Asian Journal of Scientific Research and Innovations
ISSN: 2715-xxxx (online) | IF: 10.23 | Vol: 1, issue 1
Available: http://asiansciencejournal.org

CONCEPT AND STRUCTURAL–FUNCTIONAL MODEL OF CARTOGRAPHIC TRAINING FOR FUTURE GEOGRAPHY TEACHERS BASED ON INTERACTIVE CARTOGRAPHIC TOOLS

Ibrokhim Turdaliyev Erali ugli
Namangan State university, teacher of the Department of Geography and Environmental Protection
e-mail: ibrokhimturdaliev@gmail.com

Abstract: The rapid development of digital technologies and Geographic Information Systems (GIS) has significantly transformed the content and methodology of geography education. Modern geography teachers are expected not only to possess comprehensive geographical knowledge but also to effectively apply cartographic technologies, spatial analysis, and interactive educational resources in the teaching process. This study aims to develop a concept and structural–functional model of cartographic training for future geography teachers based on interactive cartographic tools. The proposed concept considers cartographic training as a three-system pedagogical process consisting of professional, specialized, and methodological components. These systems are integrated through innovative educational approaches, interactive technologies, methodological support, practical implementation, and competency assessment. A structural–functional model was developed using theoretical analysis, systems approach, pedagogical modeling, and comparative analysis. The model places interactive cartographic tools at the center of the educational process and demonstrates the interrelationships among educational objectives, technological infrastructure, instructional methods, practical activities, and assessment mechanisms. The proposed framework contributes to the development of cartographic competence, spatial thinking, digital literacy, and professional readiness of future geography teachers. The model can be applied in higher education institutions preparing geography teachers and may serve as a methodological basis for curriculum modernization in geography education.

Keywords: cartographic training, geography teacher education, interactive cartographic tools, GIS, structural–functional model.

Introduction

The digital transformation of education has fundamentally changed the requirements for teacher preparation across all disciplines. Geography, as one of the most visually oriented sciences, has experienced particularly significant changes due to the rapid development of Geographic Information Systems (GIS), remote sensing technologies, online mapping platforms, and interactive cartographic resources. Consequently, the professional preparation of future geography teachers must evolve from traditional map-reading instruction toward competency-based education that integrates digital cartography, spatial analysis, and

innovative pedagogical approaches.

Cartographic competence has become one of the key professional competencies of geography teachers. It includes not only the ability to read and interpret maps but also the capacity to create, analyze, and apply digital cartographic information for solving educational and environmental problems. Modern geography teachers are expected to integrate interactive maps, web-based GIS platforms, satellite imagery, and spatial databases into classroom instruction, enabling students to develop spatial thinking and analytical skills.

Despite the growing importance of cartographic technologies, many higher education institutions continue to rely on traditional teaching methods in cartographic education. In numerous teacher education programs, theoretical knowledge remains insufficiently connected with practical GIS applications and innovative teaching methodologies. As a result, graduates often experience difficulties integrating digital cartographic tools into their professional activities.

The modernization of geography teacher education therefore requires the development of a comprehensive pedagogical framework capable of integrating theoretical knowledge, technological competence, and methodological skills into a unified educational system. Such a framework should ensure the systematic formation of cartographic competence while supporting the development of professional and pedagogical competencies required by contemporary educational standards.

The present research addresses this challenge by proposing a conceptual framework and structural–functional model of cartographic training for future geography teachers based on interactive cartographic tools. Unlike traditional approaches that focus primarily on technical cartographic skills, the proposed concept considers teacher preparation as a holistic pedagogical process consisting of three interconnected systems: the professional system, the specialized system, and the methodological system. These systems interact continuously throughout the educational process and are supported by modern interactive technologies.

The professional system is responsible for developing pedagogical competence, geographical knowledge, communication skills, educational values, and digital literacy. The specialized system focuses on cartographic knowledge, GIS technologies, spatial analysis, remote sensing, and digital mapping. The methodological system integrates educational theories, instructional technologies, interactive teaching methods, and practical teaching experience, enabling future teachers to effectively implement cartographic resources in geography classrooms.

The main objective of this research is to develop a structural–functional model that explains the interaction among these three systems and demonstrates how interactive cartographic tools contribute to the formation of comprehensive cartographic competence. The proposed model is intended to serve as a methodological foundation for improving geography teacher education programs and promoting the integration of digital technologies into educational practice.

