сонымен қатар коммуникативтік құзыреттілікті арттырады. Бұл бағыттағы зерттеулер когнитивтік лингвистика, этнолингвистика және лингвомәдениеттану салалары үшін теориялық және қолданбалы тұрғыдан маңызды болып табылады, себебі соматикалық тұрақты тіркестер ұлттық дүниетаным мен тілдік сананың өзара байланысын айқын көрсетеді. Сондықтан олардың семантикалық, прагматикалық және мәдени қырларын кешенді зерттеу қазақ тілінің бай фразеологиялық қорын сақтауға және дамытуға мүмкіндік береді.

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TYPES OF LEXICAL UNITS

Rakhshanda Farrukh Seyidova
Baku Business University

LEKSİK VAHİDLƏRİN NÖVLƏRİ

Rəxşəndə Fərrux Seyidova
Bakı Biznes Universiteti

Abstract

One of the most important characteristics of language is that it is the main means of communication and exchange between people in society. Therefore, language plays a key role in the development of human society. The features, characteristics, diversity of meanings, richness and diversity of words in language, all the elements of language that serve their change, formation, their connections and relationships are related to thinking and are based on the indicator of its activity.

Abstract

Dilin ən əsas xarakterik əlamətlərindən biri onun cəmiyyətdə insanlar arasında əsas ünsiyyət mübadiləsi vasitəsi olmasıdır. Buna görədə dil insan cəmiyyətinin inkişafında əsas rol oynayır. Dildə var olan əlamətlər, xüsusiyyətlər, məna rəngarəngliyi, sözlərin zəngin olmağı və müxtəlifliyi onların dəyişimə uğramasına, formalaşmasına, onların əlaqə və münasibətlərinə xidmət edən bütün dilin ünsürləri təfəkürlə əlaqəli olub, onun fəaliyyətinin göstəricisinə əsaslanır.

Keywords: *Lexsis, collocations, theory, teaching combinations, formatin*
Açar sözlər: *Leksika, birləşmələr, nəzəriyyə, söz birləşmələrinin tədrisi, forma*

Xarici dillərin söz yaradıcılığı tədqiqatçılar tərəfindən dilçilik elmində ayrı bir tədqiqat obyekti kimi tədqiq edilir. Söz yaradıcılığı anlayışı dilərdə müntəzəm olaraq təzə yaranmış sözlərin və söz birləşmələrinin yaranma prosesi ilə əlaqəli olur. Bu mərhələlərə isə dil sistemində söz yaradıcılığı adlanır . Söz yaradıcılığı anlayışı bəyan etdiyi əsl mənasında dilçilik elminin bir sahəsinin adını dəyişir və dilçilik sahəsinin bu bölməsi leksik vahidlərin yaranma prosesini müəyyənləşdirir. Söz yaradıcılığı dilçilik sisteminin ən gənc predmet obyektinə çevrilmişdir. Bir sıra dilçi alimlərin araşdırmaları göstərir ki, söz yaradıcılığı yalnız bu sistemdə tədqiqat obyektinə çevrilir ki, onun tədqiqat obyekti seçilmiş dil hadisələrinin sistem halına salmasını nəzərdə tutur, dildə olan, bir-birindən fərqlənən digər dil sistemi öz dil materialları ilə onlar arasında xüsusi münasibətləri əks etdirir, yaradıcı sözlərlə bağlı olan üsul və vasitələri bütövlüklə öyrənir . Lakin bunu da qeyd etmək lazımdır ki, əgər söz yaradıcılığı dil sisteminin başqa və sərbəst bir sahəsi kimi hesab edilirsə, o zaman onu leksikologiya, morfologiya və sintaksisdən ayrı hesab etmək mümkün deyil . Akademik V.V.Vinoqradov , E.S.Kubryakova və başqa digər alimlərin elmi tədqiqatlarında söz yaradıcılığının dilin digər aspektləri ilə qarşılıqlı əlaqəsi haqqında geniş bir məlumat verilmişdir. Məsələn, F.S.Kubryakovanın fikrinə görə "söz yaratmaq prosesinin əsas mahiyyəti yeni adların, vahidlərin meydana çıxması deməkdir və tezliklə belə adlar sözlərə çevrilir. Belə ki, sözyaratma predmetinin sözün həqiqi mənasında söz yaradıcılığı prosesinin adlandırılması mənasında çıxış edir" . Söz yaradıcılığının əsas məzmunu dil yaradıcılığında təzə yaranmış leksik vahidlərin formal, semantik, genetik və dildə olan xüsusiyyətlərini və özünə xas müxtəlif cəhətlərini ortaya çıxarmaqdan ibarətdir. Qrammatik yolla əmələ gələn leksik vahidlər müxtəlif mənalı sözlər bildirir. Eyni zamanda söz yaradıcılğı istər fonetika və istərsədə qrammatika vasitəsilə əmələ gəlmiş sözləri tədqiq etmək və onların dildə oynadığı rolu tədqiq etməkdən ibarətdir. Yaranmış sözlərin müxtəlif dillərdə olan xarakterik xüsusiyyətlərini ortaya çıxarır. Bu isə dillərin tədqiqində mühüm bir əhəmiyyət kəsb edir . Yaradıcı sözün strukturu və onun formalaşması prosesi nəticəsində yaranmış söz yaradıcı mənbələr və vasitələr əsasında formalaşır. Forma ilə məzmunun qarşılıqlı münasibəti həm semantik, həm də struktural aspektdən vahid bir quruluş kimi ortaya çıxır. Sözyaradıcı mənaların özlərinin xüsusi cəhətləri münasibətlərdə xarakterik cəhət kimi özünü ehtiva edir. Söz ilkin məna vasitəsilə yaranmış söz törəmələrinin əlaqələrinin mövcudluğu sözün ilkin mənasından tutmuş onun yaranmasına qədər onu izah etməyə kömək göstərir və sözün real mənasını aydınlaşdırmağa imkan yaradır. Söz yaradıcılığının məzmunla vəhdət təşkili prosesi dilçi alimlərin diqqətini özünə cəzb etmişdir. Təbii ki, elə bir proses yarana bilməz ki, burada olan söz yaradıcılığı morfoloji aspektdən fərqlənməmiş olsun. Söz yaradıcı

mənalar söz yaradıcı vasitələrin köməyi əsasında formalaşır. Bir çox dilçilər forma və məzmun arasında münasibətlər əsnasında məzmun anlayışına daha çox üstünlük verirlər. Yeni leksik vahidlərin əmələ gəlməsi xüsusi bir söz yaradıcı modelinin köməyi ilə həyata keçir. Bu tipdəki söz yaradıcı model isə uzunmüddətli tarixi bir prosesin nəticəsindən irəli gəlir. Törəmələrin iki əsas cəhəti mövcuddur. Bu cəhətlər forma vasitəsilə məhsuldarlıqdan və onun məna etibarilə bağlı motivləşməsindən irəli gəlir. Forma və məzmunun qarşılıqlı şəkildə vəhdəti dilçilikdə yeni bir anlayış kimi qəbul olunur. Çünki söz yaradıcılığı dilçilik elmində yeni və gənc linqvistika sahəsi kimi gec meydana gəlmişdir . Yeni əmələ gəlmiş leksik vahidlərin özünə məxsus xüsusiyyətləri və müddəaları söz yaradıcı prosesin dərin təhlili zamanı müəyyən edilir. Bu təhlil özündə morfoloji, genetik və funksional cəhətləri də bəyan edilir. Söz yaradıcı proses formal və semantik olaraq iki hissəyə bölünürlər. Əgər söz yaradıcılığı diaxronik planda aparılarsa və eyni zamanda dəqiqləşdirmək və semantik təhlinin sinxron tələbinə ehtiyac duyularsa o zaman etimoloji yəni genetik təhlil aparılacaqdır . Söz yaratma prosesinin nəzəriyyələrinə əsasən onun təhlili törəmə əlaqələrinin imkanları vasitəsilə başlanır və sözün semantik və formal xüsusiyyətlərin müəyyənləşməsi ilə sona yetir. Söz yaradıcılığı prosesində semantik qruplaşmalar özünü birüzə verir. Bu qruplaşmalar həm söz yaradıcı sxemlərlə, həm də əmələ gəlmiş leksik vahidlərlə tamamilə əlaqəli olur. İngilis dilində bir çox tədqiqatçı dilçilər tərəfindən araşdırılmış söz yaradıcılığı mərhələləri qeyd olunarkən, onlara görə morfoloji cəhətlər əsas diqqətə götürülür. Beləliklə, morfoloji elementlərsiz söz yaradıcılığı mərhələlərini qeyd etmək müşkül bir məsələdir . Günümüzdə ingilis dilində müəyyən olunmuş affikslər mövcuddur ki, iki kateqoriyaya bölünməklə başqa dillərdən fərqlənirlər. Lakin özünə xas olan şəkilçilər alınma şəkilçilərə nisbətən daha məhsuldar hesab olunurlar. Təbii ki, dildə söz yaranmalar bu üsulla həyata keçmir. Söz yaradıcılığında söz yaratma prosesi sintaktik üsulla da həyata keçirilir. Leksik yolla sözlərin yaranması prosesi sözlərin morfoloji və sintaktik yolla yaranmasına nisbətən daha sadədir və leksik yolla yaranmış sözlər daha fərqli görünür. Leksik yolla yaranmış sözlər zahirən sadə görünsələr də söz yaradıcılığında həqiqətən də daha da mürəkkəb olub, dərin tədqiqata ehtiyac olan yollardan biridir . Söz yaradıcılığının bu tərz fərqli araşdırılma təhlili bu dildə əmələ gəlmiş leksik vahidlərin daha da dərindən özünə xas xüsusiyyətlərin öyrənilməsi və araşdırılması prosesinə asanlıqla yol açа bilir. Leksik vahidlərin yaranması üçün məna kəsb edən elemetlərin proqnozlaşdırılmasını təmin edə bilir. Bundan da əlavə sözlərin forma və məzmun aspektindən yola çıxaraq onların necə formalaşmasını və eyni zamanda hansı situasiyalarda işlənmə prinsiplərini öyrənir . Söz yaradıcılığı mahiyyət etibarilə sözün necə və hansı yollarla əmələ gəlməsi kimi nəzərdə tutulur. Həm bir başa, həm də dolayı yolla ayrı-ayrı sözlər üçün xas olan struktur növlərini saxlayır və söz yaradıcılığı deyilən zaman əmələ gələn fərqli və müxtəlif sözlərin yeni mənalar kəsb etməsi qeydə alınır. Qeyd olunan sözün strukturu və onun kəsb etdiyi mənası söz yaradıcı elementlərin əsasında formalaşır. Forma və məzmunun qarşılıqlı əlaqəsi istər struktural, istərsə də semantik cəhətdən vahid bir quruluş kimi əmələ gəlmiş və inkişaf etmişdir. Söz strukturunu təhlil edərkən söz yaradıcı elementlərin iki qrupa bölmək mümkünlüyünü aydın görə bilərik: sözyaradıcı elementlərin formal əlamətlərinə görə onların bölgüsü və yaxud belə əlamətlərə malik olmayan sözyaradıcı elementlər. 1. Affiksal törəmələr (sözün affikslər əsasında formalaşması) 2. Mürəkkəb sözlər (iki və ya daha artıq müstəqil dil elementlərinin birləşməsi nəticəsində əmələ gələn söz birləşmələri) 3. Abreviaturalar 4. Qarışıq birləşmə (ön və son şəkilçilər vasitəsilə formalaşan söz birləşmələri). İkinci qrupa aid olan sözlərin əmələ gəlməsində formal söz yaradıcı elementlər mövcud deyildir. Söz yaratma mövqeyi əsasən onlar cümlədə müəyyən cümlə üzvü rolunda çıxış etmirlər və bir növ bir nitq hissəsindən digər nitq hissəsinə keçərkən keçmiş leksik vahid kimi özlərini göstərirlər [1]. Dilçilikdə bu tip söz birləşmələri daxili fleksiya nəticəsində və yaxud daxili səs dəyişimlər nəticəsində yeni söz birləşmələr yaranır. Bunları belə qruplaşdırmaq mümkündür. 1. Konversiya edilmiş sözlər 2. Kök və şəkilçilərin birləşməsi zamanı baş verən fonoloji qruplaşmalar sayəsində yaranan söz birləşmələri 3. Substantivləşmə nəticəsində əmələ gələn söz birləşmələri Söz yaradıcılığı elmində söz yaradan sözün tapılıb və onun semantik aspekti tərəfindən tədqiq edilməsi ən əsas məsələlərdən biridir. Semantik, struktural cəhətlərini özündə birləşdirən mürəkkəb quruluş yaradıcı dil kimi təzahür edir. Yaradıcı sözə affiksial, törəmə, abreviaturalar və mürəkkəb söz yaradıcı konstruksiyalar kimi ünsürlər daxildir .

