IRSTI 34.01.45 https://doi.org/10.26577/JGEM202579411

O. Amangeldi[1*], K.D. Duisebaeva[1], A. Kyrbassov[2], N. Umirzakova[1], T. Kurt[3]

[1]Almaty Humanitarian Economic University, Almaty, Kazakhstan
[2]Abai Kazakh National Pedagogical University, Almaty, Kazakhstan
[3]Gazi University, Ankara, Turkey
*e-mail: ozerke1990@gmail.com

GEOGRAPHICAL CULTURE INDEX AS A TOOL FOR ASSESSING GEOGRAPHICAL THINKING IN SCHOOL AND UNIVERSITY GEOGRAPHY EDUCATION

This study discusses approaches to assessing and developing geographical culture, based on the Geographical Culture Index (GCI) model. The study aims to diagnose the main components of geographical culture (C1-C5) and determine the effectiveness of pedagogical interventions at the school and university level.

The study was conducted at School Gymnasium No. 81 in the Bostandyk district of Almaty and at the Department of Pedagogy of Natural Science and Physical Culture at the Almaty Humanitarian-Economic University. A total of 239 people voluntarily participated in the study, including 143 10-11th grade students and 96 1st–2nd year students specializing in «6B01503 – Training of Geography Teachers».

A mixed-methods approach was used as the methodological framework: quantitative data were analyzed using ANOVA, while qualitative results were assessed based on classroom observation and reflective interviews. Cronbach's coefficient $\alpha = 0.82$ confirmed the instrument's internal consistency and reliability.

The results showed positive dynamics in all components: spatial thinking (+12%), cartographic literacy (+15%), application of methods (+16%), data handling and modelling (+16%), and geographical image and worldview (+17%). The results of the intervention confirmed the effectiveness of the GCI model in forming and assessing geographical culture at school and university levels.

The study's conclusions emphasize the importance of integration and value-based approaches in geographical education, identifying new areas of pedagogical diagnostics.

Keywords: geographical culture, Geographical Culture Index (GCI), spatial thinking, cartographic literacy.

О. Амангелди[1*], К.Д. Дүйсебаева[1], А. Қырбасов[2], Н. Умирзакова[1], Т. Күрт[3]

[1]Алматы гуманитарлық-экономикалық университеті, Алматы, Қазақстан
[2]Абай атындағы Қазақ ұлттық университеті, Алматы, Қазақстан
[3]Гази университеті, Анкара, Түркия
*e-mail: ozerke1990@gmail.com

Географиялық мәдениет индексі – мектеп және жоғары оқу орындарындағы географиялық ойлауды бағалау құралы ретінде

Мақалада Geographical Culture Index (GCI) моделі негізінде географиялық мәдениетті бағалау және дамыту тәсілдері қарастырылған. Зерттеудің мақсаты – мектеп пен жоғары оқу орындары деңгейінде географиялық мәдениеттің негізгі компоненттерін (C1-C5) диагностикалау және педагогикалық интервенцияның тиімділігін анықтау.

Зерттеу Алматы қаласы, Бостандық ауданы № 81 мектеп-гимназиясында және Алматы гуманитарлық-экономикалық университетінің «Жаратылыстану педагогикасы және денешынықтыру» кафедрасы базасында жүргізілді. Барлығы N = 239 қатысушы зерттеуге ерікті түрде қатысты, олардың ішінде 10-11-сыныптың 143 оқушысы және «6B01503 – География мұғалімдерін даярлау» мамандығының 1-2 курсында оқитын 96 студент бар.

Әдістемелік негіз ретінде аралас әдіс (mixed-methods) қолданылды: сандық деректер ANOVA талдауы арқылы өңделсе, сапалық нәтижелер сабақ барысындағы бақылау және рефлексиялық сұхбаттар негізінде бағаланды. Cronbach's $\alpha = 0.82$ көрсеткіші GCI құралының ішкі сәйкестігі мен сенімділігін дәлелдеді.

Нәтижелер бойынша барлық компоненттерде оң динамика байқалды: кеңістіктік ойлау (+12%), картографиялық сауаттылық (+15%), әдістерді қолдану (+16%), деректер мен модель-

деу (+16%) және географиялық бейне мен дүниетаным (+17%). Интервенция нәтижелері GCI моделінің мектеп және жоғары оқу орындары деңгейінде географиялық мәдениетті қалыптастыру мен бағалауда тиімді құрал екенін көрсетті.

Зерттеу қорытындылары географиялық білім беруде интеграциялық және құндылықтық тәсілдердің маңыздылығын айқындап, педагогикалық диагностиканың жаңа бағыттарын ұсынады.

Түйін сөздер: географиялық мәдениет, географиялық мәдениет индексі (ГМИ), кеңістіктік ойлау, картографиялық сауаттылық.

О. Амангелди[1*], К.Д. Дуйсебаева[1],
А. Кырбасов[2], Н. Умирзакова[1], Т. Курт[3]

[1]Алматинский гуманитарно-экономический университет, Алматы, Казахстан
[2]Казахский национальный университет имени Абая, Алматы, Казахстан
[3]Университет Гази, Анкара, Турция
*e-mail: ozerke1990@gmail.com

Индекс географической культуры как инструмент оценки географического мышления в школьном и вузовском географическом образовании

В статье рассматриваются подходы к оценке и развитию географической культуры на основе модели Geographical Culture Index (GCI). Цель исследования – диагностировать основные компоненты географической культуры (C1-C5) и определить эффективность педагогической интервенции на уровне школы и вуза.

Исследование проведено на базе школы-гимназии № 81 Бостандыкского района города Алматы и кафедры «Педагогика естествознания и физическая культура» Алматинского гуманитарно-экономического университета. В исследовании добровольно приняли участие N = 239 человек, среди которых 143 учащихся 10-11-х классов и 96 студентов 1-2 курсов специальности «6B01503 – Подготовка учителей географии».

В качестве методологической основы использован смешанный подход (mixed-methods): количественные данные были обработаны с применением дисперсионного анализа (ANOVA), а качественные результаты оценены на основе наблюдения за учебным процессом и рефлексивных интервью. Коэффициент Cronbach's α = 0.82 подтвердил внутреннюю согласованность и надежность инструмента.

Результаты показали положительную динамику по всем компонентам: пространственное мышление (+12%), картографическая грамотность (+15%), применение методов (+16%), работа с данными и моделирование (+16%), географический образ и мировоззрение (+17%). Результаты интервенции подтвердили эффективность модели GCI в формировании и оценке географической культуры на школьном и вузовском уровнях.

