

## TRAINING

OF COMPUTER SCIENCE TEACHERS WITH A SCIENTIFIC-METHODOLOGICAL APPROACH FOR MEANINGFUL TEACHING

### **FORMACIÓN DE DOCENTES DE CIENCIAS DE LA COMPUTACIÓN CON ENFOQUE CIENTÍFICO-METODOLÓGICO PARA ENSEÑANZA SIGNIFICATIVA**

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#### ABSTRACT

This article clarifies the nature and the current state of social computing as a scientific field and as the school computer science curriculum. A model has been developed to assess the preparedness of future computer science teachers for teaching social computing in schools and the process for their development. The objective, content, and process components of the methodology for developing the preparation of future teachers for teaching social computing in schools have been identified. An analysis of the scientific rigor of the research topic was conducted, and psychological, pedagogical, methodological, philosophical, and cultural literature was selected and analyzed to serve as a foundation. The study's goals, objectives, methods, and hypothesis were defined. Subsequently, the components and levels of the considered preparation structure were identified. A preliminary experiment was conducted to determine the preparedness of future computer science teachers for teaching social computing in schools. The implementation confirms its effectiveness.

**Keywords:** Information, Technologies, Informatics, Methodology, Social informatics.

#### RESUMEN

Este artículo aclara la naturaleza y el estado actual de la informática social como campo científico y currículo de informática escolar. Se ha desarrollado un modelo para evaluar la preparación de los futuros profesores de informática para la enseñanza de la informática social en las escuelas y el proceso para su desarrollo. Se han identificado los componentes objetivo, de contenido y de proceso de la metodología para desarrollar la preparación de los futuros profesores para la enseñanza de la informática social en las escuelas. Se realizó un análisis del rigor científico del tema de investigación y se seleccionó y analizó literatura psicológica, pedagógica, metodológica, filosófica y cultural, que sirven de

base. Se definieron las metas, los objetivos, los métodos del estudio, y se formuló una hipótesis. Posteriormente se identificaron los componentes y niveles de la estructura de preparación considerada. Se realizó un experimento preliminar para determinar la preparación de los futuros profesores de informática para la enseñanza de la informática social en las escuelas. Con la implementación se corrobora su efectividad.

**Palabras clave:** Información, Tecnologías, Informática, Metodología, Informática social.

## INTRODUCTION

Computer Science is widely recognized as a fundamental field of scientific knowledge, providing a systems-information framework for analyzing the world, studying information processes in systems of various natures, and investigating the methods and tools for obtaining, transforming, transmitting, storing, and utilizing information. Beyond its theoretical dimensions, Computer Science is a rapidly developing and expanding field of human activity, intimately connected with the use of information and communication technologies (ICTs). These technologies are not only tools for technical processes but also instruments that shape social interactions, economic activities, and educational practices (Acosta-Servín et al., 2025; Guasch et al., 2012). Consequently, the effective education of future Computer Science teachers requires a comprehensive understanding of both the technical and social aspects of the discipline, particularly in the context of schools as formative spaces for developing informed, responsible, and competent citizens.

The growing impact of ICTs on social processes, the emergence of new individual needs and societal roles, and the development of ethical and legal norms governing information interactions have led to the emergence of a distinct subfield within modern Computer Science: social informatics. Social informatics examines how information technologies influence societal structures, individual development, and the distribution of knowledge within the information society (Porubän et al., 2024; Ubaydullayeva, 2025). It encompasses the study of digital ethics, information security, online behavior, and the development of an information culture, highlighting the interplay between technology and human values (Batagan et al., 2011; Guasch et al., 2012).

The curriculum of social informatics in schools is therefore designed not only to cultivate technical skills but also to foster a scientific worldview, critical thinking, and an appreciation of ethical and social responsibilities. This dual purpose underscores the need for teachers to be

prepared to navigate both the cognitive and socio-ethical dimensions of Computer Science education (Gioffre, 2017; Lunenburg & Ornstein, 2011).

