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REVIEW

of the doctoral dissertation of **Dipl. Eng. Nikoleta [redacted] Nikolova**
entitled
"ANALYSIS OF THE SYMBOL SYSTEM AND CONTENT OF WEB MAPS"
submitted in partial fulfillment of the requirements for the award of the educational and scientific degree of Doctor (PhD)
in Professional Field 5.7 Architecture, Civil Engineering and Geodesy,
Doctoral Programme "Cartography and GIS",
Department of Photogrammetry and Cartography,
University of Architecture, Civil Engineering and Geodesy (UACEG)
by

Prof. Dr. Dipl. Eng. Temenoujka Bandrova
University of Architecture, Civil Engineering and Geodesy (UACEG), Sofia
Member of the Scientific Jury

General Information on the Procedure

Dipl. Eng. Nikoleta Nikolova was enrolled as a full-time doctoral student by Rector's Order No. 115 of 27 February 2023 at the Department of Photogrammetry and Cartography, Faculty of Geodesy, University of Architecture, Civil Engineering and Geodesy (UACEG), under the supervision of Prof. D.Sc. Dipl. Eng. Stanislav Vasilev, for a three-year period commencing on 1 March 2023. She was admitted to the doctoral programme "Cartography and GIS."

In the dissertation, however, she has incorrectly stated the doctoral programme as "Photogrammetry and Remote Sensing Methods," while in the dissertation abstract she refers to the doctoral programme as "Cartography (including Thematic Geographic Cartography)."

She successfully passed the two examinations required to fulfill the doctoral minimum requirements. She was subsequently deregistered with the right to defend her dissertation by Rector's Order No. 83 of 2 February 2026.

General Information about the Candidate

Dipl. Eng. Nikoleta Nikolova graduated from the University of Architecture, Civil Engineering and Geodesy in 2022 with a degree in Geodesy, specializing in Cartography and GIS. Between 2023 and 2026, she carried out her doctoral research at UACEG.

In 2025, she participated in a short-term Erasmus mobility programme at Masaryk University in Brno, Czech Republic.

She has worked for GeoPlus, GfK, Pontech, and the World Bank Group, primarily in the field of GIS technologies.

The dissertation submitted for the award of the educational and scientific degree of Doctor (PhD) in Professional Field 5.7 Architecture, Civil Engineering and Geodesy, Doctoral Programme "Cartography and GIS," is organized into a list of abbreviations, an introduction, nine chapters, a glossary of terms, lists of tables, figures, and appendices.

The dissertation comprises 170 pages of text, 133 figures, 19 tables, and 27 appendices. The bibliography contains more than 100 references, including 7 in Bulgarian and the remainder in English.

Relevance of the Research Topic

The topic, "Analysis of the Symbol System and Content of Web Maps," is highly relevant due to the widespread adoption of web-based geoinformation technologies and the growing importance of digital cartography across numerous areas of public and economic life.

The effective design of symbol systems and the appropriate representation of cartographic content are essential prerequisites for the accurate perception, interpretation, and use of spatial information by a broad range of users. An analysis of these aspects contributes to the improvement of web maps, enhances their functionality, and increases the quality of the visual communication of geographic information.

In the next part, I will translate the "Characteristics of the Dissertation" section, including the research object, objectives, methodology, and the detailed review of each chapter.

Certainly. Here is Part 2 of the translation.

Characteristics of the Dissertation

The dissertation states that "the subject of the research is web maps" (p. 2), whereas the abstract states that "the object of the research is web maps and their symbol systems" (p. 7). The subject and the object of the research should be defined clearly and unambiguously and distinguished from one another throughout the dissertation.

The objective of the research is to analyse the effectiveness of the symbol system and the content of web maps by evaluating cartographic symbols, legends, and interactive elements, and to develop recommendations for improving cartographic design and the quality of cartographic communication. To achieve this objective, contemporary usability evaluation methods are employed, including user testing and eye-tracking technologies.

The first chapter examines the theoretical foundations of the effectiveness and usability of cartographic products. Existing classifications of web maps are presented, together with the principles of cartographic communication, interaction design, and the factors influencing the perception and use of web maps by different groups of users.

The second chapter is devoted to the theoretical aspects of cartographic symbols and symbol systems. It analyses the principles of cartosemiotics, visual variables, cartographic

communication, and the criteria for evaluating the effectiveness of cartographic symbols in a web environment.