1.2.2. Lüğət ehtiyatını zənginləşdirən söz birləşmələri *İngilis dilində söz yaradıcı prosesdə elementlər müstəqil sözlərin birləşməsi nəticəsində əmələ gəlmişdir. Bu zaman söz birləşmələrini təşkil edən sözlər şəffaf və aydın şəkildə özünü göstərir. İngilis dilin iki və ya daha artıq sözün birləşməsi və onun vahid məna kəsb etməsi məfhumu "collocation", yəni söz birləşmələri adlanır. Leksik yolla sözlərin əmələ gəlmə prosesi ona görə əhəmiyyətlidir ki, bu zaman əmələ gəlmiş yeni leksik vahidlər sözə olduğu kimi daxil olur və istifadə olunur. Yeni yaranmış leksik vahid isə əvvəlki söz mənasından uzaqlaşır və*

yarandığı yeni leksik vahidin məzmunu özündə əks etdirir . Dil öyrənənlərdə söz birləşmələrinin öyrənmə strategiyalarının aşılanması vacibdir. Çünki xarici dilin tədrisi zamanı bu tip birləşmələrə müəllimələrin diqqət göstərməsi onlarda lüğət bazasının inkişafına böyük təsiri olacaqdır. Müəyyən edilmiş strategiyalara nəzər salaq: - Mürəkkəb söz birləşmələrini görən zaman onları tanımaq; - Onlara iki yeni söz kimi yox, bir söz kimi yanaşmaq; - Yeni söz öyrənilən zaman o sözə yaxın yeni mürəkkəb söz birləşməsini yaratmaq. Məsələn; öyrənilən yeni sözün "remember" olduğunu götürək və ona yaxın ola biləcək sözləri yazıb qruplaşdıraq, "remember rightly", "remember vividly" və.s. kimi misallar göstərə bilərik. - Çoxlu sayda kitab oxumaq və yaxud audiolara qulaq asaraq söz birləşmələrini situasiyada və konteksdə öyrənməyin ən səmərəli yollarından biridir - Öyrənilən "collocations" lara uyğun mətn yaratmaq onları daha yaxşı yadda saxlanılmasına kömək edəcək və onları tez-tez təkrarlamağa vadar edəcəkdir. - Yeni söz birləşmələrini öyrənərkən onları mövzü formasına salıb öyrənmək daha da əhəmiyyətlidir. Məsələn: "food", "family" "game" və.s. kimi məfhumlara ayırıb söz birləşmələrini öyrənmək daha məqsədə uyğundur. Və yaxud da bunu feillərlə etmək mümkündür. Məsələn: "take" felinə uyğun söz birləşmələrini öyrənmək olar. Dil öyrənənlərin bu kimi söz birləşmələrindən və onların xəbərdar olmalarının əsas əhəmiyyəti ondan ibarətdir ki, öyrəndikləri xarici dili daha yaxşı mənimsəyə bilsinlər. Xarici dilin tədrisi zamanı bu tip söz birləşmələrinin əksikliyi və istifadə olunmaması bu dil öyrənənlərdə yeni dilin öyrənilməsində heç bir uğur gətirə bilməyəcək və onların yeni dil öyrənilmə prosesinə manea törədəcək. Beləliklə dil öyrənənlər yeni dilin öyrənilməsinə müvəffəq ola bilməyəcəklər. Leksik vahidlərin yaranmasında dil öyrənənlər bir sıra problemlərlə üzləşə bilərlər. Bunlardan biri dil öyrənənlərin öz ana dili elementlərinə əsasən xarici dildə söz birləşmələrinin yaratmasında ibarətdir. Məsələn: " geniş kürəkli" sözün tərcüməsində Azərbaycan dilli dil öyrənənlər " wide shoulder" kimi tərcümə edirlər. Lakin ingilis dil sistemi bu cür birləşməni qəbul etmir. Bunun əvəzində isə bu birləşmə " broad shoulder" kimi tərcümə olunmalıdır. Çünki bu cür tərcümə ingilis dili lüğətlərində özünü göstərir. Xarici dilin tədrisi prosesi zamanı bu kimi problemlər ye alır. Bu zaman isə tədris prosesində əsas iş və vəzifə isə müəllimlər üzərinə düşür. Bu tip məlumatların çatdırılması önəmlidir . Dil öyrənənlərin bu tipli problemlərlə rastlaşması mümkündür. Buna görədə bu tip problemlərin aradan qaldırılması üçün dil öyrənən səviyyələrinə uyğun müəyyən çalışmalar hazırlanmalıdır. Çalışmalar vasitəsilə dil öyrənənlər artıq ingilis dilin leksik vahidləri ilə yaxından tanış olur və aşılanmış leksik strategiyalar sayəsində isə bu tip leksik vahidlər uzun müddətli yaddaş prosesi sisteminə daxil olur. Təbii ki, müəyyən xarici dilin tədrisində istifadə olunan dərsliklər də xüsusi diqqətlə seçilib hazırlanmalıdır. Bəzən dərsliklərdə bu tip leksik vahidlərin azlığı xarici dilin tədrisi prosesində axsamalara və dil öyrənənlərdə öyrənmə prosesinin ləng getməsinə onların tədrisdə uğur qazanmama kimi problemlərin gətirib çıxarmasına səbəb olacaqdır. Dil öyrənənlərin söz birləşmələrinin öyrənilməsini asanlaşdırmaq üçün onlara daim lüğətdən istifadə vərdişi aşılanmalıdır. Lüğətdən istifadə dil öyrənənlərdə söz birləşmələrinin öyrənilməsinə kömək edəcəkdir. Bununla yanaşı xarici dilin tədrisində dil öyrənənlər az səviyyəli ingilis dilinə malik olduqları üçün dilin öyrənilməsi zamanı necə başlamaq lazım olduğunu tam dərk etmirlər. Eyni zamanda lüğət seçimi də çox önəmlidir. Dil öyrənən lüğətdən istifadə edərək onun gözləntilərinin ödənməsi əsasdır. Ən çox istifadə olunan lüğətlərə biz "Oxford Student's Dictionary of Current English" , "The BBI Combinatory Dictionary of English" or "Collins Cobuild English Dictionary" və.s. kimi leksik vahidlərin öyrənilmə prosesini səmərəli edən lüğətləri misal göstərə bilərik. Lüğətlər dil öyrənilməsi üçün əsas bir mənbə kimi göstərilir. Lakin əsas məqsəd leksik vahidlərin öyrənilməsi olan zaman bu bir sıra problemlər çıxarır. Çünki dil öyrənən özünə lazım olan leksik vahidin hansı olduğu barədə daima çətinlik çəkir. Eyni zamanda dil öyrənən lüğətdən hansı aspektdən başlayacağını bilmir və onların gözləntilərinə uyğun hərəkət etməkdə çətinliklər çəkə bilirlər. Buna görədə bu tip problemlərlə üzləşməmək üçün dərs prosesində müəllimlər daima diqqətli olmalıdırlar. Bu tip problemlərin yaşanmaması üçün isə dil tədris edənlər öyrənənlərə geniş məlumat verməli və yol göstərməlidirlər [3]. Belə bir nəticəyə gəldik ki, leksik vahidlər həm qrammatik yolla həm də leksik yolla yarana bilirlər. İngilis dilində elə tip söz kombinasiyaları mövcuddur ki , bunlara "chunks" lar deyilir. "Chunks"- ların əmələ gəlməsi müəyyən səviyyələr üzrə həyata keçirilir. Bunların yaranmasında hərf, morfem, söz və söz birləşməsi səviyyələri mövcuddur. Hərf səviyyəsində məsələn "p" hərfi götürülür. Morfem səviyyəsində isə sözləri təşkil edən hərflər ayrılıqda morfem kimi götürülür. "Play" sözündə "p, l, y" bunlar morfemlərdir. Söz səviyyəsində isə yeni sözün əmələ gəlməsində həm kök söz, həm də şəkilçidən istifadə olunur. Məsələn: "player" sözünü bu səviyyəyə misal gətirə bilərik. Söz birləşməsi yəni " collocation" səviyyəsində isə " a player with promise" kimi ifadəni misal göstərə bilərik. "Chunks" – ların " collocations" lardan fərqi odur ki, onlar ümumi bir məfhumu ifadə edə bilirlər. Onlar eyni zamanda sabit söz birləşmələrinə uyğun gəlir. "Collocations"- larda isə iki mənalı sözün yan – yana

gəlməsi hesab olunur və ortaya mənalı bir məfhum çıxır. Onların tərəfləri müəyyən nitq hissələri ilə əvəz oluna bilərlər. "Chunks"- lar adətən dil prosesində hazır şəkildə olur və müəyyən bir məfhumu bildirir. "Chunks"-lar ilk baxışdan tanınır. Lakin ingilis dilində demək olar ki, "chunks"-lar mövcuddur və bu isə dil prosesində leksik vahidlərin öyrənilməsini biraz çətinləşdirir. "Chunks"-ları təşkil edən sözlər daima analiz edilib öyrənilməlidir. Məsələn: "make yourself at home" ifadəsi "öz evindəki kimi hiss et" mənasını verir. Bu söz hisslərini biz ayırıb başqa konteksdə və yaxud birləşmədə işlədə bilmərik. Artıq o müəyyən məfhum ifadə etməyəcək. Məsələn: "make yourself comfortable" kimi ifadəsi düzgün qəbul olunmayacaq. Buna görədə onu təşkil edən sözlər analiz olunmalıdır . "Chunks"- ları təşkil edən sözlərdə müəyyən limit olmalıdır. Əgər onu təşkil edən sözlər say baxımından çox olarsa və çətin olarsa bu onların istifadə tezliyini aşağı salacaq və dilin öyrənilmə prosesini aşağı salır. Buna görədə "chunks"- larda söz sayı az olan ifadələrin istifadəsi məqsədə uyğundur. "Chunks"- lar ingilis dilində hazır şəkildə mövcud olurlar. İngilis dilində bu birləşmələrin sayı olduqca çoxdur. Çox olduğuna görə yadda saxlamaq və onların işlənmə yerləri çox vaxt yadda qalmır. Xarici dilin tədrisi zamanı bu tip problemlərlə üzləşmələr daim olur. Leksik vahidlərin işlənmə yerləri ilə bağlı müəllim dil öyrənənləri daim məlumatlandırmalıdır. Bu birləşmələrin daha yaxşı yadda qalması üçün müəllimələr müəyyən internet resurslarını dil öyrənənlərə məsləhət görə bilərlər. Bunlardan biri isə külliyat (corpus) adlı resurslardır. Bunlar internetdə hazır şəklində və hazır mətn formasında özünü əks etdirir. Tədris prosesi zamanı əgər dil öyrənənlər "take" ilə bağlı birləşmələri öyrənmək və onların işlənmə yeri ilə bağlı məlumat almaq isdəyirlərsə müəllim məsləhəti ilə corpus resursundan istifadə edə bilər. Corpusun axtarış bölməsinə yazılan "take" sözünə uyğun onlarca bəlkə də yüzlərcə mətndən çıxarılmış cümlələr əks oluna bilər. Bu cümlələr sayəsində artıq dil öyrənənlərdə onların "take" sözünün işlənmə yeri və bu sözə uyğun bir çox sayda hazır birləşmələrinin olduğu barədə məlumatlar əldə edəcəklər. Bu tip resurslar dil öyrənənlərdə artıq leksik vahidlər barədə müəyyən fikir formalaşmasına kömək edəcəkdir. Bu tip resurlar sayəsində müəllimələr öyrənilən sözün daha yaxşı yadda qalması üçün çalışmalar hazırlaya bilərlər. Kompyuter olmayan sinifdə internet corpuslardan istifadə təbii ki qeyri-mümkündür. Lakin müəllim bu zaman mətni özü hazırlayıb gətirə bilər. Çalışmaları da öz hazırladığı materiala uyğun hazır edə bilər. İngilis dilində elə sözlər mövcud olur ki, onların işlənmə yerləri müxtəlif ola bilər və onların kəsb etdiyi mənada fərqli ola bilər. Bu tip məna çalarların öyrənilməsi və axtarılmasında korpus resurslarının istifadəsi xarici dilin öyrənilməsində öz əhəmiyyətini göstərir [1] . Ən çox istifadə olunan corpus resurslarında biz CIC yəni Cambridge İnternational Corpus misal göstərə bilərik. Burada axtarışlar sayəsində aydın olmuşdur ki, leksik vahidlər ikili, üçlü, dördlü, beşli formada ola bilər. Eyni zamanda isə bu leksik vahidlərin sayı müxtəlifdir. Axtarışlar sayəsində müəyyən olmuşdur ki, bu resursda ikili leksik vahid on doqquz min beş yüz altı, üçlü leksik vahid on iki min altı yüz həşdad bir, dördlü leksik vahid iki min doqquz yüz əlli üç, beşli leksik vahid isə üç yüz həşdad beş kimi müəyyən say göstərir. Bunlara misal olaraq ikili leksik vahidə " you know", " I think", üçlü leksik vahidə " a lot of" , dördlü leksik vahidə " or something like that", " and things like that" və.s. kimi leksik vahidləri misal göstərə bilərik. Bu tipli leksik vahidlərin yadda qalma prosesinin öxünə məxsus müəyyən çətinlikləri vardır. Çunki bu tipli leksik vahidlər iki və yaxud üçdən artıq elementlərdən ibarət olduqda onun öyrənilməsi də çətin olacaqdır. Buna görədə leksik vahidləri təşkil edən elementlərin azlığı onların bir o qədər yaxşı yadda qalma prosesinidə yaxşılaşdıracaqdır. İngilis dilində hazır olan bu birləşmələr yaranma prosesi müxtəlifdir və onlar müəyyən mənada dəyişir. Bəzən dildə elə söz ifadələri mövcuddur ki, onun təkrarlanma prosesi sayəsində onlar müəyyən sabit bir frazaya çevrilə bilərlər. Məsələn: " How are you today" ifadəsi dildə insanlar tərəfində çoxlu sayda təkrarlandığı üçün bu ifadələr "chunks" kimi qəbul edilə bilər. Bu tip artıq ingilis dili lüğətinə sabit bir fraza kimi daxil ola bilər. Ancaq bu ifadəni biz müəyyən formalara salmaqlada məsələn : " How are you this fine morning?" kimi ifadə oluna bilər. Buradan belə bir nəticəyə gəliriki ki, " How are you" ifadəsi ilə müxtəlif frazalar yaradılıb müəyyən situasiyalarda işlədilə bilər. Ancaq hər frazada bu tip ayırmanı etmək mümkün olmayacaq. " Make yourself at home" ifadəsindən danışarkən bu barədə məlumat vermişik . Xarici dilin tədrisi zamanı leksik vahidlərə diqqət yaratmaq və dərs prosesini bu dizaynda qurmaq əsasdır. Bu leksik metod hal – hazırda yeni məşhur olan metodlardan biridir. Dərs prosesini leksik vahidlər əsasında qurmaq və qrammatikanın ikinci hətta üçüncü planda qalması prosesi yeni yanaşmadır. Bir çox alimlərin fikrincə qrammatikanın geri planda qalması və diqqətin sırf sözlərə və onun birləşmələrinə ayrılması bunun effektsiz olacağını və dil öyrənənlərdə isə müəyyən nəticə olmayacağı barədə çoxlu alimlərin qorxuları mövcuddur. Lakin buna baxmayaraq bir çox alimlər qrammatikanın bir az geri planda qalmasını dəstəkləyir və diqqətin və tədrisin sözlərə yəni leksik vahidlərə üstün tutulmasının tərəfdarlarıdırlar. Onların fikrincə qrammatika olmadanda şəxs özünü xarici siyuasiyalarda ifadə edə bilər. Alimlərin tədris prosesinin qrammatika və yaxud leksika əsasında