One of the primary objectives of modern education is to prepare individuals for productive participation in the information society. This entails understanding the norms and rules that govern digital interaction and internalizing values associated with responsible information use. Concepts such as the “information society,” “information resources of society,” “information security,” “information ethics and law,” and “information culture” are central to this educational mission (Chhy & Kawai, 2025; Mokaleng & Möwes, 2020). Social informatics, therefore, becomes an essential component of the school Computer Science curriculum, addressing developmental and educational objectives that include building a scientific worldview, fostering information culture, and preparing students for academic and professional life in an increasingly complex and dynamic information environment (Casimiro-Urcos et al., 2025).

Despite its recognized importance, the implementation of social informatics in schools faces significant challenges. Its cross-cutting and interdisciplinary nature requires integration with fields such as philosophy, psychology, sociology, ethics, law, and cultural studies (Kert, 2019; Mouza et al., 2022). The lack of a fully established categorical and conceptual framework, insufficient instructional hours, and the limited coverage in teaching materials complicate the effective delivery of the curriculum. Furthermore, many Computer Science teachers lack sufficient training in the methodologies required to teach this multifaceted subject, which reduces the potential impact of the curriculum on students’ development (Stevens, 2007).

In response to these challenges, preparing future teachers to teach social informatics has emerged as a priority in pedagogical universities. This preparation involves developing a system of professional and personal qualities, including knowledge, abilities, skills, and experiences necessary for the effective implementation of a methodological teaching system. Research identifies (Su et al., 2022; Zenko, 2022) three key components of teacher readiness in this area: cognitive-operational, encompassing comprehensive knowledge of social informatics and the skills required for teaching it; normative-regulatory, involving the teacher’s alignment with ethical, legal, and social norms of the information society and the capacity to cultivate respect for these norms in students; and reflective-creative, which emphasizes self-reflection on personal and professional capabilities, as well as fostering creativity in both teachers and students (Batagan et al., 2011; Gioffre, 2017).

The development of teacher readiness is a staged process, progressing from low to high levels through motivational, value-semantic, and organizational-methodological phases. The motivational stage focuses on understanding the theoretical foundations of social informatics and developing positive motivation to engage with the subject. The value-semantic stage emphasizes mastering the moral, ethical, and legal norms of information activity, alongside the values of the information society. The organizational-methodological stage provides practical experience in constructing a unique methodological system for teaching social informatics, including lesson planning, pedagogical practice, and the application of ICTs in education (Lunenburg & Ornstein, 2011).

Theoretical and practical prerequisites for this preparation are increasingly well-documented in pedagogical research. Studies on teaching methods in Computer Science, social informatics as a scientific field, and the methodological aspects of integrating social informatics into school curricula provide the necessary foundation (Batagan et al., 2011; Gioffre, 2017; Stevens, 2007). Practical experiences, including the challenges of students' engagement with digital environments—such as excessive gaming, online communication, and ethical dilemmas—underscore the need for teachers to be systematically prepared to address these issues.

However, despite the contributions of existing research, the methodological foundations for developing future Computer Science teachers' readiness to teach social informatics remain insufficiently developed. There is a lack of integrative, systematic, and staged approaches that clearly define the target outcomes, substantive content, and procedural methods for teacher training. Addressing these gaps is essential to ensure that teachers can not only transmit technical knowledge but also cultivate meaningful, socially responsible learning, promoting students' comprehensive development as informed citizens of the information society (Batagan et al., 2011; Gioffre, 2017).

The relevance of this issue is highlighted by two major contradictions. First, modern society demands Computer Science teachers who are prepared to educate, develop, and nurture citizens of the information society, yet insufficient attention is devoted to training teachers to meet these challenges, which are central to the social informatics component of the school Computer Science curriculum. Second, the capabilities of professional and subject-based disciplines in social informatics for training future teachers are not fully leveraged due to the absence of adequate methods for developing students' readiness, despite opportunities to modernize content and integrate innovative teaching technologies.

