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INTEGRATED LIFECYCLE MANAGEMENT OF INFORMATION SYSTEMS AS A PEDAGOGICAL TOOL TO DEVELOP IT SPECIALIST COMPETENCIES

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INTRODUCTION

The rapid development of digital technologies and the intensification of digital transformation across all spheres of social life are driving the growing role of information systems as a fundamental tool for organizing, managing, and supporting the activities of modern organizations. Information systems have ceased to be merely technical means of automating individual processes and are increasingly acting as complex socio-technical entities that combine software and hardware solutions, organizational structures, management mechanisms, and the human factor. In such conditions, the demand for IT specialists is increasing, who must be capable not only of developing software but also of effectively managing the full life cycle of information systems. These trends highlight the need to rethink the content and methodology of training future IT specialists in higher education institutions. Traditional educational models, focused mainly on the fragmented acquisition of technical knowledge and skills, increasingly meet the requirements of the modern labor market. Instead, there is a growing need to form in students a systemic vision of the processes of creating, implementing, and maintaining information systems, the ability to integrate knowledge from different fields, make informed decisions in conditions of uncertainty, and work in interdisciplinary teams[1]. In this context, a competency-based approach to IT education, which involves the development of not only professional but also meta-competencies of future specialists, becomes critical.

One of the conceptual foundations for implementing such an approach in IT education is integrated life-cycle management of information systems. It is based on the idea of the integrity and continuity of the processes of development and maintenance of IS, assumes a close relationship among the technical, organizational, and managerial components of professional activity, and is focused on continuous improvement of digital solutions. In the pedagogical dimension, integrated IS life cycle management is

[1] Інноваційні технології навчання в умовах модернізації сучасної освіти : монографія / за наук. ред. д-ра пед. наук, проф. Л. З. Ребухи. Тернопіль : ЗУНУ. 2022. 143 с.

considered not only as a subject of study, but as an effective didactic tool that allows structuring the educational process in accordance with the logic of the real professional activity of an IT specialist.

The relevance of studying the pedagogical potential of integrated information systems management also stems from the need to transform the educational environment in higher education institutions. The integration of IS development and maintenance management practices, the use of educational projects, case-based learning, and modern digital management tools contributes to the formation of a professionally oriented educational space in which students gain experience in activities as close as possible to the real conditions of the IT industry. This approach increases the practical significance of educational results, the level of motivation for learning, and the readiness of graduates for professional activity.

The purpose of the study is to theoretically substantiate integrated information systems life cycle management as a conceptual and pedagogical basis for training future IT specialists, and to analyze its potential for developing students' professional and meta-competences and transforming the educational environment of a higher education institution. The work examines the conceptual principles of integrated IS management, its didactic and interdisciplinary potential, and the practical aspects of integrating management practices into the educational process, which together form a basis for the development of modern, innovation-oriented IT education.

1. Integrated information systems life cycle management in the context of modern IT education

The current stage of development of the information society is characterized by a comprehensive digital transformation, in which information systems (IS) serve as a key tool for ensuring the efficiency of economic, scientific, and educational processes[2]. They integrate information flows, automate decision-making, support analytical activities, and create conditions for the implementation of new models of interaction in the digital environment. As a result, information systems are increasingly considered not only as technical solutions, but as strategic resources for the development of organizations and society as a whole.

The expansion of the functional purpose of information systems increases the requirements for their quality, reliability, scalability, and adaptability to external environmental changes[3]. In the context of rapid

[2] Цифрова трансформація для України DT4UA. Режим доступу: https://ega.ee/uk/project/dt4ua/

[3] Державна цифрова трансформація: аналіз за 2019–2024 роки. Режим доступу: https://voxukraine.org/derzhavna-tsyfrova-transformatsiya-analiz-za-2019-2024-roky

technological renewal and the constant evolution of user needs, the ability of IS to continuously develop and integrate with other digital services is particularly important. This, in turn, actualizes the need for specialists who possess not only programming skills, but also the competences to manage the full life cycle of information systems – from the stage of requirements formation and conceptual design to implementation, operation, support and modernization.

These trends create significant challenges for the IT education system, which has traditionally been focused mainly on the technical aspects of training future specialists. The dominance of a narrowly technological model of training, focused on mastering individual programming languages, tools or platforms, is insufficient to form readiness to work with complex information systems in real professional conditions. In this regard, the need to transition to a system-oriented approach in IT education, integrating the technical, organizational, and managerial components of the educational process, is becoming increasingly urgent.