qurulması və onların üstünlükləri barədə birinci fəslimizdə qeyd etmişik. Dərs prosesinin leksik vahidlər əsasında qurulması və öyrənilməsi təbii ki, bir sıra problemlər ortaya çıxarır [2].

1.2.3. Leksik vahidlərə dair müxtəlif bölgülər *İngilis dilində olan "chunks" –lara alimlər müəyyən aspektdən yanaşmışlar. Bu leksik vahidlər barədə alimlərin demək olar ki, müxtəlif fikirləri mövcuddur. Kristianstad Universitetin tədqiqatçısı Ying Zhao "An empirical study of L2 learners' use of lexical chunks and language production" əsərində Nattinger və DeCarriconun fikirlərinə əsasən qeyd edir ki, "chunks"-ları belə bir şəkildə növlərə ayrılıb: - Sabit söz frazaları; - Cümlə formasında leksik ifadələr; - Cümlə düzəldən ifadələr; - Frazal məhdudiyyətlər [4]; İngilis dilində sabit söz frazalar dedikdə idiomlar və frazeoloji birləşmələr nəzərdə tutulur. Onlar müəyyən sabit bir fikri ifadə edirlər. Məhz leksik vahid kimi funksiyasının əsas səbəbi odur ki, onların parçalanması və başqa sözlərlə əvəz olunma funksiyası mövcud deyildir. Bu bölgüyə əsaslanaraq qeyd edə bilərik ki, idiomlar "chunks"- lar söz sisteminə daxildirlər və onlar dil sistemində hazır şəkildə olurlar. Bunlara biz "kick the bucket", " spill the beans" və.s kimi nümunələri qeyd edə bilərik. Bundan əlavə Nattingerə əsasən sabit söz frazalarını üç hissəyə ayırmaq mövcuddur. Bunlara aiddir idiomlar, mövzü dəyişdirici sözlər və nəticə bildirən sözlər. Mövzu dəyişdirici sözlər dil sistemində sabit olaraq fəaliyyət göstərir. Onlar bir birindən ayrı vəziyyətdə yer ala bilməzlər. Məsələn : "by the way", "in addition" və.s. kimi misalları gətirə bilərik. Nəticə bildirən kateqoriyaya isə biz "all in all", "above all" kimi ifadələri misal göstərə bilərik. Cümlə formasında olan leksik ifadələrə əsasən cümlə uzunluğunda olur və cümlə kimi başa düşülür. Bu tip ifadələrin sabit qalması və dəyişməməsi onların tez-tez istifadə edilməsindən irəli gəlir. Bu tip cümlə leksik vahidlərinə isə " I am afraid i have to be going", That is a good idea", " long time no see inviting" kimi leksik vahidləri misal göstərə bilərik. Cümlə düzəldən ifadələr vasitəsi ilə cümlənin bütöv bir mənası dəyişdirə və yaxud hər hansı bir budaq cümləsi əlavə oluna bilər. Əsasən cümlənin əvvəlində gəlir və cümləni əhatə edir. Cümlə düzəldən ifadələrdə öz növbəsində müəyyən hissələrə bölünür. Məsələn: " not only..., but also", " my point is that", " let me start by." kimi sabit leksik ifadələri misal göstərə bilərik. Frazal məhdudiyyətlərə misal olaraq isə biz " sorry about", " see you later", "see you then" və.s. kimi ifadələri misal göstərə bilərik. "Chunks"- lar barədə bir çox alimlərin tədqiqatları mövcuddur. Bu leksik vahidlərin ingilis dil sistemində hazır şəkildə olması və dəyişikliklərə uğramaması onların özlərinə məxsus olan bir keyfiyyətdir. Ying Zhao Cowie və Howarth alimlərinin tədqiqatlarına əsasən qeyd edir ki, "chunks"-ların xarici dilin öyrənilmə və onların tədris olunma əsasları daima dərs prosesi zamanı onlara diqqət ayırmalıdır. Bu leksik vahidlərin öyrənilməsi nəticəsində dil öyrənənlərdə xarici dil səviyyəsi müəyyən səviyyədə öz inkişafını verəcəkdir [4]. Granger tədqiqatlarına əsasən qeyd edə bilərik ki, dil daşıyıcısı olmayan dil öyrənənlər dil daşıyıcısı olan dil öyrənənlərə nisbətən daha az sayda leksik "chunks"- lardan istifadə edirlər. Təbii ki , buna səbəb onların ana dillərinin fərqli olmasından irəli gəlir. Buna görə də dil öyrənənlərdə leksik vahidlər sisteminin daha yaxşı mənimsənilməsi üçün onlarda bacarıqlar üzərindən tapşırıqlar verilməli və onlarda leksik vahidlərin öyrənilməsinə uyğun vərdişlər aşılanmalıdır. Müəllimlər bu zaman daxili bacarıq və qabilliyətlərdən istifadə edərək müəyyən çalışmalar hazırlayaraq dərs prosesini dizayn etməlidir. Dil öyrənənlərin yazı bacarığı üzərinə çalışmalar hazırlayarkən onlar müəllimlər dörd əsas prinsipi izləməlidirlər. Yazı bacarığının inkişafı üçün müəllim tərəfindən verilən inşa tapşırıqları zamanı onlar birinci dil öyrənənlərə leksik vahidlərin istifadəsi, onların qruplaşdırılması, müəyyən olunması barədə dil öyrənənlərə kömək edilməli və onlarda bu bacarıq barədə müəyyən leksik strategiyalar aşılanmalıdır. Dil öyrənənlərə bu tipli tapşırıqların verilməsi sayəsində onlarda hər bir dilin hazır leksik vahidlərdən ibarət olduğu barədə məlumat verilməli və onlarda bu fikir formalaşdırılmalıdır. İkinci önəmli prinsip isə tələləbələrə esse nümunəsinin oxunması barədə tapşırıq verilməli və eyni zamanda mətndə olan leksik vahidlər araşdırılıb tapılmalıdır. Bu proses mətn analizi kimi özünü göstərir. Üçüncü prinsip isə müəllimələr dil öyrənənlərin araşdırdığı leksik vahidlərin unudulmamasında ötrü onlara bu leksik vahidlərdən istifadə edərək yeni bir mətn yazılması barədə onlara tapşırıq verir. Bu tapşırıqlar sayəsində isə müəllimələr dil öyrənənlərin öyrənilmə patensialını ölçür və onlarda müəyyən bir fikir formalaşır. Sonda isə dil öyrənənlərin göstərmiş olduqları bu cəhdlər qiymətləndirilir . Bir çox alimlərin fikirlərinə əsasən "chunks"- ların müəyyən formada müxtəlif bölgüləri vardır. Ying Zhao qeyd edir ki, Michael Lewisin leksik vahid tipologiyası Nattinger tipologiyasına müəyyən prinsiplərinə görə yaxındır. Michael Lewisin leksik vahid tipologiyasına nəzər salaq: - Sabit söz frazaları; - Söz kombinasiyaları; - Cümlə tipli birləşmələr; - Cümlə düzəldən vasitələr ; Sabit söz frazaları ingilis dilinin sistemində vahiddir və dəyişməzdir. Demək olar ki özünü bir söz kimi ifadə edir. Bunlara misal olaraq: "as soon", "talk about", "grow up and so on" və.s. kimi ifadələri misal göstərə bilərik. Söz kombinasiyaları da ingilis dilində daha çox təzahür edən leksik vahidlər növüdür. Bu söz kombinasiyaların tərəfləri müxtəlif cür nitq hissələrindən ibarət ola bilər. Məsələn: fel+ isim- play the basketball, catch a cold,*