The third chapter presents an overview of eye-tracking technologies and their potential applications in the study of cartographic products. The principal types of eye-tracking systems, their characteristics, and their application in analysing users' visual perception are discussed.

The fourth chapter develops a classification framework for methods of evaluating the quality of web maps. It systematises methods for analysing content, usability, user experience, technological characteristics, and cartographic visualisation.

The fifth chapter presents the organisation and results of an experimental study investigating the effectiveness of different combinations of visual variables used in cartographic symbols. A statistical analysis of the obtained results is conducted in order to evaluate the influence of symbol size, colour, and structure on users' perception.

The sixth chapter analyses the usability of existing web maps and geoportals by assessing their functionality, navigation, and technological characteristics. An expanded classification of web maps is proposed, reflecting contemporary trends in the development of web cartography.

The seventh chapter presents an experimental study employing eye-tracking technology to analyse the perception of cartographic symbols, legends, and individual elements of cartographic design. The results make it possible to identify characteristic patterns of users' visual behaviour while working with web maps.

The final chapter formulates practical recommendations for improving cartographic symbols, legends, navigation elements, and the overall functionality of web maps. Based on the conducted research, a prototype cartographic product has been developed that implements the proposed guidelines for enhancing cartographic communication.

Scientific and Applied Contributions

The developed classification of methods for evaluating web maps, the application of eye-tracking technologies, and the practical recommendations for improving cartographic design undoubtedly represent valuable contributions.

At the same time, some of the claimed contributions should be regarded as having a predominantly applied scientific character rather than constituting fundamental theoretical advances. For example, the updated classification of web maps, the typology of difficulties encountered when working with geoportals, and the developed recommendations represent further development and systematisation of existing approaches rather than entirely new scientific concepts.

Nevertheless, these contributions may be considered original within the context of Bulgarian cartographic practice and demonstrate considerable practical applicability in the design and evaluation of contemporary web cartographic applications.

In Part 3, I will translate the sections on the Dissertation Abstract, Publications, Citations, and the beginning of the Critical Comments and Recommendations.

Certainly. Here is Part 3 of the translation.

Dissertation Abstract

The dissertation abstract accurately reflects the content of the dissertation and presents the principal issues addressed in the research. It has been prepared in accordance with the requirements of the Academic Staff Development Act of the Republic of Bulgaria.

The abstract comprises 74 pages. Its content largely reproduces that of the dissertation itself. Many of the figures are illegible, which significantly reduces their usefulness—for example, Figures 4.1, 5.1, 7.1, and others.

Evaluation of the Publications Related to the Dissertation

The principal findings of the dissertation have been disseminated through six scientific publications, all of which are single-authored. Three publications are in Bulgarian and three are in English.

Two of the publications have appeared in a Scopus-indexed journal. The academic style demonstrated in the Scopus-indexed publications exceeds the standard of writing found in the dissertation itself.

The topics addressed in these publications justify the conclusion that they are the original work of the candidate.

Citations and Use of the Research Results

To the best of my knowledge, none of the candidate's publications has yet been cited.

Critical Comments and Recommendations

I have several critical remarks concerning Dipl. Eng. Nikoleta Nikolova's dissertation.

The introduction contains numerous overly general statements and is written in a textbook-like style. It lacks a clearly defined scientific problem. For example, the statement "Maps are the primary means..." does not lead directly to a specific scientific hypothesis.

The scientific contribution is formulated insufficiently clearly. Statements such as "The dissertation provides recommendations..." (p. 2) are inadequate for a doctoral dissertation, since recommendations alone do not constitute a scientific contribution. A new model, a new method, or a new classification is not explicitly presented.

There are a number of overly strong assertions that are not supported by evidence. For example, the statement "there is a lack of systematic research..." (p. 6) would be more appropriately expressed as "there is a limited number of studies" or "there is a lack of a comprehensive approach."

Several concepts are used interchangeably without sufficient distinction, including web maps, interactive maps, and geoportals. Although these concepts are defined, they are subsequently employed almost synonymously, resulting in conceptual ambiguity.

The methodology is described too generally at the beginning of the dissertation. For instance, the text refers to "conducted experiments" without providing sufficient information regarding the experimental design or the statistical methods employed.

There is also a potential issue concerning the claimed originality of the research. Classifications, UX analysis, and eye-tracking techniques are already well established in the scientific literature. It is not sufficiently clear what exactly constitutes the novel contribution of the dissertation. Simply stating that these methods are applied in Bulgaria represents a relatively weak scientific contribution.