Within this approach, information systems are considered multi-level socio-technical objects, the functioning of which is determined not only by technical characteristics but also by organizational environment features, management decisions, and the human factor. This necessitates the development of systems thinking among students, the ability to analyze relationships among IS elements, and the capacity to assess the consequences of decisions made at different stages of the life cycle. Thus, information systems are not only the object of professional activity of future IT specialists, but also an important pedagogical tool that determines the content and direction of modern IT education.

The concept of integrated information systems life cycle management is based on the idea of continuity, integrity and close interrelationship of all stages of IS creation and functioning. Unlike traditional linear life cycle models, which assume the sequential, separate execution of the phases of analysis, design, implementation, testing, and operation, the integrated approach focuses on the continuous interaction among these stages and their mutual adjustment. Such management logic corresponds to the modern conditions of development of the IT industry, characterized by high dynamism in requirements, rapid technology updates, and the need to respond promptly to changes in the external environment.

The transition to flexible and iterative approaches within the framework of integrated IS life cycle management involves considering development and support not as completed or isolated processes, but as a continuous cycle of improving the information system. In this context, IS operations and support become equally important during the design and implementation

stages, since it is at these stages that new user needs, environmental limitations, and opportunities for further system development are identified. Thus, integrated management ensures the coordination of technical solutions with the real conditions of IS use throughout its life cycle.

In the pedagogical context, the implementation of the concept of integrated information systems life cycle management represents a departure from the fragmented study of individual technologies, methods, and tools characteristic of traditional educational programs. Instead, the emphasis shifts to the formation of a holistic vision of the processes of creation, implementation, and support of IS as complex socio-technical systems, in which technical components are closely related to organizational structures, management decisions, and students' user activities. This approach contributes to the students' awareness of the role of each stage of the life cycle and their mutual influence on the final quality and effectiveness of the information system.

Integrated IS life cycle management is considered as a methodological basis for the professional activities of an IT specialist, combining technical, organizational and management components into a single system. Within the framework of IT education, this concept provides a basis for the development of systems thinking, the ability to make informed decisions in conditions of uncertainty, and responsibility for the consequences of implemented technical solutions. It also contributes to developing readiness for interdisciplinary interaction and continuous professional development, which are key characteristics of a modern IT specialist.

Therefore, the concept of integrated information systems life cycle management in the context of IT education serves not only as a set of management approaches and practices, but also as a holistic pedagogical paradigm aimed at training specialists who can act effectively in complex and dynamic digital environments.

In modern IT education, integrated information systems life cycle management serves not only an applied but also an important didactic function, providing a methodological basis for the holistic organization of the educational process. It allows you to structure the content of academic disciplines in accordance with the logic of real professional processes, covering the stages of requirements analysis, architectural design, project management, quality assurance, implementation and operation of software products. Such structuring helps bridge the gap between theoretical training and the practical needs of the IT industry. Also, it creates in students an awareness of the interdependence of technical solutions and management processes within a single IS life cycle.

The didactic potential of integrated IS management is also manifested in the possibility of using active, practice-oriented teaching methods, in particular project-based learning, case analysis, teamwork, and modeling real production situations. Involving students in complex educational projects that simulate the full life cycle of an information system contributes to the development of planning, decision-making, communication and reflection skills. In such an educational environment, knowledge becomes applied, and the learning process is focused on achieving specific professional results.

An important feature of integrated information systems life cycle management is its interdisciplinary nature, which necessitates the synthesis of knowledge from different fields. The implementation of this approach in the educational process involves combining computer science, software engineering, systems analysis, project management, the foundations of organizational activity, and elements of pedagogy and the psychology of learning. Such interdisciplinary integration contributes to students' ability to see the problem in a broad context, analyze it from different perspectives, and find complex solutions.

As a result of the implementation of integrated IS management, the educational environment is transformed from a space for mastering individual knowledge into an environment for the formation of complex professional and meta-competences, in particular, systems thinking, responsibility for decisions, the ability to interact in teams, and continuous professional development. This approach meets the modern requirements of the labor market, which call for IT specialists able to work effectively in interdisciplinary teams and to participate in the full life cycle of information systems.

Thus, the didactic and interdisciplinary potential of integrated IS life-cycle management lies in creating a holistic model of IT education thatcombines theoretical knowledge and practical activities, thereby ensuring the training of competitive specialists for the modern digital environment.

Integrated information systems life-cycle management in the context of modern IT education should be considered a conceptual basis for training future IT specialists who can act effectively amid dynamic technological changes and the growing complexity of digital systems. This approach ensures the transition from fragmented professional training to a holistic model of competence formation, in which the development, implementation, and maintenance of information systems are considered interrelated components of a single process of professional activity.