Materials and Methods

The research is based on the principles of systems theory, competency-based education, constructivist learning, and digital pedagogy. The study employed qualitative research methods aimed at developing a conceptual and structural model of cartographic training for future geography teachers.

A comprehensive review of scientific literature on geography education, teacher preparation, cartographic competence, GIS-based learning, and interactive educational technologies was conducted to identify current trends and theoretical foundations. National educational standards, professional competency frameworks, and modern approaches to geography teacher education were also analyzed.

The systems approach served as the principal methodological framework for developing the conceptual model. Within this approach, cartographic training was considered an integrated educational system consisting of interdependent components rather than isolated instructional elements. Structural analysis was used to determine the internal organization of the proposed model, while functional analysis identified the role of each component within the overall educational process.

Pedagogical modeling constituted the core research method. A structural–functional model was designed to represent the relationships among educational objectives, technological infrastructure, instructional methods, practical activities, and competency assessment. The model was developed according to the principles of integrity, continuity, feedback, flexibility, and competency orientation.

Comparative analysis was applied to evaluate traditional approaches to cartographic education and compare them with contemporary interactive learning environments. Special attention was given to the educational potential of Geographic Information Systems (GIS), interactive maps, digital atlases, web-based cartographic platforms, and multimedia educational resources.

The resulting conceptual framework defines cartographic training as a three-system educational process integrating professional, specialized, and methodological components. These systems interact through five functional blocks: innovative educational approaches, interactive technology infrastructure, methodological support, educational practice, and assessment mechanisms. Interactive cartographic tools occupy the central position within the model, ensuring continuous interaction among all educational components and supporting the formation of comprehensive professional competence.

The effectiveness of the proposed model was evaluated theoretically by examining its consistency with competency-based educational principles, modern digital learning environments, and current trends in geography teacher education. The model is intended to provide a flexible framework that can be adapted to different institutional conditions and educational contexts while maintaining its fundamental structural relationships.

Results and Discussion

The conceptual framework developed in this study considers cartographic training as an integrated pedagogical system in which professional, specialized, and methodological

preparation are inseparable components of a unified educational process. Unlike traditional approaches, where cartographic education is often limited to studying maps and their interpretation, the proposed model expands the content of training by incorporating interactive cartographic technologies, GIS applications, innovative teaching methods, and competency-based assessment. Consequently, future geography teachers develop not only technical cartographic skills but also pedagogical and methodological competencies required for modern educational practice.

The proposed structural–functional model consists of three interrelated systems. The professional system provides the pedagogical foundation of teacher education. It focuses on developing geographical knowledge, pedagogical competence, communication skills, educational values, and digital literacy. Within this system students acquire theoretical understanding of geographical processes, educational psychology, curriculum design, and classroom management. Professional competence also includes the ability to organize educational activities, communicate effectively with learners, and continuously improve teaching performance through reflective practice.

The specialized system is aimed at developing cartographic competence through the acquisition of modern geospatial technologies. Students study the principles of cartography, geographic information systems, remote sensing, spatial databases, digital mapping, and thematic map design. Practical training includes creating digital maps, performing spatial analysis, interpreting satellite imagery, and processing geographical data using GIS software. As a result, students develop spatial thinking and analytical skills that enable them to investigate geographical phenomena more effectively.

The methodological system connects theoretical preparation with professional teaching practice. This component develops the ability to design geography lessons using interactive cartographic tools and modern educational technologies. Students learn to organize project-based learning, inquiry-based instruction, collaborative activities, case studies, and research-oriented lessons. The methodological system ensures that technological knowledge acquired within the specialized subsystem can be effectively transferred into classroom teaching.

The interaction among these three systems is illustrated in Figure 1.

Structural–Functional Model of Cartographic Training for Future Geography Teachers Based on Interactive Cartographic Tools

The central element of the model is Interactive Cartographic Tools, which function as the integrating component of the entire educational system. Around this central component five functional blocks are organized, each performing a specific role while maintaining continuous interaction with the others.

The first block, Innovative Educational Approaches, determines the conceptual basis of cartographic education. It includes educational objectives, learning outcomes, theoretical foundations, and pedagogical principles. This block establishes the educational philosophy upon which the entire training system is constructed.