Выводы исследования подчеркивают значимость интеграционного и ценностного подходов в географическом образовании и обозначают новые направления педагогической диагностики.

Ключевые слова: географическая культура, индекс географической культуры (ИГК), пространственное мышление, картографическая грамотность.

1. Introduction

Currently, the main goal of geographical education is to foster an environmentally and culturally responsible citizen who has a deep understanding of the interplay between nature and society and can think spatially.

According to the International Charter for Geographical Education (CGE, 1992: 4), geography is an important part of education for all societies, enabling the study of human–environment interactions at global and local levels. The document emphasizes the core mission of geographical education: to develop human spatial cognition and foster an informed attitude towards global environmental and social issues.

Chang and Kidman (2019) argue that the purpose of geographical education is to transmit knowledge and to develop pedagogical and assessment strategies that foster critical and spatial thinking among students (Chang & Kidman, 2019: 2).

Amrullaeva and Muzdybaeva (2021), meanwhile, emphasize the importance of geography education in achieving the Sustainable Development Goals, identifying its potential in fostering environmental responsibility and a culture of global thinking (Amrullaeva & Muzdybaeva, 2021: 14).

Therefore, the content and methodology of geographical education must be geared towards nurturing individuals who are well-equipped to address the global challenges of our time, by fostering spa-

tial thinking, environmental awareness, and a broad cultural outlook among students.

In the era of globalization, the relationship between humans and the environment is evolving, and the significance of geographical culture is growing (Anderson, 2021: 15). Geographical culture is a complex system that encompasses the human capacity to perceive and depict space and to understand the interplay of natural and social phenomena.

According to V.P. Maksakovsky, geographical culture is an integral part of an individual's general culture and is expressed through four main components: geographical thinking, the language of geography, research methods, and the geographical representation of the world (Maksakovsky, 1998). These components determine a person's level of spatial thinking and cartographic literacy, as well as their ability to connect with the environment.

Forming geographical culture is one of the strategic objectives of geography education in schools and universities. Research shows that students' ability to think geographically is related not only to knowledge content but also to the effectiveness of assessment and measurement methods. Mehren & Rempfler (2022) emphasized the importance of a systematic approach to evaluating geographical knowledge, proposing a novel methodology to measure students' capacity to grasp spatial and causal relationships (Mehren & Rempfler, 2022: 22).

Similarly, Virranmäki (2022) reveals the potential of geography education to foster analytical, critical, and creative thinking among students. He emphasizes that a geographical knowledge assessment system only produces effective results when combined with the development of higher-level thinking skills in students (Virranmäki, 2022: 15).

Taking these needs into account, this study proposes a Geographical Culture Index (GCI) model for the first time. This model is the author's methodology for comprehensively assessing students' and learners' geographical culture and determining its developmental effectiveness. The GCI model includes the five main components of geographical culture:

- Spatial and geographical thinking;
- Cartographic literacy,
- Use of geographical methods;
- Data and modelling ability;
- Geographic visualization.

The research focuses on the geographical education process at school and university level.

The subject is geographical culture and spatial thinking among students.

The research aims to determine the level of geographical culture among school and university students and to experimentally test the effectiveness of the author's Geographical Culture Index (GCI) model.

Objectives of the study:

- Analysing the theoretical foundations of the concept of geographical culture.
- Justifying the structural components of the GCI model.
- Assessing the level of geographical thinking and cartographic literacy among students based on the GCI model.
- Statistical analysis of the research results using ANOVA and ANCOVA methods.
- Determining the pedagogical effectiveness of implementing the GCI model in the educational process.

The research question is: "How effective is the proposed Geographical Culture Index (GCI) model for assessing and developing the level of geographical culture among school and university students?".

The hypothesis of the study is that if the GCI model is used in the educational process, it will contribute to improving students' and learners' geographical thinking ability, cartographic literacy, and spatial analysis.

The scientific novelty of the study lies in:

- The GCI model for assessing geographical culture was first proposed as an author's methodology and experimentally tested.
- The structural components of geographical culture have been scientifically substantiated, and a system of pedagogical measurements has been developed.
- The effectiveness of developing students' spatial thinking and cartographic abilities with the help of the GCI model has been proven.

The study involved students from grades 10 and 11 at school-gymnasium No. 81 in the Bostandyk District of Almaty, as well as students from years 1 and 2 of the Department of Pedagogy of Natural Sciences and Physical Culture at the Almaty Humanitarian-Economic University, specializing in the training of geography teachers. The experiment was conducted during April-May of the 2024-2025 academic year.

The results of the study allow pedagogical decisions to be made with the aim of improving the content of geographical education at the school and university levels, updating teaching methods, and developing geographical culture. At the present stage, improving the content of geographical edu-

cation and updating teaching methods is the main condition for improving the quality of education. Developing geographical culture and forming spatial thinking requires an effective combination of pedagogical approaches. In geography teaching, the relationship between content, research and experience is a key mechanism for developing students' critical and analytical abilities (Puttick, 2022: 900). Using innovative pedagogical technologies, such as project-based and problem-based learning methods, activates logical and creative thinking (Belov, 2025: 6). Introducing digital and geoinformation technologies into the educational process improves the quality of geography teaching and creates conditions for enhancing teachers' professional competencies (Usenov et al., 2023: 155).

In this context, integrating modern pedagogical approaches and information technologies is an effective way to develop students' geographical culture and spatial thinking.

2. Literature review

The following areas have been covered by scientific approaches to the research topic and analyses of previous studies.

The issue of the formation of geographical culture and the education of the younger generation remains relevant in the broader context of modern society. According to V. P. Maksakovsky, a lack of geographical education at all levels, from ordinary citizens to managers, creates significant difficulties in the implementation of socio-economic decisions. He also highlights the importance of developing geographical thinking, spatial outlook, and geographical culture in society (Maksakovsky, 1998).

Geographical culture is a system of knowledge and values that reflects the interaction between humans, society, and the environment. It enables us to understand, depict and model regularities in natural and social spaces. It enables individuals to understand the spiritual and moral links between nature and society and fosters environmental responsibility. In Maksakovsky's works, geographical culture is characterized by four main components: geographical thinking, the language of geography, methods of geographical study, and the geographical worldview (Maksakovsky, 1998: 1-3).