Based on these contradictions, the research problem is defined as the insufficient development of methodological foundations for cultivating the readiness of future Computer Science teachers to teach social informatics. Consequently, the aim of this study is to scientifically substantiate and develop a methodology for fostering teacher readiness in this critical area, emphasizing a systematic, staged, and scientifically grounded approach to ensure meaningful, socially responsible, and pedagogically effective teaching in schools.

## MATERIALS AND METHODS

The research hypothesis is based on the premise that training future computer science teachers at a pedagogical university will be more effective, compared to standard educational practice, if:

- 1) social informatics is considered one of the most important areas of computer science curriculum in schools, with specific features that determine the methodological complexities of its study and teaching, associated with its primary focus on solving ideological and educational problems;
- 2) developing the readiness of future computer science teachers to teach social informatics will be considered one of the priority goals of computer science teacher training, taking into account the componential and tiered structure of the preparedness being developed;
- 3) the process of developing the readiness of future computer science teachers to teach social informatics will be based on the logic of its development in a series of stages;
- 4) the methodology for developing the readiness of future teachers to teach social informatics will be based on the idea of the need to incorporate social informatics topics and issues related to its teaching methods into the content of individual disciplines of subject and professional cycles; and the use of active forms and methods of teaching that are adequate to the goals and content of the training.

To address the objectives and test the proposed hypothesis, the following groups of research methods were used:

- Theoretical: analysis and synthesis of results presented in scientific, methodological, philosophical, psychological, and pedagogical literature, and dissertations; modeling general and specific research hypotheses and projecting results and processes for achieving them at various stages of the research;
- Empirical: analysis of pedagogical documentation, observation, expert assessment, surveying students at the

pedagogical university on the research problem; analysis of student work, experimental work.

## RESULTS AND DISCUSSION

Based on an analysis of works (Holmes et al., 2019), the essential characteristics of social informatics as a scientific field are clarified. The study examines social informatics as a branch of informatics that examines the patterns and forms of information flow in society, studying the complex problems associated with the flow of information processes in society and its informatization. The object of social informatics research is the totality of all types and forms of information processes and systems in society that are of primary importance for its functioning and development. Therefore, the subject matter of social informatics includes the global process of informatization of society, its impact on the social structure of society, and the changing position of individuals in society under the influence of this process.

The structure of the subject area of social informatics (Bray, 2007) includes the following research areas: information resources of society, information potential of society, social communications, information lifestyle, information society; the social structure and specifics of work activity, etc. A fundamental problem of social informatics is the problem of aligning development, society, and the global informatization process, associated with the transition of modern civilization to a path of sustainable and secure development based on the acquisition of information and the large-scale use of new knowledge and technologies (Lunenburg & Ornstein, 2011). An analysis of research on social informatics as a scientific field allows us to conclude that its categorical and conceptual apparatus is in the process of formation.

The study analyzed social informatics as a substantive element of the informatics curriculum in schools based on an analysis of state educational standards for various levels of school education, a study of school teaching aids for their presentation of social informatics, and research devoted to the methods of teaching social informatics in schools. Based on this analysis, it was determined that social informatics is aimed at developing students' understanding of the informatization process of society and the information lifestyle; the formation of values, legal, and ethical norms of individual activity in the information environment; and also highlighted the specific features of teaching this line at the propaedeutic, basic and profile stages of studying computer science at school.

To be complete and accurate, the system of social informatics concepts studied at various stages of the school

computer science course must be supplemented with the following concepts: "informatization of society," "information lifestyle," "information environment," and "information ecology." Furthermore, it has been shown that dialogues, discussions, educational games, educational situations, projects, and essays are the most effective methods for studying this topic in primary and secondary schools.