Chapter One lacks a critical review of the existing literature. Although numerous authors are discussed, there is very little comparison, critical analysis, or expression of the author's own scientific position. The chapter primarily reports who said what, whereas it should explain why the existing approaches are insufficient.

The dissertation is difficult to read because of language and stylistic deficiencies. Expressions such as "Under this condition" (p. 2*) and "a final web product was prepared" contain grammatical errors in Bulgarian that undermine the academic quality of the work.

The reviewer notes that precise page references are difficult to provide because the pages of the dissertation are not numbered consecutively.

There are also numerous logical repetitions. Terms such as "effectiveness," "symbols," and "legends" recur repeatedly without introducing new information. This creates unnecessary verbosity and gives the impression that parts of the text have been expanded merely to increase its length.

The necessity of the research is insufficiently justified. Although the topic is described as "relevant," no concrete practical problem or specific case study is presented to demonstrate the need for the research.

The hypotheses are not formulated with sufficient clarity. Although the dissertation refers to "key research questions and hypotheses" (p. 63), these hypotheses are not stated in a clear, measurable, testable, and specific manner, as would be expected in doctoral research.

The bibliography does not comply with either Bulgarian or internationally accepted referencing standards. Essential bibliographic information is missing from many of the cited references.

There are also numerous passages where citations are either missing or insufficient. For example:

- "Cartographic communication is the process of transmitting geographic information through maps..." (p. 4) is a classical definition in cartography and should be supported by an appropriate reference (textbook, article, or author).
- "Maps are the primary means of visualising spatial data..." is a generally accepted statement but is presented as though it were an original scientific claim. It should be supported by at least one or two references.
- "...associations depend on cultural context, personal experience, and social attitudes..." is a principle derived from psychology and user experience (UX) research and therefore requires appropriate citation.
- "Their inappropriate application leads to cognitive difficulties..." is a strong claim that appears to be a personal opinion unless supported by references.
- "At present there are no systematic studies..." is a highly critical statement that should be substantiated by either a literature review or multiple references.
- "Technological progress creates both challenges and opportunities..." (p. 1) is a typical general academic statement and should preferably be supported by a citation.
- "In the literature, legends are considered separately..." represents a conclusion drawn from the literature and should therefore be supported by at least two or three references for comparison.

Questions to the PhD Candidate

I would like to ask the doctoral candidate the following questions:

1. What is the principal scientific contribution of your dissertation, expressed in a single sentence?
2. In what way does your approach differ from those already presented in the scientific literature?
3. What exactly is novel in your work—a method, a model, an application, or something else?
4. If the experimental studies were removed, what theoretical contribution would remain?
5. Can the contribution of your dissertation be generalised beyond the Bulgarian context?
6. Why do you claim that there is a lack of research in this field when numerous publications already exist?
7. Why did you choose the eye-tracking method in particular?
8. Is the sample size sufficient to support statistically valid conclusions?
9. How did you control for subjectivity in the experimental results?
10. How did you validate the results obtained from the experiments?
11. Which statistical methods did you employ, and why were they selected?

12. How do you demonstrate that your recommendations are superior to existing approaches?
13. Are your conclusions not, in fact, largely self-evident?
14. In what practical contexts can your proposed model be applied?
15. Is there an actual end user or institution that would implement your model?
16. How do you distinguish between a web map and a geoportal?

Personal Impressions of the Candidate

I have known Nikoleta Nikolova since her undergraduate years, during which she left an excellent impression through her diligence, enthusiasm for learning, and systematic approach to her work at the University of Architecture, Civil Engineering and Geodesy.

Conclusion

The results achieved in Dipl. Eng. Nikoleta Nikolova's dissertation, the scientific and applied contributions formulated in her work, together with the overall presentation of the dissertation and the accompanying publications, demonstrate that she possesses the ability to conduct independent scientific research and has the capacity to develop scientifically grounded solutions.

In view of the above, I propose that the distinguished Scientific Jury award Eng. Nikoleta [redacted] Nikolova the educational and scientific degree of Doctor (PhD) in Professional Field 5.7 Architecture, Civil Engineering and Geodesy, Doctoral Programme "Cartography and GIS."

03 July 2026

Reviewer: Prof. Dr. Eng. Temenoujka Bandrova