Geographical culture is not merely a body of knowledge; it is also a spiritual value that fosters an attitude of creativity, analysis, and environmental responsibility in individuals (Abdurakhmonov, 2021: 77). It explains how humans interact with the environment and how these connections impact beliefs and social structures. Geographical culture plays a special role in geography education, contributing to students' understanding of how people, places, and the environment interact. By focusing on cultural diversity, geography encourages learners to respect the origins, traditions, and beliefs of different peoples, fostering tolerance and shared values (Singha & Beyond, 2019: 1567). Furthermore, incorporating students' personal cultural experiences into the learning process boosts their engagement with the subject and strengthens the connection between knowledge and real-life applications (Karadeniz, 2020: 45).

From this perspective, the formation of geographical culture is one of the main objectives of geography teaching. It contributes to the personal development of schoolchildren and to the strategic goal of general education: the spiritual and intellectual development of the individual (Baransky, 1934: 10). The structure of geographical culture is based on scientific and general geographical knowledge in the field of modern geography. Its most important component is geographical thinking. Geographical thinking is the human ability to understand spatial cause-and-effect relationships and analyze natural and socio-economic processes in an integrated way. This concept is manifested in two main characteristics: cartographic thinking, which is the ability to recognize geographical conditions on a map and predict how processes will develop, and complex thinking, which is the ability to understand the interrelation of natural and socio-economic processes. This concept was first introduced in 1938 by N.N. Baransky, who emphasized the need to analyse geographical thinking on the basis of a territorial approach. Over the last half a century, the emergence of new theories and methods in geographical science has required 'new geographical thinking' (Maksakovsky, 1998).

Modern research considers the development of geographical culture and spatial thinking through new methodological and technological aspects. Gintsyak (2024: 53) emphasizes the importance of mastering fundamental concepts such as maps, scales, and directions through practical exercises, offering effective strategies for nurturing spatial thinking skills in schoolchildren. Kaymuldinova et al. (2024) analyzed the professional and cognitive aspects of developing cartographic competence in higher geographical education, noting that this competence forms an integral part of geographical culture. Duarte et al. (2022) proposed approaches to as-

sessing spatial thinking based on GIS technologies, which have been shown to positively impact the quality of education in higher education institutions.

In recent years, the problem of assessing geographical thinking has become one of the main areas of focus in pedagogical research. Abdulvagabova (2023: 12) considers geographical education to be the primary mechanism through which an individual's cultural worldview is formed. Hickman (2022) demonstrates that spatial analysis and data handling skills have a direct impact on the quality of knowledge and determine the effectiveness with which GIS and quantitative data analysis methods are integrated into the development of spatial thinking. Lee and Jo (2022), meanwhile, describe international approaches to assessing geographical thinking that are based on systematic and critical thinking, emphasizing the importance of improving assessment criteria.

Innovative pedagogical technologies have a significant impact on the development of geographical culture. Gaipova et al. (2023) demonstrated that innovative technologies such as virtual excursions, interactive maps, and geographic information systems can enhance students' spatial analysis and critical thinking abilities in geography lessons. Alimkulov (2025) noted the effectiveness of STEAM, project-based, and problem-based learning methods in developing the project competencies of future geography teachers, demonstrating that these approaches enhance professional training and foster innovative thinking. Zbereanu (2024) empirically demonstrated the positive impact of introducing digital technologies in school geography lessons on learning outcomes, showing increased student motivation and engagement.

In general, recent research shows that geographical culture development is closely related to educational content, innovative teaching methods, spatial thinking assessment systems, and pedagogical technologies. These findings provide a scientific basis for developing the Geographical Culture Index (GCI) model, defining a new methodological approach to comprehensively assessing and developing geographical culture.

Research from the last five years (2020-2025) explains the development of geographical culture in terms of both the content of knowledge and the influence of innovative pedagogical approaches and digital technologies. This approach strengthens the methodological basis for developing the GCI model.

Analysis of the current literature shows that, while the structure and content of geographical culture have been thoroughly considered, precise measurement mechanisms and diagnostic models remain to be unified. Although Maksakovsky and his followers proposed a theoretical framework of geographical culture, the methodology of its quantitative assessment and the system of indicators adapted to the educational context have not yet been fully developed. Furthermore, although foreign studies have considered the development of spatial thinking and cartographic literacy through learning technologies (Kidman, 2019; Virmani, 2022), these studies have systematically failed to describe the relationship between cultural components and their integrative influence.

This study is therefore the first to adapt the GCI model based on the five components of geographical culture and test it at the school and university levels.

3. Materials and Methods

3.1. Participants

The study was conducted among students in years 10 and 11 of general education schools in Almaty, as well as students in years one and two of university. The research was carried out at School-Gymnasium No. 81 in the Bostandyk district of Almaty and at the Department of Natural Science Pedagogy and Physical Culture at the Almaty Humanitarian-Economic University. The experiment took place during April-May of the 2024-2025 academic year.

A total of 239 participants voluntarily took part in the study, including 143 secondary school students in years 10 and 11 and 96 university students specializing in the training of geography teachers. All participants were selected from among those studying geography.

Selection criteria:

Students studying geography.

- above-average academic performance;
- give consent to voluntarily participate in the study.

The data of the study participants are summarized in table 1 below.

As shown in Table 1, the study involved a total of 239 participants, 60% of whom were schoolchildren. The participation of university students enabled the evaluation of geographical culture at the highest level of education. These data ensure the reliability of the research results.

Table 1 – Composition of the study participants (compiled by the authors)

No	Group / Class	Female	Male	Total
1	Grade 10 “А”	14	11	25
2	Grade 10 “Ә”	13	14	27
3	Grade 10 “Б”	10	6	16
4	Grade 10 “А”	14	13	27
5	Grade 10 “Ә”	13	12	25
6	Grade 10 “Б”	13	10	23
	Total	**77**	**66**	**143**
7	1st-year university studens	29	28	57
8	2nd-year university studens	21	18	39
	Total (university students)	**50**	**46**	**96**
	Overal total	**127**	**112**	**239**

3.2 Research Design

The research was conducted using an experimental design based on a mixed-method approach. This approach enabled a thorough characterization of the complex pedagogical and spatial-geographical features of the research subject, combining quantitative and qualitative data.

The study used the Geographical Culture Index (GCI) model, and its effectiveness was evaluated by comparing the results of the pre- and post-tests. The aim was to compare the geographical cultural levels of learners before and after the intervention.