Thus, social informatics is considered one of the most important substantive areas of the school computer science course, primarily aimed at solving developmental and educational problems. It has significant characteristics and challenges in its teaching: its cross-cutting nature, interdisciplinary scientific connections, an unsettled categorical and conceptual framework, a lack of adequate coverage in teaching aids, insufficient hours for its study, and a weak orientation of computer science teachers in the specifics of its teaching methods.

In this regard, the task of preparing future computer science teachers to teach such a complex topic becomes particularly urgent. The study clarifies the essence of future teachers' readiness to teach social informatics by revealing its functions: cognitive (mastering the characteristics of social informatics as a scientific field and a school-based informatics course, and implementing the process while taking into account its specific features); regulatory (understanding and acceptance of the values of the information society in unity with traditional values, compliance with legal and ethical norms of information interaction); and reflective (teachers' evaluative attitudes toward their knowledge of social informatics teaching methods and toward themselves as citizens of the information society).

Taking into account the identified functions allowed us to consider readiness for teaching social informatics as a system of professionally and personally significant qualities, motives, knowledge, abilities, skills, and experience necessary for the implementation of the methodological teaching system for this program, the structure of which includes the following components:

- cognitive-operational, which involves the acquisition of knowledge and the development of skills and abilities necessary for teaching social informatics (systematic and comprehensive knowledge of the specifics of social informatics as a scientific field and a course in informatics in school, mastery of informatics teaching methods; knowledge of the essence of key concepts in social informatics, an understanding of the complexities of mastering this educational material due to its social and humanitarian nature and interdisciplinary connections; knowledge of methods, forms, and means that facilitate the effective

acquisition of the fundamentals of social informatics, and the ability to implement them in practice):

— normative and regulatory, characterized by the teacher's established position on the norms and values of the information society and their integration with traditional values, and a desire to instill in students an understanding and acceptance of the value of information technology and a respectful attitude toward the rights of individuals in the sphere of information interactions;

— reflective and creative, consisting of reflection on one's own personal and professional capabilities, the results achieved in teaching social informatics, and their focus on realizing one's own creative potential and that of students.

The criteria for students' readiness to teach social informatics in school are based on the development of specific components of this readiness, each of which is manifested through a series of indicators characterizing the most significant and necessary manifestations of the diagnosed readiness.

The diagnostics of the manifestation of these indicators in the formation of the desired readiness in students was assessed in the study based on the analysis of the results of: questionnaires, completion of tests, analysis of the educational and professional portfolio created by students (development of technological maps of lessons, fragments of lesson plans, electronic educational resources to support them, etc.), individual reports on educational and pedagogical practices; observation of practical educational activities of students, summarizing expert assessments.

The model of the process of developing the readiness of future teachers to teach the line of social informatics includes three stages, reflecting the logic of its development over time: motivational (development of students' understanding of the prerequisites for the emergence of social informatics and its development as a science, key concepts of social informatics; development and maintenance of positive motivation for studying the field of social informatics); value-semantic (mastering the moral, ethical, and legal norms of information activity, the values of the information society); Organizational and methodological (gaining experience in building a proprietary methodological system for teaching this subject through the development of lesson fragments and their testing during teaching practice).

Therefore, it is justified that the readiness of future computer science teachers to teach social informatics in schools should be considered one of the priority goals of their university training, and the process of developing this readiness should be built in accordance with the

proposed model, which describes its structure and stages of development.

A model of this readiness and the process of its development underpins the definition of the target, content, and process components of the methodology for developing the readiness of future computer science teachers to teach social informatics in schools.

To support the presented methodology, and given that the above-mentioned disciplines are taught by different instructors, we additionally developed an integrated set of distance learning courses, implemented using distance learning technologies via the Moodle platform.

The distance learning course "Legal Aspects of Using Information Resources," which accompanies the "Software" discipline, is aimed at developing understanding of the legal basis for information use and consists of a lecture section devoted to the concepts of information resources, software products, and licensing agreements for the use of software products, as well as practical assignments implemented in the form of forums for discussing videos on copyright issues. The forums also helped resolve problematic situations regarding the legal use of various types of information.

