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## Modelling the Formation of Managerial Competence of Master's Students in Cybersecurity and Information Protection

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**Abstract.** The article substantiates the relevance of modelling as an effective scientific and pedagogical method for forming managerial competence of master's students in cybersecurity and information protection. The study emphasises that the rapid development of information technologies, the growing complexity of cyber threats, and the need for interdisciplinary coordination require specialists who possess not only technical expertise but also managerial competence as an integral component of professional competence. Modelling is presented as a dynamic phenomenon that enables the investigation of educational processes, the abstraction of essential properties, and the construction of theoretical frameworks that reflect the substantive value of pedagogical phenomena. The proposed model integrates four interrelated blocks: the target block, which defines the aim and tasks of competence formation; the theoretical-methodological block, which presents principles and methodological approaches; the content-operational block, which encompasses the content of training, organisational forms, methods, and means of instruction; and the diagnostic-result block, which reflects criteria and levels of competence formation. The article highlights that managerial competence is conceptualised as an integrative construct combining knowledge, skills, abilities, values, and attitudes, oriented toward achieving specific educational outcomes. The implementation of the model, supported by appropriate pedagogical conditions, ensures positive dynamics in the levels of competence formation among master's students. The study enriches pedagogical theory by integrating interdisciplinary approaches and offers practical recommendations for improving the quality of professional training in cybersecurity. Prospects for further research are seen in identifying and substantiating pedagogical conditions that optimise the process of forming managerial competence in rapidly changing professional environments.

**Keywords:** modelling, managerial competence, master's student in cybersecurity and information protection, model, target block, theoretical-methodological block, content-operational block, diagnostic-result block.

# Моделювання формування управлінської компетентності магістрів з кібербезпеки та захисту інформації

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**Анотація.** У статті обґрунтовано актуальність моделювання як ефективного науково-педагогічного методу формування управлінської компетентності магістрів з кібербезпеки та захисту інформації. У дослідженні наголошується, що стрімкий розвиток інформаційних технологій, зростання складності кіберзагроз та потреба в міждисциплінарній координації вимагають від фахівців не лише технічної експертизи, а й управлінської компетентності як невід'ємної складової професійної компетентності. Моделювання представлено як динамічне явище, що дає змогу досліджувати освітні процеси, абстрагувати їх сутнісні властивості та конструювати теоретичні моделі, які відображають змістовну цінність педагогічних феноменів. Запропонована модель інтегрує чотири взаємопов'язані блоки: цільовий блок, що визначає мету та завдання формування компетентності; теоретико-методологічний блок, який презентує принципи та методологічні підходи; змістово-операційний блок, що охоплює зміст навчання, організаційні форми, методи та засоби навчання; та діагностико-результативний блок, який відображає критерії та рівні сформованості компетентності. У статті підкреслюється, що управлінська компетентність концептуалізується як інтегративне утворення, що поєднує знання, уміння, навички, цінності та ставлення, орієнтоване на досягнення конкретних освітніх результатів. Реалізація моделі, за умови забезпечення відповідних педагогічних умов, гарантує позитивну динаміку рівнів сформованості компетентності у магістрантів. Дослідження збагачує педагогічну теорію завдяки інтеграції міждисциплінарних підходів та пропонує практичні рекомендації щодо підвищення якості професійної підготовки у сфері кібербезпеки. Перспективи подальших досліджень убачаються у визначенні та аргументації педагогічних умов, що оптимізують процес формування управлінської компетентності в умовах швидкозмінного професійного середовища.

**Ключові слова:** моделювання, управлінська компетентність, магістр з кібербезпеки та захисту інформації, модель, цільовий блок, теоретико-методологічний блок, змістово-операційний блок, діагностико-результативний блок.

## Introduction

**Topicality of the problem.** The relevance of this study is determined by the growing demand for highly qualified specialists in cybersecurity and information protection who possess not only technical expertise but also managerial competence as an integral component of their professional competence. In the contemporary digital environment, the rapid development of information technologies, the increasing complexity of cyber threats, and the necessity of coordinating interdisciplinary teams highlight the importance of managerial skills for future professionals. The article addresses this need by proposing a theoretical model for the formation of managerial competence among master's students in cybersecurity and information protection. The model is grounded in pedagogical principles such as integrity, scientific validity, systematicity, unity of theory and practice, functionality, individualisation, differentiation, interactivity, and collegial interaction. These principles ensure that the process

of competence formation is holistic, scientifically substantiated, and responsive to the realities of professional practice.