sifət+ isim- splendid future və.s. kimi söz kombinasiyalarına east gələ bilərik. Eyni zamanda bu barədə geiş məlumat vermişik. Eyni zamanda bu tip leksik vahidlərə stabil söz birləşmələri aiddir ki, onlar müəyyən bir mənanı bildirirlər. Məsələn: "bread and butter", "knife and fork" və.s. kimi ifadələri misal göstərə bilərik. Cümlə tipli birləşmələr gəldikdə isə biz onların müxtəlif cür tiplərini misal göstərə bilərik. Burada cümlə tipli birləşmələrə güman şübhə, təklif, istək və arzu kimi mənaları ifadə edən cümlə tipli birləşmələri misal göstərə bilərik. Məsələn: " can I give you a hand", "İf I were you", " I would be delighted to" və.s. kimi ifadələri misal göstərə bilərik. Cümlə düzəldən ifadələrə gəldikdə isə "It is suggested that…", "The fact is…", "My point is that", " This paper concentrates on…", "firstly, secondly…, finally…" kimi ifadələri misal göstərə bilərik. Bu tip ifadələr hazır şəkildədi və onları dəyişmək və başqa elementlərlə əvəz etmək mümkün deyildir. Bu tip leksik vahidlər ingilis dilinin hər bir sahəsində rast gəlinir və dil daşıyıcıları tərəfindən istifadə olunur. Bu birləşmələr içərisindədə təbii ki, ən çox istifadə edilənlər tezliyi də mövcuddur. Ying Zhao Nyyssonenin fikirlərinə əsasən qeyd edir ki, dil daşıyıcısı olmayan dil öyrənənlər yeni bir dil öyrənərkən mütləq leksik vahidlərə xüsusi bir diqqət yetirməlidirlər. "Chunks"-lar ümümiyyətlə hər bir dilin özəyini təşkil edir. Leksik vahidlər strukturca sabit, dəyişməzdir, eyni komponentli olur, və başqa sözlərlə əvəz olunmur. Sabit birləşmələrin tərkibi və sırası dəqiq və sabitdir . Onların tərkibini dəyişmək və sırasını pozmaq olmaz. Sabit birləşmələrin tərkibinin və komponentlərinin yercə, sıraca, daimiliyi sözün tərkibindəki morfemlər kimidir. Leksik vahid birləşmələrinin çoxu başqa dilə hərfi şəkildə tərcümə olunmur. Onlar tərcümə ediləndə mənasız , gülünc ifadə vəziyyətində olur [4]. Tədqiqatlar göstərir ki, ikinci dilin öyrənilməsi üçün leksik vahidlər əsasdır. Çünki bu tip leksik vahidlər ikinci dilin öyrənilməsi üçün dilin dəqiqliyinə, mənalılığına, yaradıcı xüsusiyyətlərinə sahib olmasına, onların onun tezliyi barədə dil öyrənənlərə xüsusi bir məlumat verir və onlarda dil öyrənənlərdə yeni dil barədə diqqət oyadır. Nyyssonenun fikirlərinə əsasən leksik vahidlər dil öyrənənlərdə yeni dil öyrənmə ilə bağlı motivasiya yaradır. Bu motivasiya insanlarda yeni dilin mənimsənilməsinə və onların öyrənilməsinə dair bir cəhd yaradır. Dil öyrənənlər yazıda və danışıqda leksik vahidlərin istifadəsi və onların düzgün yerdə tətbiq olunması barədə tələblər olduğunu başa düşür və onlarda müəyyən bir fikir formalaşır . Leksik ifadələrdən istifadə etmək dil öyrənənlərin bacarığını, başqa sözlə, onların səlis danışmağına kömək edir. Bu prefabrik nitqin həm daha səmərəli alınması, həm də dinamiklərin (və dinləyicilərin) diqqətini diskursun daha geniş quruluşuna yönəltməsinə imkan vermək, həm də istehsal edildikləri zaman fərdi sözlərə az diqqət yetirməkdən daha çox üstünlüyü vardır. Birlikdə olan leksik hissələr vasitəsilə dinamiklər səlis dildə danışmağı bacarırlar. Leksik hissələrin istifadəsi dil işlənməsinin yükünü azaltdığına görə dinamiklərə müntəzəm tərəddüd və fikir ayrılığı olmadan müntəzəm, naxışlanmış diskurs seqmentlərini işlətməyə imkan verir. Eyni zamanda, bu, öyrənənlərə dilin məzmununa daha çox diqqət ayırmağa imkan verir. Beləliklə, belə nəticəyə gəlmək olar ki, leksik toplular dil sərbəstliyini böyük dərəcədə təşviq edə bilər. Lyuis, dillərin böyük bir hissəsinin axıcılıq və dəqiqlik əldə etmək üçün sözlərin yığılmış hissələrində tapıla biləcəyi mənalı hissələrdən ibarət olduğunu qeyd etdi. Buna görə bir dili mənimsəmək üçün öyrənənlər təkcə onun fərdi sözlərini deyil, həm də onları bir yerə yığmağın yollarını bilməlidirlər [1]. Ying Zhao Pawley və Syder-a istinadən iddia edir ki, hətta ən bacarıqlı olmayan natiq üçün ən çətin işlərdən biri də ümumiyyətlə yerli natiqlər tərəfindən istifadə olunan sözləri toplamağı öyrənməkdir. Və "doğma kimi seçim" termini "doğma danışanın qabiliyyətini nəinki qrammatik baxımdan doğma kimidir ". Beləliklə, çox sayda doğma seçimi istifadə edən ana dilçilərinin səriştələrini əldə etmək üçün, öyrənənlər dəqiq və idiomatik sözləri necə seçməli və fikirlərini doğma dil kimi çatdırmağı bilməlidirlər . Leksik hissələr yalnız həmişə dəyişməz olmur və onlar bütöv olaraq istifadə edilmir, həmçinin sabit ifadələr, frazalı məhdudiyyətlər və cümlə qurucuların hamısı tam ifadə kimi nəzərə alınmır. Onlardan dil hazırlamaq üçün hazır əsas formalar kimi də istifadə etmək olar. O, həmçinin bu hissələrin ayrı və ya təsadüfi olmadığını təklif edir yaradıcı qaydaqanun əməliyyatı, amma əslində onun inkişafında rol oynayır. Zhao Ying Hakutanın tədqiqatlarına əsasən qeyd edir ki, yaradıcı dil istehsalı üçün rutin və naxışların əhəmiyyətinə dair fikirləri Lily Wong-Fillmore tərəfindən təsdiqlənmişdir. Hakuta kimi Wong-Fillmore, "dil əldə etmə prosesində öyrənilən qaydalar və nümunələr birbaşa yaradıcı dilə çevrilir" deyə düşünür. Bu baxımdan belə nəticəyə gəlmək olar ki, əksər vaxt leksik hissələr sabit deyil, bir neçə çevik komponentə malikdir. Göründüyü kimi, leksik hissələr qaydaları inkişaf etdirərkən sonrakı bölgü və təhlil üçün xam məlumatlardır . Pawley və Syder qəti şəkildə inanırlar ki, leksik hissələr dil istehsalının bünövrəsi rolunu oynayır və yenilik və yaradılış üçün mövcud modelləri təmin edir. Nattinger və DeCarrico də iddia edirlər ki, xeyli miqdarda leksik dəyişikliyə imkan verən sadə ifadələr ən güclü nümunə generatorları ola bilər. Sintaktik naxış sadədirsə və elastiklik və dəyişkənliyə imkan verirsə, yaradıcı dil istehsalında davamlı bir artım təmin ediləcəkdir . Lyuis leksikanı qrammatika və ya lüğət baxımından deyil, dilin əsası hesab edir. Sabit mənaları olan fərdi

sözlərin bir hissəsi kimi başa düşülən söz ehtiyatından fərqli olaraq, leksikaya təkcə sözlər deyil, eyni zamanda zehni leksikonumuzda saxladığımız tez-tez istifadə olunan söz birləşmələri də daxildir. Buna görə də leksik yanaşmanın tərəfdarları, dillərin böyük bir hissəsinin birləşdikdə ardıcıl və idiomatik mətnlər yaradan mənalı leksik ifadələrdən ibarət olduğunu iddia edirlər . Leksikanın təməl prinsipi yanaşma "dil leksikləşdirilmiş qrammatikadan deyil, qrammatikləşdirilmiş leksiklərdən ibarətdir" deməkdir. Bu, leksemanın dilin əsasını və ya ürəyini, qrammatikaya tabe rol oynayacağını göstərir. Başqa sözlə, leksik hissələr dildən daha çox generativ güc təklif edir. Leksik yanaşma şagirdlərin bilik səviyyəsini leksik hissələrlə inkişaf etdirməyə yönəldir. Nəticədə, müəllimlər əvvəlcə yaradılan cümlələrdən daha çox dildə tez-tez yaranan sabit və ya yarı sabit ifadələrə diqqət yetirməlidirlər. Zhao Ying Lyuisin tədqiqatlarına istinad edərək qeyd edir ki, leksik yanaşmada təklif edir ki, "pedaqoji chunks"-lar tez-tez sinif fəaliyyətində olmalıdır. Dil öyrənənlər məruz qaldıqları dil haqqında məlumatlılığı inkişaf etdirməlidirlər . İngilis dilində tədris və təlim prosesi vacibdir, çünki dil öyrənən və müəllimlərə ingilis dilində olan işləri başa düşmək üçün dinləmə, danışma, yazı və oxu bacarıqlarını inkişaf etdirməyə imkan verir. Bu tədqiqat çərçivəsində yaranan problem dil öyrənənlərin söz ehtiyatının olmamasına səbəb olur. İngilis dilində yazılı paraqrafları başa düşmək, İngilis kitabından başa düşülən sözlər və sadə ifadələr almamağa səbəb olur. Bu səbəbdən bu tədqiqatın əsas məqsədi, lüğət öyrənməsini təşviq etmək üçün ədəbiyyat araşdırması vasitəsi ilə aydın öyrənmə leksikasını öyrənməkdir. dil öyrənənlər. Problemi təhlil etmək üçün dil öyrənənlərin ingilis dilini öyrənmək üçün lüğət ehtiyatlarının olmamasının səbəbini bilmək lazımdır[4]. İngilis dilində leksik vahidlərin qeyd etdiyimiz kimi bir çox bölgü sistemləri mövcuddur. Bu bölgülərdən biri isə belədir : - Sərbəst söz birləşmələri; - Yarı-sərbəst söz birləşmələri; - Feli birləşmələr; - Söz birləşmələri ; Sərbəst birləşmələr , nitqdə həmin dilin qrammatik normaları əsasında hər dəfə yenidən yaranır. Məsələn : "black cat", " green book". Sabit söz birləşmələri dildə hazır şəkildə olur və onlar nitqdə yenidən yaradılmır, lakin yeniden təkrarlanır , canlandırılır . Fikrin təbiətinə və tələbinə uyğun şəkildə işlədilir. Məsələn :"over the hill"-" getting too old", "pan out"-" succed". Sərbəst söz birləşmələrinin struktur dəyişkəndir , niqt situasiyasından , fikirdən asılı olaraq dəyişir. Sərbəst birləşmələr struktur-semantik modellər əsasında düzəlir. Ona görə də belə birləşmələrə nitq prosesində söz əlavə etmək olar. Onlarda aparıcı sözü ayırmaq mümkündür. Onun əsasında bir sıra birləşmələr düzəltmək olar, çünki daimi leksik tərkibə malik deyildir. Buna görədə onun sinonimi olmur. Sərbəst söz birləşmələrinə ingilis dilində "fixed-phrases" kimi ifadə olunur . Yarı- sərbəst söz birləşmələri dediyimiz zaman bura idiomları daxil edə bilərik. İdiom- daimi konteksin vahididir. İdiom tam məna ilə səciyyələnir. Ç.Hokket idioma və idiomatikliyə böyük diqqət yetirərək, "idiom" terminini hər şeyi əhatə edən leksikoqrafik və sintaktik hadisələrin təsbiti üçün istifadə edir və qeyd edir ki, bu hadisələrin strukturun mənalarını qabaqcadan xəbər vermək mümkün olmur. U.Çeyfin "idiom" anlayışı haqqında orijinal bir konsepsiyası var. U.Çeyf qeyd edir ki, dildə idiom mövcudluğu şübhəsizdir. Məsələn: to spill the beans "sirr vermək"; to burn bridges "körpüləri yandırmaq"; to throw dust into smb's eyes "bir kəsin başını aldatmaq"; to point the devil blacker than he is "şişirtmək"; to put a spoke in somebody'swhell "bir kəsə mane olmaq", "əngəl törətmək"; to hold one's cards close one`s chest "bir şeyi sirr olaraq saxlamaq", "ağzını bərk tutmaq", "susmaq"; to be narrow in the shoulders "zarafat başa düşməyən" bu tip idiomları misal göstərə bilərik. Bəzi yarı - sabit söz birləşmələrini təşkil edən sözlərdən birinin həqiqi mənası az da olsa, nəzərə çarpan səviyyədədir. Bu tip birləşmələrə "semi-fixed" ifadələr deyilir . İngilis dilində çoxlu sayda feli birləşmələr mövcuddur. Feli birləşmələr ingilis dilində "phrasal verb" kimi ifadə olunur. Bu birləşmələr fel+ zərf və yaxud fel+ sözönü strukturlarına əsasən yaranır. Bu birləşmələrdə istifadə olunan sözönüləri istifadə olunmuş felin mənasını dəyişir və müxtəlif mənada istifadə olunur. Məsələn: "take off", "put on", "get out", "chip in", "come across" kimi feli birləşmələri misal göstərə bilərik. Feli birləşmələr xarici dilin tədrisində tədris olunarkən dil öyrənənlər bir çox sayda problemlərlə üzləşir. Bu problemlərinin yaranmasında isə bir sıra səbəblər özünü göstərir. Bu səbəblərin bəzilərinə nəzər salaq. Ən önəmli məsələ feli birləşmələrin dildə çox olması və onların bir birinə bənzəyən strukturların olmasından irəli gəlir. Bu tip problem dil öyrənənlərdə çaşqınlıq yaradır və onların öyrənilmə prosesini çətinləşdirir. Sonrakı bir məsələ isə onların mənalarının bir- birinə çox yaxın olmasından irəli gəli ki, buda bir sıra problemlərə yol açır. Elə feli birləşmələrdə mövcuddur ki, onların konteksdə işlədilməsi daim dil öyrənənlər üçün çətinlik yaradır. Elə feli birləşmələrdə mövcuddur ki, onlar qeyri-formal situasiyalarda baş verir və onun dil öyrənənlər tərəfindən başa düşülməsi və anlaşılması daim çətin problemlər yaradır [3]. İki və ya daha artıq mənalı sözün birləşib yeni mənalı birləşmə əmələ gətirməsinə söz birləşməsi deyilir. Söz birləşmələri müxtəlif nitq hissələrinin köməyi ilə həyata keçir. Bu ifadə ingilis dilində "collocations" kimi ifadə olunur. Burada əsas məsələ iki və daha artıq sözün birgə olmasında irəli gəlir. Məsələn: sifət+isim, fel+zərf və.s kimi strukturları misal göstərə bilərik. Biz bu barədə dissertasiya

işimizdə geniş məlumat vermişik. İngilis dilində semantik və struktur cəhətdən birləşib yeni məna ifadə edən çoxlu sayda birləşmələr vardır. Bunlara ingilis dilində ikili və üçlü birləşmələr yəni "binomials" və "trinomials" kimi ingilis dilində ifadə olunur. "Binomials"-a misal olaraq: to and fro, black and white, salt and pepper, fish and chips, sick and tired kimi ifadələri misal göstərə bilərik. "Trinomials"-a misal olaraq: "cool, calm and collected", "hook, line and sinker", "left, right and centre"," ready, willing and able" kimi ifadələri misal göstərə bilərik . Zhao Ying Nattinger və DeCarrikoya istinadən qeyd edir ki, leksik "chunks"-ların özlərinə məxsus üç əsas funksiyası mövcuddur: sosyal qarşılıqlı təsir, zəruri mövzu və diskurs cihazı : - Sosial qarşılıqlı əlaqə: leksik ifadələri müxtəlif sosial funksiyaları yerinə yetirmək və danışıq məqsədi ilə əlaqəli olan funksional məna ifadə etmək üçün istifadə edirik. - Lazımi mövzular: gündəlik danışıqlardakı bu zəruri leksik ifadələr dil öyrənənlərdən tez-tez soruşulan və onlardan öyrənilən mövzuları qeyd edir. - Diskurs cihazları: diskurs cihazları kimi leksik hissələrin funksiyası diskursun mənasını və quruluşunu birləşdirən funksiyasına aiddir . Michael Lewisin nəzəriyyəsində qeyd edilir ki, leksik cəhətləri öyrətmək öyrənənlərin məyusluğunu azaltmağa, motivasiyasını artırmağa və dil səlisliyini yaxşılaşdırmağa kömək edə bilər. Leksik hissələrin tədrisi üç aspektdə öz əksini tapmışdır: nitq və ya mühazirə, dinləmə bacarığı təhsili, oxumaq anlayışı və yazı [1].