The application of mixed methods was based on the integrated analysis of transformational learning approaches in educational geography, as described by Jones & Walker (2019), and on the principle of enhancing the relationship between qualitative and quantitative geoinformatics analysis data, as proposed by Yoon & Lubienski (2017). Additionally, as demonstrated by Soler & Aliaga-Aguza (2025), mixed methods are recognised as an effective tool for evaluating pedagogical values and methodological strategies.

The research process consisted of three main stages:

- Initial diagnosis (GCI-pre): determining the initial level of geographical culture of the participants;
- The pedagogical intervention learning stage: conducting special classes that included components of the GCI model (spatial thinking, cartographic literacy, working with data, modelling and geographic video);
- Final diagnosis (GCI-post): comparing the results after the intervention with the initial data and conducting statistical analyses (ANOVA and ANCOVA).

This approach enabled the effectiveness of the GCI model in developing students’ geographical culture to be evaluated comprehensively, based on the principles of systematicity and triangulation inherent in mixed-methods research.

3.3 GCI Model and Data Collection Methods

The Geographical Culture Index (GCI) model, which was developed by the author, is a methodological tool used to comprehensively assess the level of geographical culture among students. The model is theoretically based on V.P. Maksakovsky’s (1998) four components of geographical culture: geographical thinking, spatial orientation, ecological culture, and geographical image. However, in light of modern educational requirements and the updated curricula of the Republic of Kazakhstan, the model has been supplemented with a fifth component.

The teaching content, based on the spiral principle of the modern education system, ensures the sequential continuation of geographical knowledge in grades 7-11. In this regard, the GCI model includes five main components aimed at forming geographical culture in students.

Spatial-geographical thinking: describes learners’ ability to compare spatial phenomena, analyze maps, and establish cause-and-effect relationships.

Cartographic literacy includes skills in reading and analysing graphic information on geographical maps and symbols (C2).

Use of geographical methods shows the level of proficiency in measuring, observing, experimenting, and studying natural and social phenomena (C3).

- Data work and modelling: assesses the ability to analyze statistical and numerical data, produce diagrams, and create models (C4).

- Geographical image and worldview: covers the nature of society and the interconnected culture of perception in spatial environments, as well as environmental and civic responsibility (C5).

The GCI model's theoretical novelty lies in its introduction of a system for assessing geographical culture. This approach enables individual and aggregate indicators for each component to be calculated for learners.

The GCI formula is as follows:

$$GCI = \frac{C1 + C2 + C3 + C4 + C5}{5}$$

where C1-C5 are the mean scores calculated for each component.

The quantitative results of the GCI index assess participants' level of geographical knowledge on a four-level scale ranging from low to high (low, medium, sufficient, high).

The GCI model corresponds to the strategic directions of geographical education as defined in the National Academy of Education's methodological and instructional letter named after I. Altynsarin for the academic year 2025-26 (Ministry of Education of the Republic of Kazakhstan, 2025) This document outlines the main goal of teaching geography in modern Kazakhstani schools: the formation of geographical culture and the development of spatial thinking. In this regard, the GCI index is introduced as a new scientific tool that meets the requirements of the national education standard and updated curriculum.

Mixed methods were employed to collect the data. Quantitative data were obtained through surveys and diagnostic tests, while qualitative data were collected via observations, open-ended questions, essays, and analyses of teachers' and students' opinions. All information was collected on the basis of a prior agreement and in accordance with the principles of confidentiality.

3.4 Data Analysis

The data obtained during the study were analyzed using a mixed-methods approach, combining quantitative and qualitative techniques. This approach enabled a thorough interpretation of the results and an impartial evaluation of the effectiveness of the GCI model.

The quantitative analysis of the data involved:

GCI test scores were evaluated using a scoring system for each component (C1-C5), and the participants' overall index was calculated using the above formula. The arithmetic mean (mean), standard deviation (SD), and percentage for each component were determined.

Analysis of variance methods were used to determine the differences between the GCI pre- and post-stage results:

- ANOVA (analysis of variance) was used to assess the level of change in scores within the same group;

- ANCOVA (analysis of covariance) was used to analyze the initial level of the trainees and compare the results before and after the intervention.

In the analyses, a value of $p < 0.05$ was accepted as reflecting statistical significance. The results were presented in charts and tables, and when interpreting them, the contribution and dynamics of changes in each component were considered individually.

Qualitative Data Analysis:

Students' responses to open-ended questions, observation protocols, and essay texts were used as qualitative data. These materials were processed using content analysis and grouped into recurring themes and semantic categories.

The analysis examined students' reflective thinking, their practical impressions of participating in the GCI model, and the dynamics of geographical culture formation. The qualitative data complemented the interpretation of the quantitative results, serving as proof of the model's pedagogical effectiveness.

Validity and reliability:

All diagnostic tools were pretested. The internal consistency of the questionnaires and test items was assessed using the Cronbach's alpha coefficient (the accepted level is $\alpha \geq 0.7$). The reliability of the qualitative data was ensured by comparing the study results with those from different sources (triangulation) and expert judgement.

Overall, the data processing and analysis stage revealed the relationship between the structural components of the GCI model, the level of students' spatial-geographical thinking development, and the effectiveness of the pedagogical intervention.

3.5 Ethical Considerations and Limitations

All academic honesty and research ethics requirements were observed during the study. All participants were informed of the purpose and content

of the study in advance and gave their consent to participate voluntarily. The results of the questionnaires and diagnostic tests were kept confidential, and no personal data was disclosed.

The ethical principles were fulfilled in accordance with the scientific research rules of the Republic of Kazakhstan and the university's internal code of ethics. All data were used for scientific purposes only, and the results did not permit the personal characteristics of the participants to be revealed during interpretation.

The study's limitations mainly depended on the sample size and the time taken to collect the data. As the study was conducted in one school and one higher education institution in Almaty, the findings may be difficult to disseminate across the whole country. Additionally, the use of mixed methods was time-consuming and resource-intensive, resulting in unequal sizes of the control and relative groups.

However, these limitations did not significantly affect the scientific value or practical significance of the research results or the GCI model.

3.6 Assessment Instrument for Ceographical Culture Index

To determine pupils' and students' level of geographical culture, a special diagnostic test has been developed. Designed according to the five components of the GCI model, the test aims to assess students' competence in each component.

The purpose is to provide a comprehensive measurement of students' geographical cultural development (C1-C5).