At each stage, the students' level of readiness to teach social informatics was assessed based on the development of each specific component.

Statistical processing of the obtained data was performed using the  $\chi^2$  test. Distribution of students by level of readiness to teach social informatics at the beginning of the experiment showed that the null hypothesis was accepted, i.e., there were no significant differences between the control and experimental groups. At the end of the experiment, the null hypothesis was rejected at the 0.05 significance level, and the alternative hypothesis was accepted: the results of the control and experimental groups differed. This result is a consequence of the applied methodology for developing readiness to teach social informatics. Based on the fact that the control and experimental groups trained future computer science teachers within the same state standard disciplines, we concluded that the significant changes in the experimental group were due to the potential of the methodology we developed and implemented for preparing future computer science teachers to teach social informatics in schools.

The training of future Computer Science teachers represents a central challenge in contemporary education, as schools are expected to prepare students not only in technical skills but also in social and cognitive competencies related to information management. In this context,

the integration of the social informatics component into the school computer science curriculum becomes strategically important, as it addresses educational problems, develops a scientific worldview, and fosters an information culture among students. However, its implementation faces significant challenges, including the component's cross-cutting nature, scientific connections with other subjects, an underdeveloped categorical and conceptual framework, insufficient coverage in teaching materials, limited instructional hours, and a lack of familiarity with specific teaching methods among computer science teachers.

Accordingly, preparing future teachers to teach social informatics is a priority goal in pedagogical university programs. This preparation involves a system of professional and personal qualities, knowledge, skills, and experiences necessary to implement an effective methodological system for teaching this field. The study examines the structure of this readiness, its development criteria, and a model for training teachers based on three main stages: motivational, value-semantic, and organizational-methodological, each with specific content and disciplines designed to develop both technical competence and ethical and social awareness in information use.

This research provides a comprehensive approach to designing educational programs that strengthen the capacity of teachers to foster information and social literacy in students, promoting meaningful, socially responsible learning in computer science education.

1. The social informatics component of the school computer science curriculum should be considered a key component, with a primary focus on solving educational problems and developing the foundations of a scientific worldview and information culture in schoolchildren. Specific features of this component include its cross-cutting nature, subject-specific scientific connections, an unsettled categorical and conceptual framework, a lack of adequate coverage in teaching aids, insufficient hours for its study, and a weak understanding of computer science teachers' specific teaching methods. The social informatics component of the school computer science curriculum needs to be supplemented with concepts such as "informatization of society," "information lifestyle," "information environment," and "information ecology."

2. The readiness of future computer science teachers to teach social informatics in schools is considered one of the priority training goals at a pedagogical university and represents a system of professionally and personally significant qualities, motives, knowledge, abilities, skills, and experience necessary for the implementation

of the methodological system for teaching this area. The structural model of this readiness identifies the following components:

- cognitive-operational (systematic and comprehensive knowledge of social informatics issues and the development of the skills and abilities necessary for teaching social informatics);
- normative-regulatory (development of the teacher's own position in relation to the norms and values of the information society and the desire to instill in students a respectful attitude toward the rights of people in the sphere of information interactions);
- reflective-creative (reflection on one's own personal and professional capabilities in teaching social informatics, a focus on realizing one's own creative potential and the potential of students).

Readiness to teach social informatics in schools is not a fully formed system of personality traits, but rather goes through stages of development: low, medium, and high. The criteria for its development are the criteria for the development of specific components.

3. The model for developing future teachers' readiness to teach social informatics includes three stages:

- motivational (developing students' understanding of the background to social informatics and its development as a scientific field, as well as key concepts of social informatics; developing and maintaining positive motivation for studying social informatics);
- value-based (mastering the moral, ethical, and legal norms of information activities, as well as the values of the information society);
- organizational and methodological (gaining experience in building a unique methodological teaching system for this subject through the development of lesson fragments and their testing during teaching practice).