Furthermore, the study integrates a complex of methodological approaches (competency-based, personality-activity, systemic, axiological, acmeological, synergistic, and praxeological) which reflect the interdisciplinary nature of managerial competence and its role in preparing students for effective decision-making in dynamic professional environments. By combining theoretical foundations with practical orientation, the article contributes to the advancement of pedagogical science and offers a structured framework for improving the quality of training in cybersecurity education.

**Literature review.** In order to foster the managerial competence of master's students in cybersecurity and information protection, it is necessary to design a model that will define the logic of this process and outline the sequence of actions required to achieve the expected outcomes. Reference to publications that highlight the specificity of modelling as one of the most effective scientific methods confirms that scholars assign it a significant role in research: "Modelling is a means of investigating processes through models that cannot be studied under natural conditions. The synthesis of research results concerning one phenomenon occurs through the study of the properties of another phenomenon of a different nature. It is possible to model the properties of various objects: social systems, physico-chemical and biological processes" [2, p. 29].

Within pedagogical science, modelling is applied to the study of the characteristics of the educational process, the preparation of specialists in different fields, and the enhancement of their qualifications. In particular, modelling is used to examine educational phenomena as systems of interrelated components with established connections that play a substantial role and exert mutual influence upon one another: "Modelling in pedagogy is the material or conceptual imitation of an existing pedagogical system through the creation of special analogues (models) that reproduce the principles of organisation and functioning of this system. Through modelling, it is possible to abstract from non-essential properties of the system; however, any model presupposes a certain simplification of the class of pedagogical phenomena that constitutes the object of study and cannot be identical to the object in all respects" [4, p. 19].

V. Abrakitov emphasizes that the method of modelling should be applied in conjunction with other methods of scientific cognition: "Modelling is not only one of the means of representing phenomena and processes of the real world, but also, despite its relative nature described above, an objective practical criterion for verifying the truth of our knowledge, carried out directly or through establishing their relation to another theory that serves as a model, the adequacy of which is considered practically substantiated. When applied in organic unity with other methods of cognition, modelling functions as a process of deepening knowledge, its movement from relatively information-poor models to more substantive ones that more fully reveal the essence of the studied phenomena of reality" [1, p. 61]. Similarly, S. Vazhynskyi and T. Shcherbak draw attention to another property of modelling, its capacity to facilitate the cognition of the unknown through comparison and analogy: "Modelling is one of the ways of cognition, which consists in replacing a certain object with another object that has similar properties. That is, the modelling method is one of the means of mediated cognition. Modelling is always a comparison of the known with the unknown by analogy" [6, p. 75].

The construction of a model of an educational phenomenon or process requires the application and development of creativity, since it is regarded as "...a creative, purposeful process of constructive-design, analytical-synthetic activity (based on the processing of existing information) aimed at representing an object (system) as a whole, or its characteristic components that determine the functional orientation of the object (system), ensuring the stability of its existence and development" [16, p. 5]. This is realized both at the theoretical and practical levels of research: "Modelling is one of the fundamental categories of the theory of

cognition. In fact, the idea of modelling underlies any method of scientific inquiry, whether theoretical (employing various symbolic and abstract models) or experimental (using material models)” [18, p. 27].

**The aim of the article.** The aim of the article is to present a model for the formation of managerial competence of master’s students in cybersecurity and information protection and to characterise its components.

### Research results

In the context of a scientific-pedagogical study devoted to the problem of forming managerial competence among master’s students in cybersecurity and information protection, the essence of modelling lies in constructing a theoretical model that reflects the substantive value of the educational phenomenon, its characteristic properties, processes, and so forth. “Modelling is a dynamic phenomenon that helps to investigate processes related to the formation of professional competence of the future specialist” [14, p. 60]. The author defines a model as “a subjective reproduction in human consciousness and an external representation of the most essential features, traits, and qualities inherent to a specific object, process, or system, which objectively belong to them and provide a general understanding of the phenomenon under study” [14, p. 77]. We share the position of researchers who argue that “a model is a representation of a real object, system, or concept in a form that differs from its actual state of existence. A model serves as a key link between the researcher and the object, functioning as a substitute for the object and enabling the acquisition of new knowledge about it. A model is a source of information about the object and helps to explain, understand, or improve it. A model may be an exact copy of the object (though made of different material and at a different scale) or may represent certain characteristic properties of the object in an abstract form” [6, p. 76].

When modelling the formation of managerial competence in future electromechanical engineers, T. Hura includes in the corresponding model the “target, content, procedural-operational, and result blocks” [10, p. 104]. In modelling the development of managerial competence of a general school principal, T. Volotovska identifies among the main components of the model the target, organisational-content, technological, and result blocks [7].