The test consists of 30 tasks (six for each component). Each task aims to identify students' theoretical knowledge, practical skills, and spatial analysis skills.

GCI components and task templates:

C1. Spatial thinking:

1. Identify the pattern of the location of major cities in Kazakhstan on a map.

2. Explain the relationship between rivers and mountain ranges on a map.

C2. Cartographic Literacy:

1. Map the symbols of minerals on a map.

2. Identify the intersection of the 45th parallel and the 60th meridian on an atlas.

C3. Use of geographic methods:

1. Make a simple plan for recording plant species in a schoolyard.

2. Complete a short observation report (e.g., three days of weather monitoring).

C4: Data and statistical analysis (data and statistics):

1. Analyze the graph showing Kazakhstan's population dynamics.

2. Draw conclusions from a graph representing monthly rainfall.

C5. Modelling and geographic images:

1. Create a model of urban population growth, considering the associated transport and environmental impacts.

2. Predict how climate change will affect agriculture.

The evaluation scale is given in Table 2 below.

Table 2 – Geographical Culture Index Rating Scale (compiled by the authors)

Level	Percentage range	Description
Low level	0-40%	The geographical culture is at an emerging stage; knowledge and understanding are limited to basic concept and fragmented representations.
Moderate level	41-60%	Core geographical concepts and methods are partially formed the ability to apply knowledge is inconsistent.
Sufficient level	61-75%	Geographical knowledge and spatial thinking are systematically developed and applied with confidence.
High level	76-100%	All components of geographical culture are comprehensively mastered; spatial reasoning and problem-solving skills are demonstrated at a creative and analytical level.

The test results were calculated using the GCI index formula.

This diagnostic tool was tested at the experimental stage and found to be valid using Cronbach's alpha coefficient ($\alpha = 0.82$).

The structure of the test and the evaluation system fully correspond to the educational objectives set out in the instructional letter on education and methodology of the National Academy of Education named after I. Altynsarin (Ministry of Education of the Republic of Kazakhstan, 2025).This defines the formation of geographical culture and the development of spatial thinking as a strategic goal of geography teaching.

Therefore, the Geographical Culture Index (GCI) is a new, evidence-based tool that will be presented as a pedagogical innovation and incorporated into the education system in this study.

4. Results and Discussion

This study assessed the Geographical Culture Index (GCI) in five components: spatial-geographical thinking (C1), cartographic literacy (C2), use of geographical methods (C3), data and modelling (C4), and geographical image and worldview (C5). The intervention structure consisted of within-subject assignments, short research projects, and map- and data-based analyses. The pre-test results characterized the baseline level of the students, while the post-test demonstrated the effect of the intervention. The data were analysed using a mixed-method approach: the quantitative analysis examined average percentages and magnitudes of change, while the qualitative analysis examined attendance, reflective responses, and work samples. The comparative results presented in Table 3 therefore show that gains were made in all components after the intervention. Particularly high momentum was observed in areas C3 and C5, suggesting the effectiveness of systematically introducing methodological actions (e.g., measurements, observations, and working with field data) and spatial image modelling during training.

The table illustrates several important trends. Foremost among these is the clear advancement of a set of skills (C2), such as map reading, understanding of scale and projections, and the use of symbols. This advancement is the result of systematic time devoted to practical tasks and map analytics. Additionally, the rise in data and modelling (C4) has been achieved by strengthening interdisciplinary links with mathematics and informatics. Thirdly, the increase in C5 involved tasks that required a holistic approach to content topics (nature, society, and the economy). The overall index increased from 63% to 78%, indicating the intervention's impact on learning outcomes.

Table 3 – Comparative results of GCI components (pre/post) (compiled by the authors)

GCI components	Description	GCI-pre (%)	GCI-post (%)	Δ (Change)
C1	Spatial geographical thinking	62	74	+12
C2	Cartographic literacy	64	79	+15
C3	Use of geographical methods	66	82	+16
C4	Data work and modeling	61	77	+16
C5	Geographical image & worldview	63	80	+17
Average index (GCI)		**63**	**78**	**+15**

The visualization below presents the pre/post comparison of the components of the GCI model as a radial diagram. This clearly shows the pattern of growth and which components were the leading drivers.

The expansion of the Post area from the Pre area in the diagram confirms progress in all directions, with the greatest contribution coming from the C3 and C5 components. This makes it easy to interpret the results and make a pedagogical decision quickly. Visual interpretation complements tabular analysis, allowing the effective elements of the intervention architecture to be highlighted.

The mean overall GCI value increased from 63 percent to 78 percent, indicating a 15 percent difference. This index indicates significant development in the main components of geographic culture, such as spatial thinking, cartographic literacy, data handling, modelling, and geographic video.

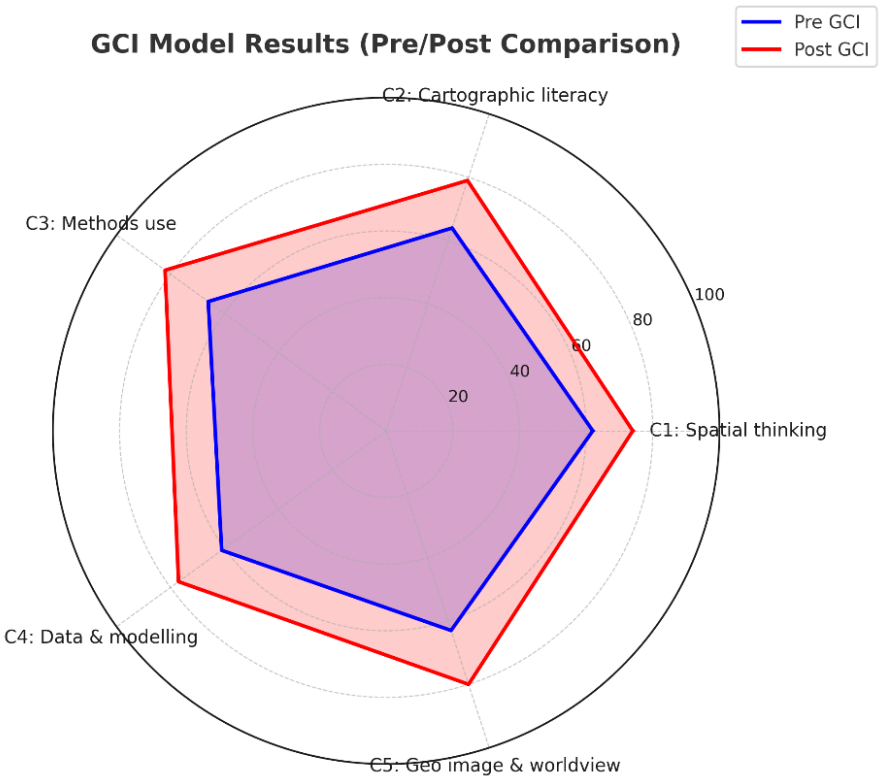

Figure 1 – Visualization of GCI model results (pre/post test comparison) (compiled by the authors)

The study's results showed that implementing an integrative approach in the educational process improves students' spatial thinking, analytical skills, and ability to model geographical information. Thus, the GCI model was identified as a diagnostic and pedagogically effective tool for assessing and developing geographical culture.