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THE FUTURE OF INTELLIGENCE: HUMAN AND ARTIFICIAL IN THE TEACHING PROCESS OF FOREIGN LANGUAGES

Tarana Guliyeva[1]
Senior Lecturer
Natavan Abbasova[2]
Senior Lecturer
Department of Foreign Languages, Philology Faculty[1,2],
Sumgayit State University[1,2]

БУДУЩЕЕ ИНТЕЛЛЕКТА: ЧЕЛОВЕЧЕСКОГО И ИСКУССТВЕННОГО В ПРОЦЕССЕ ОБУЧЕНИЯ ИНОСТРАННЫМ ЯЗЫКАМ

Тарана Гулиева[1]
Старший преподаватель
Натаван Аббадова[2]
Старший преподаватель
Кафедра иностранных языков, филологический факультет[1, 2]
Сумгаитский государственный университет[1, 2]

Abstract

The rapid development of artificial intelligence (AI) has significantly transformed educational paradigms, particularly in the field of foreign language teaching. This article explores the future of intelligence—human and artificial—and their interaction in the teaching and learning of foreign languages. Emphasis is placed on the complementary roles of human cognitive, emotional, and cultural intelligence and artificial intelligence–driven technologies such as adaptive learning systems, intelligent tutoring systems, and natural language processing tools. The study analyzes current trends, pedagogical opportunities, ethical challenges, and future prospects of integrating AI into foreign language education. The research highlights that the most effective model of foreign language teaching is not the replacement of teachers by AI, but a hybrid model that combines human pedagogical expertise with intelligent technologies to enhance personalization, motivation, and learning outcomes.

Аннотация

В статье рассматривается будущее интеллекта — человеческого и искусственного — в процессе обучения иностранным языкам. Подчеркивается, что искусственный интеллект предоставляет новые возможности, такие как адаптивные обучающие системы, распознавание речи и интеллектуальные обучающие платформы, однако человеческий интеллект остается незаменимым для эмоциональной поддержки, креативности, этического мышления и межкультурной коммуникации. Обосновывается идея гибридной модели обучения, в которой ИИ выступает в роли помощника преподавателя, а не его замены. Преподаватель направляет учебный процесс, обеспечивает коммуникативную и культурную составляющую, в то время как ИИ повышает персонализацию и эффективность обучения. Также анализируются проблемы цифрового неравенства, защиты данных и подготовки педагогов. Сделан вывод, что гармоничное сочетание человеческого и искусственного интеллекта способствует повышению качества иноязычного образования.

Keywords: *Human intelligence; artificial intelligence; foreign language teaching; educational technology; hybrid learning*

Ключевые слова: *человеческий интеллект; искусственный интеллект; обучение иностранным языкам; образовательные технологии; гибридное обучение*

Introduction

The teaching of foreign languages has always been closely connected with the development of human intelligence, communication skills, and cultural awareness. In the 21st century, rapid technological progress and the emergence of artificial intelligence have introduced new dimensions to educational processes. AI-based tools such as chatbots, speech recognition systems, and adaptive platforms are increasingly used in language classrooms, reshaping traditional teaching methods.

This article was written with this awareness, and since it was thought that an ontological analysis would be incomplete without building a background, the historical method, whose subject is the ontological evaluation of educational psychology, was used in this article (Isgandar, S. M., and others, 2024).

The actuality of this research *lies in the growing need to understand how human intelligence and artificial intelligence can coexist and complement each other in foreign language education. While AI offers efficiency, personalization, and data-driven feedback, human intelligence remains essential for emotional support, ethical judgment, creativity, and intercultural competence. Therefore, exploring the balance between these two forms of intelligence is a key issue for modern pedagogy.*

The purpose of this article is to analyze the future role of human and artificial intelligence in the foreign language teaching process, identify their strengths and limitations, and propose an integrative model for effective language education.

Main Body

Human Intelligence in Foreign Language Teaching

Human intelligence plays a fundamental role in foreign language education. Teachers possess cognitive, emotional, and social intelligence that allows them to adapt instruction to learners' needs, motivations, and cultural backgrounds. According to Gardner's theory of multiple intelligences, linguistic and interpersonal intelligences are especially crucial in language learning (Gardner, 2011).

Human teachers are capable of interpreting learners' emotions, encouraging critical thinking, and fostering communicative competence through real-life interaction. Moreover, teachers act as cultural mediators, helping students understand not only linguistic structures but also sociocultural norms and values embedded in the target language (Byram, 2020).

Despite technological advancements, human intelligence remains irreplaceable in developing empathy, creativity, and ethical responsibility in learners. These qualities are essential for meaningful communication and lifelong language learning.

Artificial Intelligence in Foreign Language Teaching

Artificial intelligence has rapidly expanded its presence in language education. AI-powered applications use machine learning, natural language processing, and big data analytics to provide personalized learning experiences. Intelligent tutoring systems can adapt content to individual proficiency levels, learning styles, and progress rates (Holmes et al., 2019).

Speech recognition and automated feedback tools help learners improve pronunciation and fluency, while chatbots simulate conversational practice in a low-anxiety environment. AI also supports teachers by automating assessment, tracking learner performance, and identifying learning gaps.

However, AI systems have limitations. They lack genuine understanding, emotional sensitivity, and cultural awareness. Bias in algorithms and data privacy issues also raise ethical concerns in educational contexts (Williamson & Eynon, 2020).

The Hybrid Model: Human–Artificial Intelligence Synergy

The future of foreign language teaching lies in a hybrid model that integrates human and artificial intelligence. In this model, AI functions as an assistant rather than a replacement for teachers. Teachers design learning objectives, guide interaction, and provide emotional and cultural support, while AI enhances efficiency and personalization.

Research suggests that blended learning environments supported by AI can improve learner autonomy, motivation, and outcomes when guided by competent educators (Luckin et al., 2016). Such synergy allows teachers to focus on higher-order pedagogical tasks while AI handles routine and data-intensive processes.

Challenges and Ethical Considerations

The integration of AI in language education presents challenges related to equity, data security, and teacher training. Not all learners have equal access to advanced technologies, which may deepen educational inequalities. Furthermore, educators need professional development to effectively use AI tools without losing pedagogical control.

Ethical use of AI requires transparency, accountability, and respect for learners' privacy. Human intelligence is essential in ensuring that AI serves educational values rather than purely technological efficiency.

Conclusion

The future of intelligence in foreign language teaching is not a competition between human and artificial intelligence, but a collaborative partnership. Human intelligence provides creativity, empathy, and cultural understanding, while artificial intelligence offers personalization, efficiency, and innovative

learning tools. A balanced integration of both forms of intelligence can transform foreign language education, making it more inclusive, adaptive, and effective.

To achieve this future, educators, policymakers, and researchers must focus on developing ethical frameworks, teacher training programs, and pedagogical models that harness the strengths of both human and artificial intelligence. Ultimately, the human teacher remains central, guiding learners in an increasingly intelligent digital learning environment.

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Technical sciences

ASSESSMENT OF THE EFFECT OF CONDENSATE PRESENCE IN GAS PIPELINES ON GAS TRANSPORTATION PRESSURE

A.R. Nagizadeh
Oil and Gas Scientific Research Project Institute, SOCAR

Abstract

The study of natural gas and associated petroleum gas transportation shows that, in contrast to natural gas, associated gas cannot be conveyed over long distances in a single-phase condition. In certain operational scenarios, associated petroleum gas is reinjected into the reservoir to improve oil recovery efficiency through gas lift techniques. Nevertheless, the gas demand at production sites is considerably lower than the volume of gas available. At the same time, contemporary approaches to the utilization of natural and associated gases require their treatment and delivery to end users in compliance with established regulatory requirements. Growing export gas demand has therefore necessitated the efficient gathering, processing, and pipeline transportation of associated gas produced with oil, minimizing losses throughout the system.

In comparison with dry gas, the gathering and transportation of associated petroleum gas present additional technological complexities. One of the main challenges is the formation of condensate as a result of gas condensation during pipeline flow, which can lead to partial filling of the pipeline with liquid. Consequently, it becomes essential to evaluate the condensation behavior of the gas along the pipeline route.

This paper examines how transportation pressure in a gas pipeline varies with different levels of condensate accumulation under varying gas flow rates. The results indicate that during multiphase flow of associated gas, condensate buildup within the pipeline causes an increase in operating pressure.

Description of experimental work

Based on the above considerations, it is essential to analyze gas behavior and quantify its effects in order to make technical decisions that enable the efficient utilization of associated petroleum gases. It is well established that determining the location of maximum gas condensation along a pipeline requires a sequence of calculations carried out at multiple points, typically not fewer than ten. These calculations are performed for various pressure–temperature conditions, including the initial PK0 point, the pipeline outlet, the location of minimum gas temperature, as well as several intermediate points between PK0 and the minimum-temperature point.

A frequent problem in such calculations arises at the PK0 point, where the calculated gas dew point temperature does not coincide with the oil separation temperature. In many cases, the dew point temperature is 30–70°C lower than the separation temperature, which may lead to the conclusion that condensate formation does not occur within the pipeline. Nevertheless, operational experience clearly indicates that condensate is consistently present in the pipeline downstream of the first-stage separation unit, typically at temperatures around 40°C or after passing through the compressor unit.

For the first stage of separation, the pressure and temperature are set at 0.8 MPa and 333 K, respectively. A primary challenge in the condensation process is the identification of the C6+ fraction. Calculations are typically carried out using phase equilibrium coefficients; however, for the C6+ group, which comprises multiple components in unknown proportions, the phase equilibrium coefficient is not clearly defined (Ismayilov et al., 2019; Ismayilov et al., 2020; Ismayilov et al., 2024). Therefore, in the initial calculations, the C_{6+} group is treated as a single component. The dew point temperature (or the gas's final boiling point) is first determined, after which the C_{6+} fraction is replaced with its constituent components—C7, C8, C9, C10, and C11—for further calculations. The resulting data are presented in Table 1.

Table 1

Calculated results for C_{6+} group

C_{6+}	Pressure, MPa	Temperature, K	Final boiling temperature, K (°C)
C_6	0.8	333	269.47 (-3.53)
C_7	0.8	333	282.78 (9.78)
C_8	0.8	333	298.82 (25.82)
C_9	0.8	333	314.9 (41.09)
C_{10}	0.8	333	330.12 (57.12)
C_{11}	0.8	333	343.05 (70.05)

As presented in Table 1, the gas composition determined from the calculated dew point or final boiling temperature—where the C_{6+} fraction is represented as C_{10}—corresponds to 57.12°C. For a gas pipeline measuring 120 km in length and 0.2 m in diameter, at the location of maximum condensation (P = 1.89 MPa, T = 273 K), a condensate forms with a mass fraction of 4.18%. The detailed composition of this condensate is provided in Table 2.

Table 2

Constituent makeup of the condensate (4.18%) generated at the point of maximum condensation (P = 1.89 MPa, T = 273.16 K)

Components	Mass fraction %	Components	Mass fraction %
C_1	2.57	$i\text{-}C_5$	10.361
C_2	1.257	$n\text{-}C_5$	14.272
C_3	12.147	C_{10}	32.897
$i\text{-}C_4$	6.925	CO_2	0.184
$n\text{-}C_4$	19.102	N_2	0.015

Based on the known component composition of the condensate (see Table 2), the following parameters can be evaluated:

- *The condensate evaporation rate at T = 273 K (0°C) under atmospheric pressure, which is essential for assessing evaporation losses when transferring the condensate into an open tank;*
- *The evaporation rate at atmospheric pressure and T = 313 K (40°C), a key factor in estimating condensate losses during summer transport;*
- *The condensate vapor pressure at T = 311.8 K (38.8°C), which is critical for determining the physical state of the condensate, i.e., whether it behaves as a gaseous hydrocarbon or as a light viscous liquid;*
- *The vapor pressure at T = 313 K (50°C), an important parameter for selecting appropriate transport equipment for the condensate.*

The results obtained for these parameters are summarized in Table 3.