Summarising these approaches, the principal components of the model for forming managerial competence of master’s students in cybersecurity and information protection should be as follows:

Target block – represented by the aim and the main tasks, the fulfilment of which ensures the achievement of this aim.

Theoretical-methodological block – presenting the theories and concepts underlying the formation of managerial competence of master’s students in cybersecurity and information protection, the principles and methodological approaches, as well as the structural composition of managerial competence.

Content-operational block – encompassing the content of training, forms of organisation of learning, methods, and means of instruction.

Diagnostic-result block – reflecting the criteria and levels of formation of managerial competence of master’s students in cybersecurity and information protection.

The implementation of the model for forming managerial competence of master’s students in cybersecurity and information protection, together with the introduction of appropriate pedagogical conditions, makes it possible to achieve the expected outcome, which we perceive as positive dynamics in the levels of managerial competence formation among these students.

We now turn to the characterisation of the target block of the model for forming managerial competence of master’s students in cybersecurity and information protection. First

of all, it is necessary to identify the aim, which consists in the formation of managerial competence as a component of the professional competence of master's students in cybersecurity and information protection.

The theoretical-methodological block of the model for forming managerial competence of master's students in cybersecurity and information protection presents a set of principles, among which are: the principle of integrity, scientific validity, systematicity and consistency of learning, unity of theory and practice, functionality, individualisation and differentiation, interactivity, and collegial interaction.

According to the principle of integrity, the formation of managerial competence of master's students in cybersecurity and information protection is implemented in our study as a process in which the aim and objectives, the substantive content of training, and its organisational-technological component constitute a coherent whole.

Drawing on the contributions of domestic researchers, we consider the formation of managerial competence of master's students in cybersecurity and information protection through the prism of the principle of integrity at the organisational, semantic, and procedural levels [15]. At the organisational level, the formation of managerial competence is understood as a holistic process that integrates interrelated stages of learning with the gradual complication of tasks. At the semantic level, a triune aim is integrated: education, upbringing, and personal development of the master's student in cybersecurity and information protection, as well as the interconnection between knowledge, skills, abilities, values, and attitudes. At the procedural level, the principle of integrity substantiates the relationship between the activity of the teacher and the learners, the methods of instruction employed, and the process of mastering knowledge, as well as the formation and development of skills and abilities [15].

Grounded in the principle of scientific validity, we interpret the formation of managerial competence of master's students in cybersecurity and information protection as a process based on the achievements of contemporary science, which encourages learners to develop and apply research skills and critical thinking skills necessary for searching, verifying, and processing information for its subsequent practical use. According to O. Balaieva, "the requirement of scientific validity in education can be realized at a qualitatively higher level thanks to the possibility of imitating scientific inquiry, scientific discoveries, and scientific research through elements of mathematical and simulation modelling, as well as the possibility of deeper and more comprehensive study of subjects and phenomena when using such forms of information delivery as multimedia and virtual reality programs" [3, p. 329].

The principle of systematicity and consistency of learning substantiates the need to construct the process of forming managerial competence of master's students in cybersecurity and information protection as a systemic phenomenon, characterized by a defined logic of structuring the educational material and a sequence of its assimilation (from simple to complex) [19].

Equally important is the principle of the unity of theory and practice, according to which it is necessary to understand the demand for managerial competence in the professional activity of specialists in cybersecurity and information protection. This principle is reinforced by the effective correlation between the content of training and the methods of instruction, the acquisition of theoretical material and its application in practice, which can be realised through the creation of a practice-oriented learning environment.

Taking into account the characteristics of the modern professional environment in which specialists in cybersecurity and information protection operate, it is essential to consider the principle of functionality. This implies that, for the formation of managerial competence of master's students in cybersecurity and information protection, it is first necessary to define the professional functions and responsibilities assigned to such specialists in the professional environment. Based on their specificity, the essence of managerial competence, the substantive content of training, and the orientation toward achieving its formation should be determined.

In the context of our study, it is appropriate to base the formation of managerial competence of master's students in cybersecurity and information protection on the principle of individualisation and differentiation. This is due to the fact that we regard each learner as a personality with unique characteristics, the positive ones requiring further development and the negative ones requiring overcoming. Accordingly, consideration of the individual characteristics of future master's students presupposes the selection of educational material, methodologically substantiated forms of organising instruction, as well as teaching methods and tools aimed at forming managerial competence in cybersecurity and information protection.

With regard to differentiation, we concur with the position that it involves the application of diverse approaches to individual learners or groups of learners and the organisation of instruction differentiated "by content, volume, complexity, methods, and means" [11, p. 77].