The internal consistency score was used to assess the reliability of the GCI instrument. Each GCI (C1-C5) showed a correlation between components and heterogeneity of responses, with δ = 0.82.

The calculation formula is as follows:

$$a = \frac{k}{k-1} \times \left(1 - \frac{\sum \sigma_i^2}{\sigma_t^2}\right)$$

Where k is the number of tasks, σ_i^2 is the variance of each task, and σ_t^2 is the total variance.

The result is α = 0.82, indicating a very good level of reliability (an internal reliability level of 0.2-0.9 is considered high). Consequently, the GCI indicators have high internal consistency, and the test is stable and suitable for measuring intervention outcomes.

One-way ANOVA (one-factor analysis of variance) was used to determine the differences between the students' Geographic Culture Index (GCI) results before and after the intervention. This method enables us to assess the impact of the intervention.

Model pattern:

$$GCI_{post} = \mu + Intervention + \epsilon$$

Where μ is the overall mean, intervention is the experimental effect factor, and ϵ is the random error.

The analysis showed that the difference in GCI scores before and after the intervention was significant ($F(1, 180) = 4.95$, $p < 0.001$, $\eta^2 = 0.17$). This indicates that the intervention impacted all components of geographic culture (C1-C5). Calculated Cronbach's alpha (α = 0.82) proves that the GCI instrument used has a high level of internal consistency.

Diagnosis of the GCI showed clear differences between pre- and post-intervention scores for the five components of geographical culture: spatial thinking, cartographic literacy, use of methods, data and modelling, and geographical representation and

worldview. Positive dynamics were recorded in all areas, with an average increase of 15 percentage points, which was particularly evident in the method use (C3) and geographical representation (C5) components. ANOVA results proved that this difference was statistically significant ($F(1, 180) = 4.95$, $p < 0.001$, $\eta^2 = 0.17$), indicating a moderate yet robust intervention effect. The Cronbach score $\alpha = 0.82$ indicates the high internal consistency of the GCI instruments used. This result substantiates the reliability of the research methodology and the pedagogical validity of the model.

The comparison of GCI results is consistent with international findings. Metoyer & Bednarz (2015) demonstrated that spatial thinking forms the basis of geographical thinking and that introducing geographical information technology in the classroom enhances students' ability to imagine and analyze spatially. In this sense, the 12% increase in spatial-geographical thinking (C1) observed in our study is consistent with their findings. Jo & Hong (2018) highlight the link between developing geographic information thinking skills and increased civic responsibility. This is supported by the increase in components C4 (data and modelling) and C5 (geographic video) observed in our study.

Nazarenko (2019) considers map literacy to be the basis of communication and security, demonstrating that map reading skills are sociocultural rather than purely technical. The growth of the C2 component (+15%) in the GCI results supports this idea, demonstrating that working with maps has become a means not only of spatial understanding but also of building a culture of effective geographic information communication. These results also complement Valieva's (2023) findings on pupils' cartographic literacy. She showed that cartographic reading and analysis are underdeveloped in school geography through a questionnaire study, and our intervention produced results that compensated for this deficiency.

Combining Maksakovsky's concept with a description of four structural components of geographical culture in higher education (geographical thinking, methods, cartographic literacy, and language of geography) is achieved by Appoeva & Bayramkulova (2020). GCI model builds on this framework to include geographical image and worldview as a fifth component, in line with current educational requirements. In their study, students' cartographic and cognitive skills grew in stages, which is consistent with the results of our GCI post.

The most effective way to develop geographical skills, as identified by Kozlova (2020), is through a teaching approach that involves students conducting their own research and completing research tasks. This concept is also integral to our intervention design, with elements of inquiry and research (e.g., fieldwork and data analysis) strengthening students' methodological skills and ensuring growth in C3 and C4. Thus, systematically applying research activities in the classroom increased the qualitative measure of geographic culture in the GCI model.

The philosophical underpinnings of our research direction are closely aligned with the Transformative Sustainable Curricula (TSC) model pioneered by Granados-Sánchez (2022). Its stages, "Adaptation-Reform-Transformation", enable us to characterize the practical transformation of the GCI model.

Granados-Sánchez's (2022) Transformative Sustainable Curricula (TSC) model is intertwined with our line of inquiry at a philosophical level. The practical transformation of the GCI model can be characterized using its stages, which are Adaptation, Reform and Transformation. Our intervention is close to the "Reform" level: educational content has been updated, and students have developed systemic and constructive thinking skills by interacting with data, maps, and models. In the future, to move to the "Transformation" level of the TSC model, the links between the curriculum and society need to be expanded, increasing the social impact of geographic culture.

In general, the results obtained coincide with the main conclusions of foreign authors: geographical culture is characterized by the development of spatial and cartographic thinking, working with data and models, and forming an ecologically valuable worldview. The GCI model has proven to be an effective tool for measuring and analysing these indicators.

Furthermore, the results of the study demonstrate the importance of the combined application of qualitative and quantitative methods when assessing the formation of geographical culture. This approach aligns with the concept of 'transformative learning' as outlined by Granados-Sanchez (2022) and Sterling (2012): Geography should be viewed not only as a subject but also as an experiential domain capable of altering worldviews.

The results of this study expand the role of geography in today's education system. The GCI model enables the transformation of educational content and learning experiences by developing V. P. Mak-

sakovsky's four components. It is presented for the first time in the context of Kazakhstan as a tool for the systematic assessment of the pedagogical diagnosis of geographical culture.