Table 3

Parameters of condensate

Definition of indicator	Value
Evaporation rate, (%) P=0.1 MPa, t=0 °C	14 (C_2-4.2; C_3-29.4; C_4-41.5; C_5-17;
Evaporation rate, (%), P=0.1 MPa, t=40 °C	62
Vapor pressure, MPa, t=38.8°C	1.6
Vapor pressure, MPa, t=50°C	1.8

As indicated in Table 3, at T = 38.8°C, the condensate within the pipeline behaves as a liquid hydrocarbon gas, with a vapor pressure of $P_{w.p.}$ = 16 kgf/cm². Consequently, its transportation requires specialized road or rail tankers designed for handling liquid propane. It is well known that using tankers intended for gasoline to transport condensate of this composition can result in significant mass losses, reaching up to 34% during winter and 62% during summer filling operations.

For fields located more than 30 km from gas consumers, it is essential to evaluate the feasibility of transporting gas to external users under the conditions of oil separation pressure. This consideration arises primarily due to the complexities associated with multiphase gas transport (Iskandarov et al., 2024; Ismayilov et al., 2019). Indeed, transporting gas over distances exceeding 30 km via pipeline at separation pressure is generally impractical. Therefore, decisions regarding the utilization of associated petroleum gas should follow a structured approach. Initially, it must be determined whether the gas can be consumed locally at the field. In practice, the gas demand at production facilities is considerably lower than the available gas volume.

Several options are typically considered for the effective use of associated petroleum gas:

- *Conversion of gas into electricity at the field's power station;*
- *Transportation of gas in a multiphase state to a gas processing plant using compressors;*
- *Single-phase transportation to a processing plant under separation pressure;*

• *Single-phase transportation to a processing plant at the oil separation temperature, involving isothermal transfer without compression;*

• *Combined transportation without compression, incorporating condensate removal from the pipeline;*

• *Multiphase transportation with pipeline cleaning devices integrated along the route.*

Although literature sources often recommend reinjecting associated petroleum gas to enhance oil recovery or employing gas lift operations, these methods are not directly related to the technology of gas utilization, as they primarily involve recirculation of the gas (Bayadilova et al., 2024; Deryayev, 2024).

Conclusion

1. The impact of condensate accumulation in gas pipelines on gas transportation pressure, taking into account the availability of associated petroleum gases, has been investigated.

2. It was found that with an increase in the pipeline's equilibrium condensate filling, the transportation pressure rises almost linearly for all gas flow rates. Simultaneously, the equilibrium condensate volume within the pipeline decreases monotonically as the gas flow rate increases.

3. Based on the equilibrium condensate volume and the time required for its accumulation, the study highlights the importance of removing the accumulated liquid to maintain stable gas pipeline operation.

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EXPERIMENTAL DETECTION OF ELECTROMAGNETIC WAVES

Shafizade Qayana
Huseynova Elvira
Yagubzade Naile
National Aerospace Agency of Azerbaijan

To date, the theoretical foundations for electromagnetic radiation (EMR) of cells and the entire human body in the millimeter wavelength range of low intensity have been established [1, 2, 3]. Biologically significant UHF (extremely high frequency) frequencies have been identified, which have been used to develop a number of medical devices and apparatuses [4, 5,].

*As is well known, in practical medicine, preference is given to diagnostic research methods that exclude the adverse effects of various types of radiation on humans. Unfortunately, not all modern methods for identifying pathological foci meet this requirement. Therefore, it is of undoubted interest to create a highly sensitive device for diagnosing diseases that is capable, without affecting the biological object, of recording its own electromagnetic radiation in the UHF range, including from pathologically altered cells, the spectral power flux density of which is estimated at 10-21...10-22 W/Hz*cm^2.*

One of the important results that followed from Maxwell's theory of the electromagnetic field was the prediction of the possibility of the existence of electromagnetic waves. According to Maxwell's theory, an electromagnetic wave is the propagation of an alternating electromagnetic field in space over time.

Electromagnetic waves are transverse, since the directions of the oscillations of the electric field strength and magnetic field induction vectors of the wave occur in a plane perpendicular to the direction of wave propagation.

Like elastic mechanical waves, electromagnetic waves are reflected from obstacles, but, unlike elastic waves, they can also propagate in a vacuum.

Also, in the previous lesson, we discussed that the faster the change in magnetic induction, the greater the strength of the resulting electric field. Conversely, the faster the change in electric field strength, the greater the magnetic induction. This leads to an important consequence: to generate intense electromagnetic waves, it is necessary to create electromagnetic oscillations of very high frequencies. As we mentioned earlier, electromagnetic waves were only experimentally detected 22 years later, after their theoretical substantiation. We know that high-frequency oscillations can be produced using a conventional resonant circuit. The cyclic frequency of the oscillations will be greater, the smaller the circuit's inductance and capacitance. However, in a conventional circuit, also called a closed circuit, almost the entire magnetic field is concentrated within the coil, and the electric field is concentrated within the capacitor. Consequently, far from the circuit, there is virtually no electromagnetic field, and almost no electromagnetic waves are emitted. Consequently, a high frequency of electromagnetic oscillations does not guarantee intense electromagnetic wave emission.

Therefore, an open resonant circuit is used to produce electromagnetic waves. This can be achieved by moving the capacitor plates apart, reducing their area, while simultaneously reducing the number of turns in the coil.

Ultimately, we obtain simply a straight wire—an open oscillatory circuit in which the capacitance and inductance are very small. Consequently, the oscillation frequency will be quite high. Moreover, the charges in such a circuit are not concentrated at its ends, but distributed throughout the entire conductor. However, the current in different sections of the conductor varies: at the ends, it is zero, but reaches its maximum in the middle.

The first device for generating electromagnetic waves was invented in 1887 by the German scientist Heinrich Rudolf Hertz, later called the Hertz vibrator.

Fig.1. The device for generating electromagnetic waves.

The vibrator consisted of a thin rod, split in half so that a small air gap, called a spark gap, remained between the cut ends. Small balls were placed on the ends of the rod. Large opposite charges were imparted to the balls. When the potential difference between the balls exceeded a certain limit, an electric discharge occurred between them. Electromagnetic oscillations were generated in the rods themselves, propagating through space as electromagnetic waves. Moreover, the waves were emitted only in a direction perpendicular to the vibrator axis.

The receiving device was also quite simple. It consisted of a coil of wire with two balls at the ends—a resonator.

The method of radiothermometry (in the microwave and infrared ranges) used in diagnostics excludes negative impact on the patient; however, it has quite significant errors (30% or more) of the first and second types. In X-ray (mammography), errors of the first and second types do not exceed 10%, but this method is not passive. The sensitivity of ultrasound in diagnosing various forms of cancer depends on the histological structure of the neoplasm and ranges from 68% to 100%. However, according to publications of recent years, the sensitivity of the combined use of mammography and ultrasound diagnostics in detecting breast cancer was 78%.

The medical device (fig. 2) is a highly sensitive receiver with a lens-resistant antenna. Reception is contactless via two orthogonal polarization channels.

Fig. 2. External appearance of the device

Electromagnetic signals were recorded at 15 strictly defined points on the patient's body, corresponding to the projections of organs and tissues involved in carcinogenesis in women with breast cancer (projections of the mammary glands, kidneys, ovaries, thyroid gland, liver, spleen, and uterus).

Human radiation is noisy in nature with low-frequency modulation [5], which we hypothesize is due to the intrinsic rhythm of the biological object (BO). Intrinsic rhythm is known to play a decisive role in the functioning of the BO, and its frequency characteristics are used as diagnostic data in various fields of medicine. Research (both theoretical and practical) has identified the frequency characteristics of BOs as applicable to the diagnosis of oncological diseases.

The signals recorded by the device (fig. 3) represent a combination of non-thermal radiation from the BO, ambient noise, and the device's own noise (the noise level is several times higher than the radiation level of the BO).

The signal is stochastic in nature, and to further analyze it, it is necessary to determine the properties of the random process: stationarity, periodicity, and normality. The requirement for a random process to be stationary is important, since non-stationarity means that results cannot be reproducible.

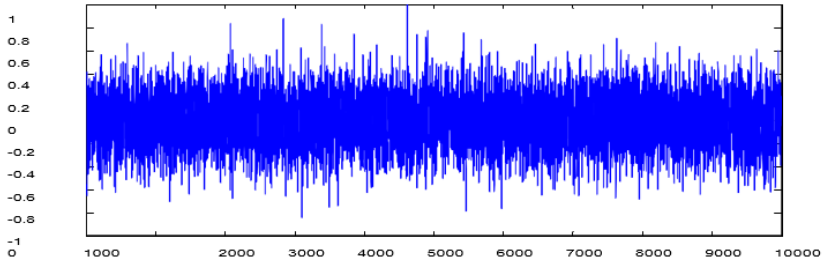

Fig. 3. Typical signal appearance

Classical methods of mathematical statistics were chosen to determine these properties. Based on the analysis of individual realizations, the method of series, and the method of inversions, a conclusion was reached regarding the weak stationarity of the random process. Individual realizations were compared at moments (initial and central) of various orders, up to 15; however, the process still cannot be considered strictly stationary. The normality of the distribution was determined using the chi-square goodness-of-fit test. Even though the distribution of the signal recorded by the device was determined to be normal according to the goodness-of-fit test, this does not mean that this type of process characterizes radiation from a biological object (BO), since the intensity of this radiation is much lower than noise from external and internal sources. Noise can be described by the white Gaussian noise model, which is strictly stationary and normal. The modified method employs a different approach to determining the frequency characteristics of a signal. It is based on estimating the cross-correlation function. This allows for empirically selecting the sensitivity and subsequently obtaining the required significance level for the hypothesis about the relationship. The cross-correlation function itself undergoes multi-stage filtering, including Cauer and Butterworth filters, the Hilbert transform, and a moving average procedure. Based on the obtained data, an automated system for determining the relationship can then be built, and the hypothesis about the relationship can then be tested using the classical method with the determined significance level. Systems for identifying cross-correlation functions exist; they can be found, for example, in. However, this problem has a specific feature—the presence of a high level of noise, which complicates the construction of such a system.

Therefore, a method for identifying the frequency characteristics of a signal in high noise was developed. Its essence lies in the combined use of hypotheses about the relationship and the identification of the cross-correlation function. After significant optimizations to the method's algorithm, it is now relatively time-efficient even when working with large samples (approximately 100,000 elements). However, determining the signal's frequency characteristics alone is clearly insufficient for constructing a diagnostic system.

Thus, the conducted studies indicate that this medical diagnostic device can rapidly detect breast cancer in women at early stages with a high degree of certainty (including during mass medical examinations).

This study provided preliminary data on the presence of highly specific characteristics of human electromagnetic fields in cancers of other localizations, which determined the direction of further research.

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DIGITAL IMAGE PROCESSING BASED ON PARALLEL ALGORITHMS

Baimakhanova Aigerim
PhD Senior lecturer
Department of Computer Engineering,
Khoja Akhmet Yassawi International Kazakh-Turkish University,
Turkistan, Kazakhstan
Mirzaliyeva Shakhzoda
Student
Faculty of Engineering
Khoja Akhmet Yassawi International Kazakh-Turkish University,
Turkistan, Kazakhstan

Abstract

Nowadays, digital image processing plays a crucial role in numerous scientific and technological fields, including computer vision, artificial intelligence, and medical imaging. The continuous growth of image data and the increasing demand for real-time processing require high-performance computational methods. Parallel algorithms provide an effective solution by significantly reducing processing time and improving resource utilization.

This paper focuses on the study of digital image processing based on parallel algorithms. The fundamental concepts of image processing and the core principles of parallel computing are discussed. Various parallel computing architectures, including multi-core processors and distributed systems, are analyzed in terms of their applicability to image processing tasks. Additionally, examples of parallel image processing algorithms are presented to demonstrate their effectiveness in enhancing computational efficiency. The results highlight the advantages of parallel approaches in achieving faster and more scalable image processing systems.

Keywords: *parallel algorithms, image processing, computer vision, multithreaded computing, filters (Gaussian, edge detection, grayscale, sharpen), real-time processing, multi-core processors, GPU, video analysis, computational performance.*

Introduction

Image processing is a key area of information technology that involves analyzing, enhancing, and transforming digital visual data. It is widely applied in medical diagnostics, security systems, autonomous vehicles, and entertainment technologies. For instance, medical imaging techniques such as X-rays, CT, and MRI rely on image processing for accurate diagnosis, while video surveillance systems detect abnormal activities using similar algorithms. Autonomous vehicles also depend on computer vision for environmental perception.