According to the principle of interactivity, we regard the formation of managerial competence of master's students in cybersecurity and information protection as an interactive process.

The principle of collegial interaction defines the formation of managerial competence of these students as a process of building and utilising the potential of active communication and teamwork. This not only enables the acquisition of relevant knowledge, skills, abilities, values, and attitudes that constitute managerial competence, but also fosters the presentation of personal ideas, the articulation of one's own position, engagement in discussion, and the making of well-reasoned decisions.

In the context of forming managerial competence among bachelor's students of economic specialities, A. Hrusheva substantiates the application of a complex of scientific approaches, paying particular attention to the following:

Activity-based approach – "the actions and techniques of activity formed in future economists acquire the character of skills depending on the level of their assimilation, and most importantly, they master the actions and techniques of operational thinking" [9, p. 58]. Rational approach – presupposes "the broad use of interdisciplinary connections, integrated courses aimed at forming a system of professional knowledge, values, convictions, and views" [9, pp. 58–59]. Personality-oriented approach – "focuses attention on the professional needs of the individual; prioritizes individuality and self-value; fosters cooperation, partnership, and co-creation between students and teachers; improves pedagogical relations by making them more open; develops empathy and spiritual-moral unity between the academic staff and students; creates situations of choice and responsibility in the learning process; adapts methods to the educational and potential capabilities of the student (actualizing the problem of personal growth as the basis of independence in mastering educational content; stimulating the development and self-development of the student)" [9, p. 60]. Synthesis of integrative and interdisciplinary approaches – "enables young specialists to use knowledge and ideas from related disciplines to solve practical problems in their professional activity as financiers and ensures the complementarity of developmental potential and all its main components" [9, pp. 63–64]. Competency-based approach – "directs the educational process toward the formation and development of key (basic, core) and subject-specific competences of the individual" [9, p. 66].

Based on the analysed sources, we substantiate the need to form managerial competence of master's students in cybersecurity and information protection through reliance on a complex of methodological approaches, among which are: competence-based, personality-activity, systemic, axiological, acmeological, synergistic, and praxeological.

In particular, according to the competence-based approach, managerial competence of master's students in cybersecurity and information protection is regarded as an integrative construct that combines knowledge, skills, abilities, values, and attitudes. Researchers interpret

its essence through the orientation of education toward achieving a specific outcome, namely, the formation of competence.

Within the framework of the personality-activity approach, the formation of managerial competence of master's students in cybersecurity and information protection is implemented through the prism of "the unity of the personal and activity components, and in its personal component it presupposes that the learner is placed at the centre of the educational process: his or her motives, goals, psychological characteristics, that is, the student as a personality" [20, p. 102]. Emphasis is placed on taking into account the personal characteristics, interests, and needs of learners. According to A. Hrusheva, "personality-oriented learning primarily involves the development of students' cognitive and creative activity in the learning process, their cognitive engagement. The role of the teacher also changes, as he or she must become a 'conductor,' an organizer of the student's cognitive activity, a mentor in the creative choice of priorities for further self-development. Certain modifications are required in the design and organization of the educational content. It should be presented in such a way that the student independently chooses the content, type, and form when completing tasks" [9, p. 141].

As for the activity component, it presupposes an active position of master's students in cybersecurity and information protection in the process of forming their managerial competence. Such a position necessitates the organization of learning aimed not only at the acquisition of knowledge and the performance of tasks that require its application, but also at the formation of the personality of the future specialist in cybersecurity and information protection.

To ensure the effectiveness of activities aimed at forming the managerial competence of master's students in cybersecurity and information protection, it is essential to ground this process in the principles of the systemic approach. According to this approach, not only is the very process of competence formation considered a holistic system, but also the developed educational material and didactic tools (organisational forms of learning, methods, and means of instruction) are presented as an integrated system with a clearly defined place and function for each of its components.

Moreover, the application of the systemic approach allows managerial competence itself to be conceptualized as a system. Our reasoning is confirmed by the thesis that outlines the main characteristics of competence as a system: "the effective use of an individual's abilities enables productive professional activity in accordance with workplace requirements; possession of the knowledge, skills, and abilities necessary for professional work, combined with autonomy and flexibility in solving professional problems; developed collaboration with colleagues and the professional interpersonal environment; integrated combination of knowledge, abilities, and attitudes optimal for performing professional tasks in the modern production environment; the ability to do something well and effectively across a wide range of contexts with a high degree of self-regulation, self-reflection, and self-assessment; rapid, flexible, and adaptive response to the dynamics of circumstances and environment" [5, p. 197].