The second block represents the Interactive Technology Infrastructure, which provides

the technological environment necessary for implementing digital cartographic education. It includes GIS software such as ArcGIS and QGIS, online mapping services including Google Earth and OpenStreetMap, multimedia educational resources, Internet technologies, and digital spatial databases. These technologies enable students to visualize geographical phenomena, perform spatial analyses, and work with authentic geospatial information.

The third block comprises Methodological Research and Teaching Approaches. This component integrates innovative instructional methods including project-based learning, problem-based learning, collaborative learning, practical GIS assignments, case studies, and interactive classroom activities. These instructional strategies encourage active participation and independent investigation, thereby improving the quality of geographical learning.

The fourth block corresponds to Educational Practice, where theoretical knowledge is transformed into professional teaching experience. Laboratory exercises, field investigations, GIS projects, seminars, conferences, and teaching practice allow students to apply acquired competencies in real educational contexts. Practical implementation strengthens professional confidence while improving the ability to solve authentic educational problems.

The fifth block includes the Assessment and Evaluation Mechanism, which continuously monitors competency development throughout the educational process. Competency assessment is performed through practical examinations, GIS projects, electronic portfolios, classroom observations, self-assessment, and reflective evaluation. Feedback obtained from these assessment activities contributes to the continuous improvement of both instructional methods and student learning outcomes.

The relationships among these five blocks are represented by multidirectional connections indicating that the educational process operates as a dynamic system rather than a sequence of isolated instructional stages. Information continuously circulates among conceptual planning, technological implementation, methodological support, educational practice, and assessment, ensuring the adaptability and sustainability of the proposed model.

The structural relationships illustrated in Figure 1 demonstrate that interactive cartographic tools serve not merely as educational resources but as the central mechanism coordinating all components of teacher preparation. Their integration promotes the development of comprehensive cartographic competence while simultaneously strengthening professional and methodological competencies.

To clarify the internal organization of the proposed model, the main characteristics of the three educational systems are summarized in Table 1.

Characteristics of the Three-System Model of Cartographic Training

Educational System Main Content Competencies Developed

Professional System Geography, pedagogy, psychology, communication, digital literacyProfessional competence, pedagogical competence

Specialized System Cartography, GIS, remote sensing, spatial databases, digital mapping

Cartographic competence, GIS competence, spatial thinking

Asian Journal of Scientific Research and Innovations
ISSN: 2715-xxxx (online) | IF: 10.23 | Vol: 1, issue 1
Available: http://asiansciencejournal.org

Methodological System Interactive teaching methods, lesson planning, project work, assessment technologies Methodological competence, instructional competence

Table 1 demonstrates that each educational system contributes different competencies while functioning together within a unified pedagogical framework. None of the systems can independently ensure comprehensive teacher preparation. Their effectiveness depends upon continuous interaction and integration.

The functional blocks of the model are summarized in Table 2.

Functional Blocks of the Structural–Functional Model

Functional Block Primary Function Educational Contribution

Innovative Educational Approaches Defines goals, principles and theoretical foundationsDetermines educational direction

Interactive Technology Infrastructure Provides GIS technologies and digital resources. Supports technology-enhanced learning

Methodological Approaches Organizes instructional methods and teaching strategies. **Improves instructional quality**

Educational Practice Implements practical training and teaching experience Develops professional skills

Assessment Mechanism Evaluates competency development and provides feedback. **Ensures continuous quality improvement**

As shown in Table 2, the proposed model combines theoretical preparation, technological support, instructional methodology, practical implementation, and assessment into a coherent educational system. Such integration significantly improves the continuity of teacher preparation and reduces the gap between university education and professional teaching practice.

The implementation of the proposed model is expected to improve several dimensions of professional competence. Students acquire stronger geographical knowledge, develop advanced spatial thinking skills, master modern GIS technologies, improve digital literacy, and become capable of designing learner-centered geography lessons supported by interactive cartographic resources. Furthermore, the model promotes independent learning, critical thinking, collaborative problem solving, and lifelong professional development.

Compared with traditional cartographic instruction, the proposed concept creates substantially richer educational opportunities. Students no longer function as passive recipients of cartographic information but become active participants in creating, analyzing, and interpreting spatial data. Such educational transformation corresponds to the current requirements of digital education and competency-based teacher preparation.