The growing volume of high-resolution images, video streams, and large datasets imposes significant computational demands. Traditional sequential algorithms often struggle with processing time, particularly in real-time applications. Parallel algorithms address this challenge by distributing tasks across multiple processors or cores, enabling simultaneous execution and significantly reducing computation time. Image operations at the pixel or region level, such as filtering, edge detection, Gaussian blur, grayscale conversion, and sharpening, are particularly suitable for parallelization.

In this project, a Python-based application is developed using OpenCV for image processing and Tkinter for the graphical user interface. The system divides images into four segments, processing each concurrently in separate threads. OpenCV provides high-performance functions for filtering and image transformations, NumPy accelerates numerical and matrix operations, threading ensures parallel execution, and Tkinter offers interactive visualization. PIL modules facilitate the display of processed images in the GUI.

Together, these tools form an efficient framework for parallel image processing, enabling faster computation, real-time visualization, and effective handling of large-scale image and video data. This approach improves processing speed, optimizes resource utilization, and enhances the scalability and performance of modern image processing applications.

```python
def apply_filter(image_section, filter_type, result, index):
    """Беремо бір беліктe фильтр колдану."""
    if filter_type == 'blur':
        result[index] = cv2.GaussianBlur(image_section, ksize: (15, 15), sigmaX: 0)
    elif filter_type == 'edge':
        result[index] = cv2.Canny(image_section, 100, 200)
    elif filter_type == 'grayscale':
        result[index] = cv2.cvtColor(image_section, cv2.COLOR_BGR2GRAY)
    elif filter_type == 'sharpen':
        kernel = np.array([[0, -1, 0], [-1, 5, -1], [0, -1, 0]])  # Шарпен фильтрі
        result[index] = cv2.filter2D(image_section, -1, kernel)

```

Figure 1. Functions used for applying filters

Core image processing techniques involve filtering operations, feature extraction, and enhancement methods aimed at improving visual quality or extracting meaningful information from digital images. In the proposed system, the apply_filter function serves as the central component for performing image processing on segmented regions of an image. This approach allows for localized processing, which reduces computational complexity and improves performance, particularly when integrated with parallel processing strategies (Figure 1).

The apply_filter function operates with three primary parameters:

1. Image_section – the array corresponding to a specific segment of the image.

2. Filter_type – the type of filter to be applied, such as Gaussian blur, edge detection, grayscale conversion, or sharpening.

3. Result – the array where processed image segments are stored. The index in the Result array determines the position of each processed segment in the final reconstructed image.

By invoking the function across multiple threads, different segments of the image can be processed concurrently, enabling efficient parallel execution and significant reduction of overall processing time.

Gaussian blur reduces image sharpness and produces a smoothing effect, commonly used to remove noise and identify homogeneous regions within an image. In the implementation, the cv2.GaussianBlur function is applied with a kernel size of (15, 15) and a standard deviation of 0 to achieve the desired effect.

Edge detection emphasizes object boundaries and structural features, which is critical for applications such as video surveillance, object recognition, and robotics. The cv2.Canny function is employed for edge detection, using lower and upper threshold values of 100 and 200, respectively, following the standard Canny algorithm.

Grayscale conversion simplifies image processing by transforming a color image into a single intensity channel. By removing color information, data complexity is reduced, which accelerates computational processing. This operation is implemented using the cv2.cvtColor function with the cv2.COLOR_BGR2GRAY parameter.

The sharpening filter enhances image clarity and emphasizes fine details and contours, improving the visibility of object boundaries and small features. A convolution kernel representing the sharpening operator is applied through the cv2.filter2D function.

Depending on the selected filter type, the corresponding algorithm is applied to each image segment. Multithreaded execution ensures that multiple segments are processed simultaneously, with results stored in the Result array before being recombined to generate the final output image. This parallelization not only significantly reduces processing time for large images but also optimizes computational resource utilization.

The combination of these filtering techniques—Gaussian blur, edge detection, grayscale conversion, and sharpening—with parallel execution enables the extraction of relevant features and enhancement of image quality for various applications. Each method addresses specific processing tasks, such as identifying object shapes, reducing data complexity, or improving visual clarity. The integration of parallel filtering is particularly advantageous for real-time scenarios, including video surveillance, medical imaging, and autonomous systems, providing higher processing speed, improved efficiency, and greater scalability. This demonstrates the practical benefits of multithreaded image processing in contemporary computer vision and digital image analysis applications.

Methodology

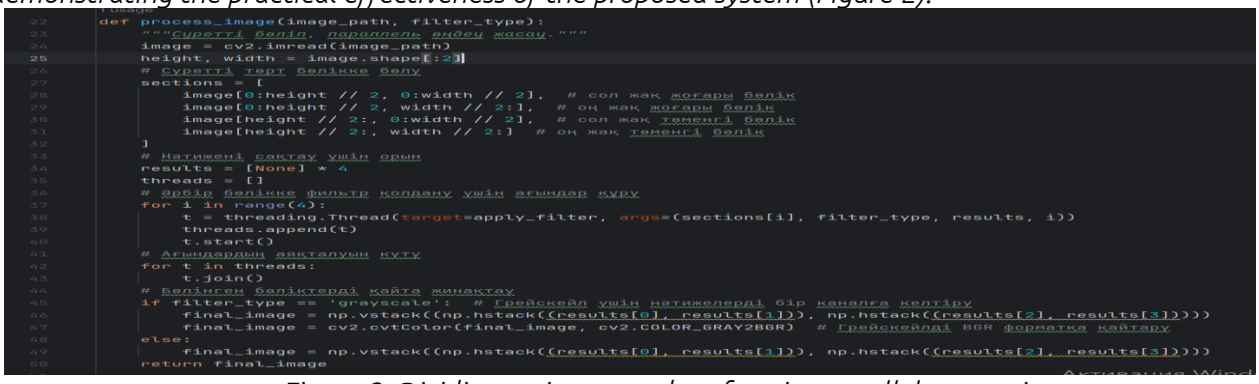
Parallel algorithms enhance the efficiency of image processing by utilizing the computational power of multi-core processors and multithreaded systems. Digital images consist of large volumes of data, and processing each pixel individually can be computationally intensive, especially for high-resolution images. By dividing an image into multiple segments and processing each segment concurrently, parallel algorithms significantly reduce overall computation time.

The selection of an appropriate parallel algorithm depends on several factors, particularly in image processing tasks. Parallel algorithms achieve optimal performance when implemented on multi-core processors or graphical processing units (GPUs), enabling efficient utilization of computational resources. Each thread or processor core independently processes a specific portion of the image, thereby accelerating execution. For example, processing a large image with four threads can potentially reduce execution time by a factor of four. Furthermore, parallel algorithms allow multiple filters to be applied simultaneously, so that operations such as Gaussian blur, edge detection, and grayscale conversion can be performed concurrently on separate image segments.

The implementation of a parallel algorithm follows a systematic approach. First, the image is divided into several regions, typically four segments: top-left, top-right, bottom-left, and bottom-right. Each segment is assigned to a separate thread, which performs specific processing operations, such as Gaussian blur, edge detection, or grayscale conversion. Once all threads complete their tasks, the processed segments are recombined to generate the final image.

The image is loaded using the cv2.imread function, which also handles resizing. Four threads are then created—one for each segment—each invoking the apply_filter function. The processed segments are stored in a results array. If a grayscale filter is applied, the output consists of a single channel; otherwise, the image remains in BGR format. The final image is reconstructed and displayed to the user.

Parallel processing not only accelerates computation but also improves energy efficiency. By distributing workloads across multiple threads, system resources such as processor cores and memory are utilized effectively, reducing power consumption and enhancing overall system performance. This approach delivers high performance across a variety of platforms, including modern multi-core CPUs and GPUs. Parallel image processing is particularly advantageous for real-time applications, such as video surveillance, medical imaging, autonomous vehicles, and high-speed video analysis. The adoption of parallel algorithms enables faster processing, improved system performance, and efficient resource utilization. Moreover, these techniques open opportunities for applications in artificial intelligence and machine learning, highlighting their potential for innovative technological development. To provide an interactive and user-friendly experience, the parallel image processing algorithm is integrated with a graphical user interface (GUI) developed using Tkinter. This interface allows users to select an image, choose a filter, and apply it concurrently to different segments. The apply_filter function executes in parallel threads, ensuring efficient application of operations such as Gaussian blur, edge detection, grayscale conversion, or sharpening. Tkinter components, including FileDialog for file selection, Label for image display, and Button for user actions, facilitate seamless interaction and real-time visualization. This integration of parallel processing with a GUI allows immediate observation of filtered results, demonstrating the practical effectiveness of the proposed system (Figure 2).



```
def process_image(image_path, filter_type):
    """Суретті бөліп, параллель өңдеу жасау."""
    image = cv2.imread(image_path)
    height, width = image.shape[:2]
    # Суретті төрт бөлікке бөлу
    sections = [
        image[0:height // 2, 0:width // 2],   # сол жақ жоғары бөлік
        image[0:height // 2, width // 2:],   # оң жақ жоғары бөлік
        image[height // 2:, 0:width // 2],   # сол жақ төменгі бөлік
        image[height // 2:, width // 2:]   # оң жақ төменгі бөлік
    ]
    # Нәтижені сақтау үшін орын
    results = [None] * 4
    threads = []
    # Әрбір бөлікке фильтр қолдану үшін ағындар құру
    for i in range(4):
        t = threading.Thread(target=apply_filter, args=(sections[i], filter_type, results, i))
        threads.append(t)
        t.start()
    # Ағындардың аяқталуын күту
    for t in threads:
        t.join()
    # Бөлінген бөліктерді қайта жинақтау
    if filter_type == 'grayscale':  # Грейскейл үшін нәтижелерді бір каналға келтіру
        final_image = np.vstack((np.hstack((results[0], results[1])), np.hstack((results[2], results[3]))))
        final_image = cv2.cvtColor(final_image, cv2.COLOR_GRAY2BGR)  # Грейскейлді BGR форматқа қайтару
    else:
        final_image = np.vstack((np.hstack((results[0], results[1])), np.hstack((results[2], results[3]))))
    return final_image
```

Figure 2. Dividing an image and performing parallel processing

To understand the practical implementation of the parallel image processing algorithm, the main steps of the code are analyzed. Initially, the image is loaded and resized using the cv2.imread function. The image is then divided into four segments: top-left, top-right, bottom-left, and bottom-right. These segments are processed in parallel using four separate threads, each invoking the apply_filter function to perform the selected image processing operation on its respective segment. The processed segments are stored in a list, and after all threads complete execution, the segments are recombined to form the final image. If a grayscale filter is applied, the resulting image is reduced to a single channel; otherwise, the output remains in the BGR color format. Finally, the processed image is displayed to the user.

Experimental Results

The parallel processing approach is highly effective for large and complex images, as it significantly reduces overall computation time while ensuring efficient utilization of system resources. By dividing the

image into multiple segments and applying filters concurrently, processing speed is increased, and overall system performance is enhanced. This method is particularly advantageous in applications such as video content processing, real-time video surveillance, and medical image analysis. In addition to improving speed, parallel processing enhances energy efficiency. Each thread executes specific operations, optimizing processor and memory usage, which reduces power consumption and improves long-term computational efficiency. Parallel algorithms also maintain high performance across diverse computing platforms, including modern multi-core CPUs and GPUs. Currently, this approach is widely applied in real-time systems such as autonomous vehicles, geospatial data processing, and high-speed video analysis. The continuous development of parallel processing technologies has considerably increased the ability to handle large datasets and enabled more efficient utilization of computational resources. In the future, these methods are expected to be further integrated into emerging fields such as artificial intelligence and machine learning. Consequently, parallel image processing not only overcomes the limitations of traditional image and video processing techniques but also facilitates the development of innovative solutions across multiple domains.

To provide a user-friendly interface, the algorithm is integrated with Tkinter, the standard Python GUI library. The implemented function allows users to select an image file, choose a filter type, and apply the selected filter in parallel to the image segments. The processed image is displayed directly within the Tkinter interface, providing real-time visualization of the results (Figure 4). This integration of parallel processing and an interactive GUI ensures a convenient, efficient, and accessible workflow for users, enabling immediate observation of filter effects and seamless interaction with the image processing system.

This part of the code prompts the user to select an image. The FileDialog.askopenfilename() function opens a file selection dialog and returns the path of the chosen file. The selected filter type is obtained from the user interface using filter_var.get(), where filter_var is a StringVar variable in Tkinter that stores the user's choice. The image is then processed by the process_image function, to which the parameters file_path and filter_type are passed. The process_image function applies the selected filter and returns the processed image.