Among the key priorities in forming the managerial competence of master's students in cybersecurity and information protection, the application of the axiological approach presupposes the identification of values and value orientations of learners. Researchers note that today "there is a tendency toward orientation on values that ensure the possibility of achieving personal life success, whereas values reflecting orientation toward interaction with other people (willingness to help, tolerance, friendliness, etc.) are relegated to the background" [8, p. 124]. However, this situation can be corrected through pedagogical influence on the development of the personality of the future specialist in cybersecurity and information protection: "The formation of the future specialist at the stage of his or her studies in a higher education institution must be subordinated to the goal of 'ensuring sufficiently reliable behaviour of the individual in specific typical life and professional conditions,' which makes it

possible to form professional values in students and stable traits of their personality characteristic of the future type of activity” [8, p. 124].

V. Kvas asserts: “Synergetics is one of the newest scientific directions, which may be considered a leading field of interdisciplinary research extending to all spheres of social existence. Contemporary scientific studies demonstrate that the synergetic paradigm contributes to a profound understanding of such complex nonlinear open systems as society and its various subsystems, including education and learning” [13, p. 126].

In our study, we see the potential of applying the synergetic approach, since we investigate and implement the formation of managerial competence of master’s students in cybersecurity and information protection on the basis of achievements from such fields of scientific knowledge as public administration, political science, psychology, economics, management, and pedagogy. We agree with the position of the author who outlines the characteristics of the educational process from the perspective of interaction between teacher and learners: “openness of the educational process and the content of learning material to innovations proposed not only by teachers but also by students; the creative nature of learning and upbringing in higher education; the transition from a predominant orientation toward reproductive learning tasks to an orientation toward productive theoretical and practical activity; replacement of subject-subject relations between teacher and student with relations of free cooperation for the sake of development and cognition; adherence by teachers to the principles of an individual approach to students with a focus on self-education, self-upbringing, and self-realization; liberation of both student and teacher from stereotypes and pedagogical dogmas in the organization and content of the educational process; the fundamental absence of an upper limit of professionalism for future specialists and teachers, accompanied by the natural requirement of constant professional growth of the learner’s personality; recognition of the possibility of influence on the process of personality development by any social systems hierarchically located at higher levels; and the contribution of the higher education system to the formation of responsibility among future specialists for the fate of society as a whole” [17, p. 28].

Praxeology is the branch of science that studies human practical experience, decision-making processes in various situations, and ways of successfully achieving goals. The main task of praxeology lies in combining theory with practice and increasing the efficiency of activity” [21, p. 32]. We substantiate the application of the praxeological approach. According to this approach, the formation of managerial competence of master’s students in cybersecurity and information protection is carried out with consideration of the specifics of the professional environment and the activities of the specialist. This enables their preparation for functioning in a rapidly changing environment, solving professional tasks of varying complexity, and making well-reasoned decisions based on the processing of information from alternative sources.

Another component of the theoretical-methodological block of the model for forming managerial competence of master’s students in cybersecurity and information protection consists of the components of managerial competence itself (motivational, cognitive, technological, and personal), the essence and characteristic features of which were described in the previous section.

The content-operational block of the model for forming managerial competence of master’s students in cybersecurity and information protection encompasses such elements as the content of training, forms of organising instruction, methods, and means of teaching.

The structure of the theoretical model for forming managerial competence of master’s students in cybersecurity and information protection is completed by the diagnostic-result block. This block presents the value-motivational, informational-content, activity-operational, and personal-reflective criteria, the essence and indicators of which were outlined in the

previous section. The block also includes the identified levels of managerial competence formation: basic, sufficient, and high.

### Conclusions

The conducted study substantiates the relevance and necessity of modelling as an effective scientific and pedagogical method for forming managerial competence of master's students in cybersecurity and information protection. The proposed theoretical model integrates four interrelated blocks (target, theoretical-methodological, content-operational, and diagnostic-result), which together ensure the holistic character of the competence formation process. The target block defines the aim and tasks of forming managerial competence as a component of professional competence. The theoretical-methodological block presents the guiding principles (integrity, scientific validity, systematicity, unity of theory and practice, functionality, individualisation and differentiation, interactivity, collegial interaction) and methodological approaches (competence-based, personality-activity, systemic, axiological, acmeological, synergistic, praxeological) that provide the conceptual foundation of the model. The content-operational block encompasses the substantive content of training, organisational forms, methods, and means of instruction, ensuring the practical implementation of the model. The diagnostic-result block establishes criteria and levels of competence formation (basic, sufficient, high), enabling evaluation of the effectiveness of the process.

The prospects for further research lie in the identification and substantiation of pedagogical conditions for the formation of managerial competence of master's students in cybersecurity and information protection.

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