Conclusion

The results of the study demonstrated the effectiveness of the Geographical Culture Index (GCI) model in providing a comprehensive assessment of the various components of geographical culture (spatial thinking, cartographic literacy, the use of geographical methods and data, modelling, and geographical imagery and worldviews). The intervention produced positive results for all components, with the overall index rising from 63% to 78%. ANOVA analysis revealed a statistically significant difference ($F(1, 180) = 4.95$, $p < 0.001$, $\eta^2 = 0.17$), while Cronbach's $\alpha = 0.82$ confirmed the reliability of the GCI instruments.

The GCI model enables an integrative approach to be implemented in geographical education, extending Maksakovsky's four-component theory in five directions that meet modern educational requirements. The study's results proved that developing spatial and cartographic thinking, modelling, research skills, and an ecological outlook is a crucial strategic direction in geography teaching. Thus, the GCI model is presented as an innovative and practical tool for diagnosing and developing geographical culture in the Kazakhstani education system.

Recommendations

In line with the Ministry of Education of the Republic of Kazakhstan's strategic objectives, which prioritize the development of geographical knowledge and thinking in education, it is recommended that the five-component structure of the Geographical Culture Index (GCI), as presented in this study, be incorporated into geography teaching at the school and university level.

Teachers and educators are encouraged to use the GCI model as a diagnostic and monitoring tool to regularly assess students' level of geographical culture through control testing and comparative analysis. This will enable the dynamics of students' spatial and cartographic literacy, analytical and modelling skills, and ecological and civic worldview to be tracked.

As the GCI is a new term and methodological tool in pedagogical geography, further research is also recommended to deepen its theoretical foundations, test it in various educational contexts, and expand its application to other regions and academic levels.

References

Abdulvagabova, S. A. (2023). Geographical education as the basis for the formation of geographical culture. In Modern geographical education: Problems and development prospects (pp. 10–13). [in Russian].

Abdurakhmonov, B. M. (2021). Formation of geographical culture through a complex of teaching aids. Economics and Society, 1–2(80). Retrieved from https://clck.ru/3M7wwB [in Russian].

Alimkulov J. Innovative methods in geography education: strategies for developing project-based competency among future teachers // Economics and society. 2025. №3-2 (130). URL: https://cyberleninka.ru/article/n/innovative-methods-in-geography-education-strategies-for-developing-project-based-competency-among-future-teachers

Amrullaeva, S. A., & Muzdybaeva, K. K. (2021). Geographical education as a tool for achieving sustainable development goals. Bulletin of Abai KazNPU. Series "Geographical and Environmental Sciences", 4(70), 14–18. [in Russian].

Anderson, J. (2021). Understanding cultural geography: Places and traces (3rd ed.). London: Routledge. – 280 p. https://doi.org/10.4324/9780367814816

Appoeva, L. I., & Bayramkulova, B. O. (2020). Formation of geographical culture of students at the university. International Journal of Experimental Education, (6), 50–53. [in Russian].

Baransky, N. N. (1934). On teaching economic geography. Geography at School, (1), 3–13. [in Russian].

Belov, V. O. (n.d.). Innovative pedagogical technologies in the process of forming logical actions among students in geography lessons. Scientific-Methodological Journal, 6–10. [in Russian].

Chang C.H., Kidman G. Curriculum, pedagogy and assessment in geographical education – for whom and for what purpose? // *International Research in Geographical and Environmental Education*. – 2019. – Vol. 28, No. 1. – P. 1–4. https://doi.org/10.1080/10382046.2019.1578526

Commission on Geographical Education of the International Geographical Union (CGE IGU). *International Charter on Geographical Education.* – 1992. – 2016 edition. – 6 p.

CGE IGU (Commission on Geographical Education of the International Geographical Union). (2016). *International Charter on Geographical Education*. International Geographical Union, 6 p.

Duarte, L., Teodoro, A. C., & Gonçalves, H. (2022). Evaluation of Spatial Thinking Ability Based on Exposure to Geographical Information Systems (GIS) Concepts in the Context of Higher Education. *ISPRS International Journal of Geo-Information*, 11(8), 417. https://doi.org/10.3390/ijgi11080417

Gaipova, R., Turdybekova, Z., & Bayramova, A. (2023). The use of innovative technologies in geography teaching. Economics and Society, 12(115)-1. Retrieved from https://cyberleninka.ru/article/n/ispolzovanie-innovatsionnyh-tehnologiy-v-prepodavanii-geografii [in Russian].

Gintsyak, S. V. (2024). Formation of students' spatial thinking skills in geography lessons. Editorial Board Proceedings, 53–57. [in Russian].

Granados-Sánchez, J. (2022). Levels of Transformation in Sustainable Curricula: The Case of Geography Education. Sustainability, 14(8), 4481. https://doi.org/10.3390/su14084481

Hickman, J. (2022). Spatial thinking and GIS: developing and assessing student competencies. *International Research in Geographical and Environmental Education,* 32(2), 140–158. https://doi.org/10.1080/10382046.2022.2138172

Jo, Injeong and Hong, Jung Eun (2018) "Geography Education, Spatial Thinking, and Geospatial Technologies: Introduction to the Special Issue," *International Journal of Geospatial and Environmental Research:* Vol. 5: No. 3, Article 1. Available at: https://dc.uwm.edu/ijger/vol5/iss3/1

Jones, J., & Walker, S. L. (2019). Transformative learning in community college human geography: a mixed methods study. *Journal of Geography in Higher Education*, 43(4), 452–467. https://doi.org/10.1080/03098265.2019.1660865

Karadeniz, C. B. Assessment for Awareness and Perception of the Cultural Heritage of Geography Students / C. B. Karadeniz // Review of International Geographical Education (RIGEO). – 2020. – T. 10, № 1 (Special issue). – P. 40–64. – [Electronic resource]. – Available: http://www.rigeo.org/vol10no1/Number1Spring/RIGEO-V10-N1-2.pdf

Kaymuldinova, K. D., Beykitova, A. N., Sabdenaliyeva, G. M., & Zhandosova, G. O. (2024). Cartographic competence in higher geography education research: A review of the subject field. Higher Education in Russia, 33(4), 144–168. [in Russian].

Kozlova, G. V. (2020). Research activity of students in the study of geography. In Modern geographical education: Problems and development prospects (pp. 72–74). [in Russian].