The proposed structural–functional model therefore provides not only a theoretical framework for organizing cartographic training but also practical guidance for improving university curricula. Its flexibility enables adaptation to different institutional conditions while preserving the fundamental relationships among educational objectives, technological

infrastructure, teaching methodology, practical implementation, and competency assessment. Consequently, the model may serve as an effective methodological basis for modernizing geography teacher education in higher education institutions.

Conclusion

The modernization of geography teacher education requires the integration of innovative pedagogical approaches with contemporary geospatial technologies. In this context, the present study proposed a concept and structural–functional model for the cartographic training of future geography teachers based on interactive cartographic tools. The proposed concept considers cartographic training as a holistic pedagogical process rather than a collection of isolated theoretical and practical courses.

A distinctive feature of the proposed concept is the integration of three interrelated educational systems: the professional, specialized, and methodological systems. The professional system provides the pedagogical and geographical foundation necessary for teaching activities. The specialized system develops cartographic knowledge, GIS competencies, spatial analysis skills, and digital literacy, while the methodological system enables future teachers to transform these competencies into effective educational practice through innovative instructional methods and interactive learning technologies.

The structural–functional model demonstrates that interactive cartographic tools perform a central integrating role within the educational process. Rather than serving merely as supplementary teaching resources, they connect educational objectives, technological infrastructure, methodological support, practical activities, and competency assessment into a unified educational system. This integration promotes the systematic development of professional competencies required for modern geography teaching.

The analysis also indicates that the proposed model contributes to improving the quality of geography teacher preparation by strengthening spatial thinking, digital competence, cartographic literacy, and methodological readiness. Through the continuous interaction among conceptual planning, technological implementation, practical experience, and assessment, future teachers acquire the ability to apply cartographic technologies effectively in solving educational and geographical problems.

The practical significance of the research lies in the possibility of applying the proposed model within bachelor's and master's programs preparing geography teachers, professional development courses, and curriculum modernization projects. The model may also be adapted to other educational contexts where digital cartographic technologies constitute an essential component of professional training.

Although the present research is conceptual in nature, it establishes a theoretical and methodological foundation for further empirical investigations. Future studies should experimentally evaluate the effectiveness of the proposed model by comparing learning outcomes of students trained through traditional instructional approaches and those participating in competency-based cartographic education supported by interactive technologies. Such research would provide quantitative evidence concerning the impact of

the model on professional competence, digital literacy, and teaching effectiveness.

Overall, the proposed structural–functional model represents a comprehensive framework capable of supporting the modernization of geography teacher education in accordance with contemporary educational standards and the ongoing digital transformation of geographical sciences.

REFERENCES

1. Акабоев И.З., Хакимов М.М., & Турдалиев И.Э. (2023). ЗНАЧЕНИЕ ЭКОЛОГИЧЕСКИХ КАРТ В ОХРАНЕ ПРИРОДЫ И ОКРУЖАЮЩЕЙ СРЕДЫ. Экономика и социум, (6-1 (109)), 593-598.
2. Abduraxmonov, B. M. (2023). TABIIY GEOGRAFIYA DARSLARI UCHUN KARTOGRAFIK KATALOG YARATISH. Research and education, 2(5), 319-325.
3. Turdaliyev, I. E., & BM, A. (2023). Фойдаланган адабиётлар. O ‘ZBEKISTON RESPUBLIKASI OLIY TA’LIM, FAN VA INNOVATSIYALAR VAZIRLIGI NAMANGAN DAVLAT UNIVERSITETI GEOGRAFIYA KAFEDRASI, 362.
4. Абдурахмонов Б. М., Рахимов И. Б., Турдалиев И. Э. СОСТОЯНИЕ ПРОБЛЕМЫ ИСПОЛЬЗОВАНИЯ СОВРЕМЕННЫХ СРЕДСТВ ОБУЧЕНИЯ В ГЕОГРАФИЧЕСКОМ ОБРАЗОВАНИИ // Экономика и социум. 2025. №6-1 (133).
19. 5.Naimov, H. N. (2022). Analysis of structure and geoeecological situation of North Fergana mountain landscape. Экономика и социум, (6-1 (97)), 193-196.
6. Naimov H.N Shimoliy Farg‘ona tog‘oldi landshaftlarining strukturasi, baholash va geoekologik vaziyati // Geografiya fanlari falsafa doktori (PhD) ilmiy darajasini olish uchun yozilgan dissertatsiya. Samarqand 2025