The OpenCV library reads images in BGR format, whereas Tkinter requires images to be displayed in RGB format. Therefore, the image is converted from BGR to RGB using the cv2.cvtColor function. The NumPy array is then converted into a PIL image using Image.fromarray, and finally into a Tkinter-compatible image object using ImageTk.PhotoImage. The processed image is assigned to a Tkinter Label widget. When display_label.config(image=img_tk) is used, the image is displayed, and when display_label.image = img_tk is set, the image is preserved in memory; otherwise, it may not appear.

The code shown in Figure 5 creates the Tkinter graphical interface. It allows the user to select an image and also provides an option to exit the program.

```
# Tkinter интерфейсі
root = tk.Tk()
root.title("Сурет өңдеу: Параллель фильтр")

# Батырмаларды орналастыру үшін жаңа Frame жасаймыз
button_frame = tk.Frame(root)
button_frame.pack(pady=10)

# Сурет таңдау батырмасы
select_button = Button(button_frame, text="Суретті таңдаңыз", command=open_image)
select_button.grid(row=0, column=0, padx=5)

# Программадан шығу батырмасы
exit_button = Button(button_frame, text="Программадан шығу", command=root.quit, bg="red", fg="white")
exit_button.grid(row=0, column=1, padx=5)
```

Figure 3. Creating the Tkinter graphical interface

The graphical user interface (GUI) for the parallel image processing system is implemented using Tkinter, the standard Python library for building interactive applications. A main window, referred to as root, is created and titled "Image Processing: Parallel Filter", serving as the primary interface for user interaction.

To organize the interface elements, a frame named button_frame is created to group the control buttons. The frame is positioned within the main window using the pack(pady=10) method, providing a vertical padding of 10 pixels for proper spacing.

Two main buttons are incorporated within this frame. The first button, labeled "Select Image", allows users to browse and select an image file. When clicked, it invokes the open_image function, enabling the image to be loaded into the system for processing. This button is positioned in the first row and first column of the frame using the grid method with a horizontal padding of 5 pixels. The second button, labeled "Exit", is designed to terminate the application by calling root.quit. It is styled with a red background and white text for emphasis and is placed in the second row of the same column. As a result,

the Tkinter window provides a simple and intuitive interface with two primary functions: selecting an image to process and exiting the application. This design facilitates user interaction, allowing the parallel image processing workflow to be initiated or terminated easily (Figure 3).

Next, an interface is created that allows the user to select different filters and apply them to the image. Radio buttons are used to choose among the filters, and a label widget is used to display the image. This interface is simple and user-friendly (Figure 4).

```
# Фильтрді таңдау
filter_var = tk.StringVar(value="blur")  # әдепкі фильтр - blur
blur_radio = tk.Radiobutton(root, text="Гаусс фильтрі (Blur)", variable=filter_var, value="blur")
edge_radio = tk.Radiobutton(root, text="Шеттерді анықтау (Edge)", variable=filter_var, value="edge")
grayscale_radio = tk.Radiobutton(root, text="Грейскейл (Grayscale)", variable=filter_var, value="grayscale")
sharpen_radio = tk.Radiobutton(root, text="Шарпен фильтрі (Sharpen)", variable=filter_var, value="sharpen")

blur_radio.pack()
edge_radio.pack()
grayscale_radio.pack()
sharpen_radio.pack()

# Суретті көрсету
display_label = Label(root)
display_label.pack(pady=20)

# Tkinter қолданбасын іске қосу
root.geometry("800x600")
root.mainloop()
```

Figure 4. Selecting a filter and displaying the image in the Tkinter interface

An additional component of the Tkinter GUI allows users to select different filters and apply them to the loaded image. Radio buttons are employed to enable filter selection, while a Label widget is used to display the processed image, providing a simple and user-friendly interface (Figure 7).

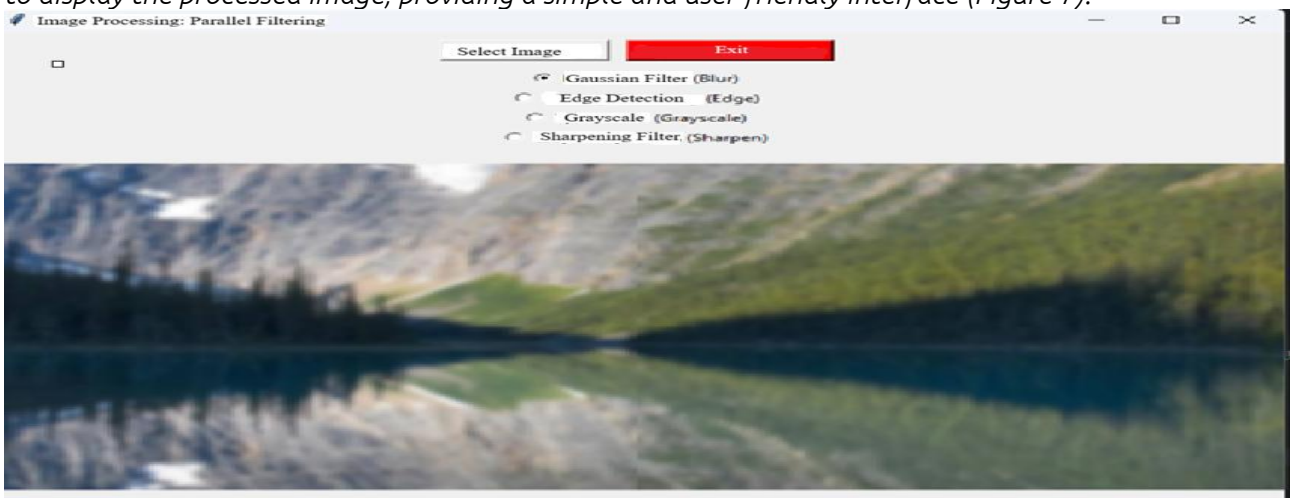


Figure 8. Result of the Gaussian filter

In this implementation, filter_var is a Tkinter StringVar variable that stores the currently selected filter type. The default value is set to blur, indicating that the Gaussian blur filter is initially applied. The program monitors this variable to determine which filter has been chosen and applies the corresponding processing operation to the image.

Four radio buttons are created, each representing a distinct filter option. Each button is labeled with descriptive text and assigned a corresponding value, which updates filter_var upon selection. The radio buttons are arranged vertically using the pack() method, ensuring consistent spacing and a clear visual layout (Figure 8).

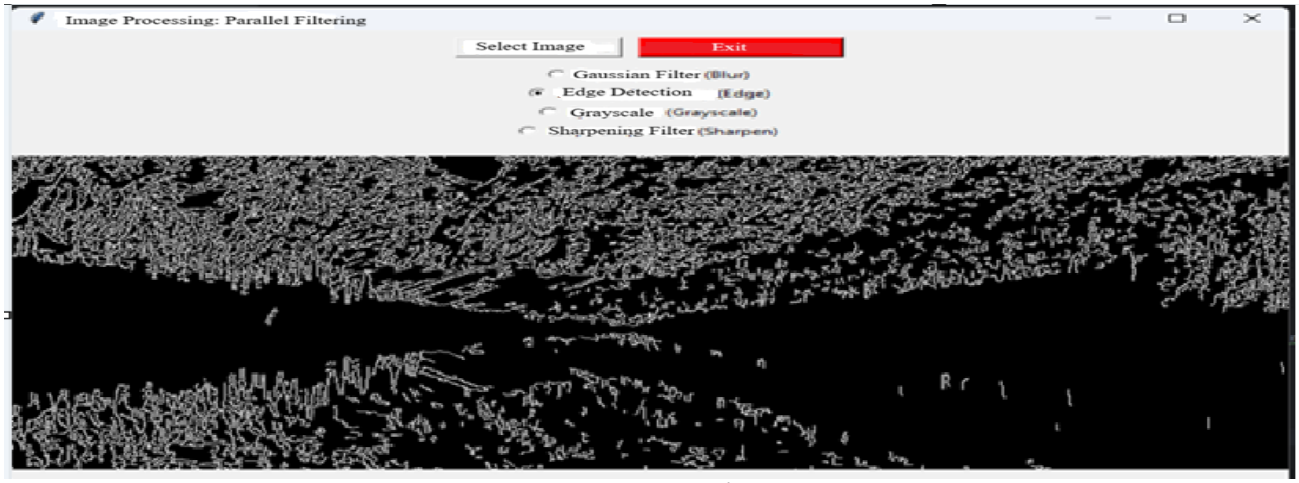


Figure 9. Result of the Edge Detection filter

A Label widget is used to display the processed image. After applying the selected filter, the image is rendered within this label. Vertical spacing around the label is provided using the pack(pady=20) method, enhancing the overall layout of the interface (Figure 9).

The main window dimensions are set to 800×600 pixels using root.geometry("800x600"), providing a comfortable working area for user interaction. The root.mainloop() function initiates the Tkinter event loop, continuously listening for user actions, such as image selection or filter changes.

Figure 10. Result of the Grayscale filter

This interface allows users to select a filter and immediately view the processed result. The effects of applying different filters are illustrated in Figures 8–11, demonstrating the practical application of parallel image processing in real time.

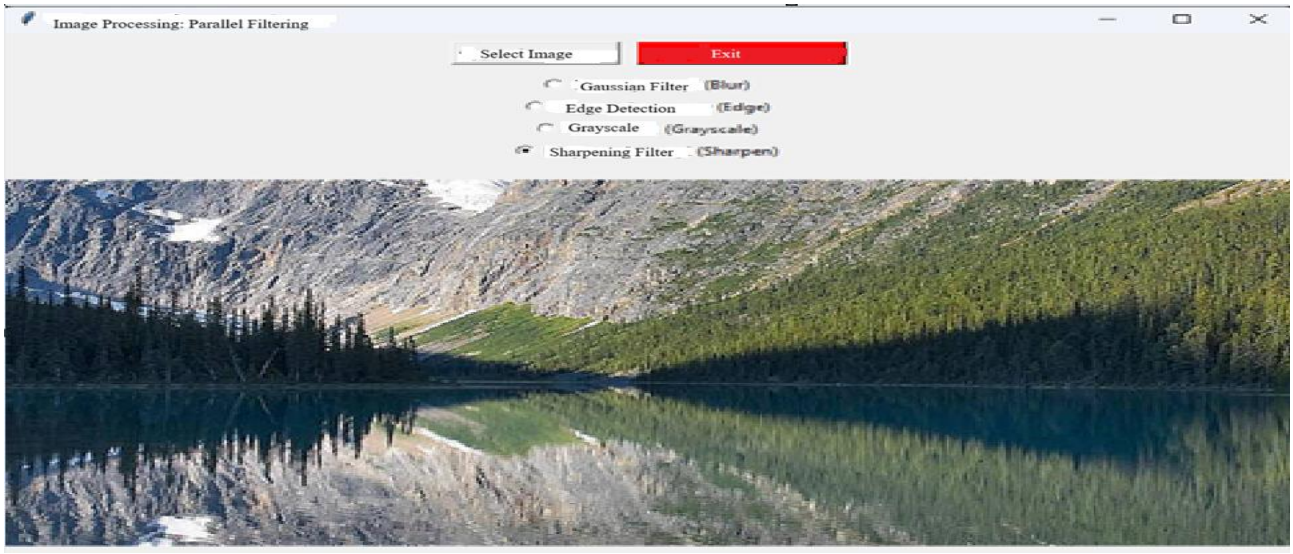


Figure 11. Result of the Sharpen filter

The implementation of parallel algorithms significantly enhances the efficiency of image processing and optimizes the utilization of system resources. Digital image processing typically involves large volumes of data, which can demand considerable computational time and resources. By dividing the processing task into multiple independent subtasks executed simultaneously, parallel processing substantially reduces overall computation time. Each filter applied in the system performs a specific function and exhibits distinct computational characteristics (Figure 11).

Conclusion

The Gaussian blur filter provides image smoothing and is particularly effective for reducing noise and eliminating unwanted details. When applied in a parallel processing framework, this filter can be executed independently on multiple image segments, thereby decreasing total processing time.

The edge detection filter identifies object boundaries and structural features, which is crucial in applications such as computer vision and medical image analysis. Parallel execution allows different regions of the image to be processed concurrently, resulting in faster and more efficient edge detection. The grayscale filter converts a color image into a single-channel black-and-white representation by removing color information while preserving essential structural details. Parallel processing of image segments improves performance when handling high-resolution or large-scale images. The sharpening filter enhances image clarity and emphasizes fine details and edges. In a multithreaded environment, different threads process separate image segments concurrently, reducing execution time and increasing overall efficiency.

By applying parallel algorithms, multiple filters can be executed simultaneously on different parts of an image. This approach not only accelerates processing but also maximizes the utilization of computational resources, including multi-core CPUs and graphical processing units (GPUs), ensuring high-performance image processing. Each filter's unique properties serve specific purposes, and parallel execution allows them to be applied rapidly and efficiently, which is especially important in real-time video and medical imaging applications.

Overall, high-performance parallel algorithms substantially improve the effectiveness, speed, and reliability of modern image processing systems, enabling advanced real-time applications and paving the way for further technological developments in the field.

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