Lee, J., Jo, I. (2022). Assessing Spatial Skills/Thinking in Geography. In: Bourke, T., Mills, R., Lane, R. (eds) Assessment in Geographical Education: An International Perspective. Key Challenges in Geography. *Springer, Cham.* https://doi.org/10.1007/978-3-030-95139-9_4

Maksakovsky, V. P. (1998). Geographical Culture: A Textbook for Universities. Moscow: Vlados. [in Russian].

Mehren, R., & Rempfler, A. (2022). Assessing systems thinking in geography. In Bourke, T., Mills, R., & Lane, R. (Eds.), *Assessment in Geographical Education: An International Perspective* (pp. 19–34). Cham: Springer. https://doi.org/10.1007/978-3-030-95139-9_2

Metoyer, S. K., Bednarz, S. W., & Bednarz, R. S. (2015). Spatial thinking in education: Concepts, development, and assessment. In Geospatial technologies and geography education in a changing world: Geospatial practices and lessons learned (pp. 21-33). *Tokyo: Springer Japan.*

Ministry of Education of the Republic of Kazakhstan. (2025). Methodological guidelines for general education schools for the 2025–2026 academic year. Astana: MOE RK. [in Kazakh].

Nazarenko, T. (2019). Cartographic Literacy as a Condition of Communication and Security. *Intercultural Communication*, 1(6), 117-137.

Puttick, S. (2022). Geographical education I: fields, interactions and relationships. *Progress in Human Geography*, 46(3), 898-906. https://doi.org/10.1177/03091325221080251

Singha, T. Beyond The Textbook: Incorporating Culturally Responsive Teaching In Geography / Tuhin Singha // Ilkogretim Online – Elementary Education Online. – 2019. – T. 18, № 3. – Б. 1564–1571. – DOI: 10.17051/ilkonline.2019.612787.

Soler, S., & Aliaga-Aguza, L. M. (2025). Active Methodologies, Educational Values, and Assessment Strategies in Master's Theses: A Mixed-Methods Study by Gender and Educational Level in Geography and History Teacher Education. *Trends in Higher Education,* 4(3), 42. https://doi.org/10.3390/higheredu4030042

Valieva, E. S. (2023). Formation of cartographic literacy in the process of studying geography at school (based on a survey). In Lomonosov Scientific Readings of Students and Young Scientists of the Higher School of Natural Sciences and Technologies SAFU (p. 67). [in Russian].

Virranmäki, E. (2022). *Geography's ability to enhance powerful thinking skills and knowledge. Nordia Geographical Publications, 51*(1). Geographical Society of Northern Finland. https://doi.org/10.30671/nordia.113997

Yoon, E.-S., & Lubienski, C. (2017). Thinking Critically in Space: Toward a Mixed-Methods Geospatial Approach to Education Policy Analysis. *Educational Researcher,* 47(1), 53-61. https://doi.org/10.3102/0013189X17737284 (Original work published 2018)

Zbereanu, G. (2024). The effects of using digital technologies on high school geography learning. *Journal of Innovation in Psychology, Education and Didactics,* 28(1), 47-60. https://doi:10.29081/JIPED.2024.28.1.05

Usenov, N., Layshanov, S., Abikbaev, E., & Issakov, Y. (2023). Experience in using geoinformation technologies in the secondary education system of developing countries. Journal of Educational Sciences, 75(2), 150–160. https://doi.org/10.26577/JES.2023.v75.i2.014 [in Kazakh].

Information about authors:

Amangeldi Ozerke (corresponding author) – Senior Lecturer at the Department of Pedagogy of Natural Sciences and Physical Education, Almaty Humanitarian Economic University (Almaty, Kazakhstan, e-mail: ozerke1990@gmail.com);

Duisebayeva Kulzada – Candidate of Geographical Sciences, Almaty Humanitarian Economic University (Almaty, Kazakhstan, e-mail: kulzada.duisebayeva@gmail.com);

Kyrbassov Akzhan – Doctoral Student of Abai Kazakh National Pedagogical University (Almaty, Kazakhstan, e-mail: akjan_91@mail.ru);

Umirzakova Nagima – PhD, Senior Lecturer at the Department of Pedagogy of Natural Sciences and Physical Education, Almaty Humanitarian Economic University (Almaty, Kazakhstan, e-mail: Umirzakova-nagi@mail.ru);

Turker Kurt – PhD, Associate Professor, Faculty of Education, Gazi University (Ankara, Turkey, e-mail: turker@gazi.edu.tr).

Авторлар туралы мәлімет:

Амангелди Озерке (корреспондент автор) – жаратылыстану педагогикасы және денешынықтыру кафедрасының аға оқытушысы, Алматы гуманитарлық-экономикалық университет (Алматы, Қазақстан, e-mail: ozerke1990@gmail.com);

Дуйсебаева Кульзада – г. г. к., Алматы гуманитарлық-экономикалық университет (Алматы, Қазақстан, e-mail: kulzada.duisebayeva@gmail.com;

Қырбасов Ақжан – Абай атындағы ҚазҰПУ-дың докторанты (Алматы, Қазақстан, e-mail: akjan_91@mail.ru);

Умирзакова Нагима – PhD, жаратылыстану педагогикасы және денешынықтыру кафедрасының аға оқытушысы, Алматы гуманитарлық-экономикалық университет (Алматы, Қазақстан, e-mail: Umirzakova-nagi@mail.ru);

Туркер Курт – PhD, білім беру факультетінің қауымдастырылған профессоры, Гази университеті (Анкара, Түркия, e-mail: turker@gazi.edu.tr).

Сведения об авторах:

Амангелди Озерке (корреспондент автор) – старший преподаватель кафедры педагогики естествознания и физической культуры, Алматинский гуманитарно-экономический университет (Алматы, Казахстан, e-mail: ozerke1990@gmail.com);

Дуйсебаева Кульзада – к. г. н., Алматинский гуманитарно-экономический университет (Алматы, Казахстан, e-mail: kulzada. duisebayeva@gmail.com);

Кырбасов Акжан – докторант КазНПУ им. Абая (Алматы, Казахстан, e-mail: akjan_91@mail.ru);

Умирзакова Нагима – PhD, старший преподаватель кафедры педагогики естествознания и физической культуры, Алматинский гуманитарно-экономический университет (Алматы, Казахстан, e-mail: Umirzakova-nagi@mail.ru);

Туркер Курт – PhD, ассоциированный профессор факультета образования, Университет Гази (Анкара, Турция, e-mail: turker@gazi.edu.tr).

Received: September 1, 2025
Accepted: December 5, 2025