4. The target component of the methodology for developing future teachers' readiness to teach social informatics is determined by the goals of specific stages of the development process—motivational, value-semantic, and organizational-methodological.

The substantive component of the methodology for developing the readiness under study is determined by:

- at the motivational stage, by studying the disciplines "Computer Science" and "Software," which additionally include topics such as "Information Society," "Information Resource," "Information Security," and "Information Culture";

— at the value-semantic stage, by studying the disciplines “Computer Networks. Internet and Multimedia Technologies,” “Fundamentals of Artificial Intelligence,” and “Computer Technologies in Teaching,” as well as by completing practical training assignments, which additionally include topics such as “Social Aspects of Internet Use,” “Specifics of Computer-Mediated Communication,”

“Ethical and Legal Standards of Activity in the Information Environment,” “Problems of Information Ecology,” etc.;

— at the organizational and methodological stage, through the study of the disciplines “Theory and Methods of Teaching Computer Science,” “Methods of Teaching the Fundamentals of Social Informatics,” and “Using Information and Communication Technologies in Education,” as well as through the completion of pedagogical practice assignments, which additionally include topics such as “Social Informatics as a Scientific Field and a Computer Science Curriculum in Schools,” “Social Informatics as a Foundation for Developing a Student’s Scientific Worldview and Solving the Problems of Student Development in Computer Science,” “Developing an Information Culture in Teachers and Students,” and others.

The procedural component of the methodology for developing student readiness for teaching social informatics is determined by the use of dialogue, game-based, problem-based, research-based, and project-based teaching methods, supported by a set of distance learning courses based on the Moodle platform.

The conclusion presents the main results of the study:

1. The essential characteristics of social informatics as a computer science curriculum in schools have been clarified.
2. The components of student-teacher readiness for teaching social informatics in schools (cognitive-operational, normative-regulatory, and reflective-creative) and the stages of readiness development (motivational, value-semantic, and organizational-methodological) have been identified.
3. A methodology for developing future teachers’ readiness to teach social informatics in schools has been developed, identifying the specifics of the target, content, and process components at the motivational, value-semantic, and organizational-methodological stages of the development process.
4. A mechanism for developing the readiness of future computer science teachers to teach social informatics

in schools through the study of subject-based and professional training cycles, supported by distance learning courses, has been identified and experimentally tested.

## CONCLUSIONS

The scientific novelty of this study lies in the development, for the first time, of a methodology for developing the readiness of future computer science teachers to teach social informatics as a system of professionally and personally significant qualities, motives, knowledge, abilities, skills, and experience of students, realizing the humanitarian potential and the priority focus of this approach on solving ideological and educational problems in computer science courses at school:

— components (cognitive-operational, normative-regulatory, reflective-creative) were identified, and the levels and criteria for the development of future teachers’ readiness to teach social informatics at school were determined;

— a model for the process of developing the readiness of future computer science teachers to teach social informatics was developed, including the motivational, value-semantic, and organizational-methodological stages of the development process;

— The target (goals of specific stages), content (an integrated set of disciplines of subject and professional cycles with the inclusion of elements of social informatics and its teaching methods and distance courses in social informatics) and process (active teaching methods - dialogic, problem-based, game-based, project-based, distance learning technologies) components of the developed methodology have been defined.

The theoretical significance of the study’s results lies in the fact that the findings contribute to modern theory and methodology of teaching and training (informatics, higher professional education) by providing a theoretical justification for the structure of future computer science teachers’ readiness to teach social informatics in schools, the stages of the development process, and the definition of the target, content, and process components of the methodology for developing this readiness. The study’s key findings can serve as a basis for further developments in improving the quality of professional training for future computer science teachers (addressing ideological and educational challenges in the context of the emerging information society and the evolving information environment).

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