Integrated IS life cycle management fosters systems thinking among students, enabling them to analyze information systems as complex socio-technical objects, predict the consequences of technical and management decisions, and assess their impact on the functioning of organizations and

users. Orientation to the full IS life cycle contributes to the awareness of students of responsibility for the results of professional activity at all stages – from design to operation and modernization of systems.

An important result of implementing an integrated approach to training IT specialists is the development of readiness for continuous professional development and adaptation to technological changes. Since modern information systems are constantly evolving, the ability to learn throughout life and to critically reflect on new technologies and management methods becomes an integral part of the professional competence of an IT specialist. Integrated IS life cycle management is, in this context, not only a subject of study but also a means of fostering a culture of continuous improvement.

In addition, the use of integrated information systems lifecycle management in the educational process helps to bring the learning environment closer to the real conditions of professional activity. Involving students in complex educational projects that reproduce the full cycle of IS creation and support forms practical skills in teamwork, resource management, communication with stakeholders and decision-making under conditions of uncertainty. This increases graduates' professional readiness and competitiveness in the labor market.

Thus, integrated information systems lifecycle management serves as a holistic conceptual basis for modern IT education, ensuring the training of a new generation of specialists capable of combining deep technical knowledge with managerial and organizational competencies, working effectively in interdisciplinary teams, and carrying out professional activities in real educational and production environments.

2. Pedagogical potential of integrated IS management in the formation of professional and meta-competences

The modern paradigm of higher education is oriented towards a competency-based approach, within which the outcome of learning is considered not as a set of isolated knowledge, skills, and abilities, but as the student's ability to effectively apply them in real professional situations[4]. Such an orientation requires the search for pedagogical conditions that integrate theoretical training with practical activities and foster a holistic professional experience for future specialists. In this context, integrated management of the information systems life cycle is one of the key pedagogical conditions for implementing competency-based training in the IT education system.

[4] Ярушак М. Застосування компетентнісного підходу у процесі підготовки фахівців закладів вищої освіти. *Молодь і ринок*. 2021. № 9/195.https://doi.org/10.24919/2308-4634.2021.243892

Integrated IS management ensures the content and procedural integrity of training for future IT specialists by combining the technical, managerial, and organizational aspects of professional activity. Unlike the traditional division of educational material into separate disciplines, this approach allows for building the educational process in accordance with the real-life cycle of the information system[5]. This creates conditions for the formation of complex competencies, including the analysis of user needs, making design decisions, organizing development processes, assessing quality, and ensuring the stable functioning of IS.

The use of an integrated approach in the educational process provides an opportunity to model real professional situations in which students must make decisions that take into account the interdependence and mutual influence across the different stages of the IS life cycle. In such conditions, learning becomes active, and students are involved in solving complex tasks that require systematic analysis, planning, and responsibility for the results of their work. This contributes not only to the assimilation of knowledge, but also to the formation of professional thinking focused on achieving practically significant results.

An important pedagogical effect of integrated management of the IS life cycle is the formation of students' awareness of the systemic nature of future professional activity. Considering information systems as complex socio-technical objects allows students to understand the role of each stage of the life cycle and the importance of consistent decisions across different stages of development and support. As a result, integrated management of IS serves not only as a subject of study but also as an effective pedagogical tool that ensures the implementation of a competency-based approach and improves the quality of training for future IT specialists.

The pedagogical potential of integrated management of the information systems life cycle manifests primarily in the purposeful development of key professional competencies of future IT specialists necessary for effective activity in a modern digital environment. Such competencies include the ability to perform a system analysis of the subject area, formulate, specify, and document requirements for information systems, design their architecture taking into account functional and non-functional characteristics, and organize the processes of development, testing, implementation, and support of software products.

[5] Скрипник Л.М. Педагогічні умови організації інформаційно-консультативного середовища закладу професійної освіти : дис. … д-ра філос. наук із спец. 015 Професійна освіта (цифрові технології). Кривий Ріг : Криворізький державний педагогічний університет. 2023. 275 с. https://doi.org/10.31812/123456789/7239

The orientation of the educational process to the full life cycle of an information system ensures the comprehensive development of professional competencies. Students learn to consider software development not as an isolated technical stage, but as a component of a continuous process that includes user interaction, change management, quality assurance, and maintenance of the system's operability under operational conditions. This approach contributes to the development of the ability to make sound technical and managerial decisions, taking into account the long-term consequences for the IS's functioning.

An important component of the development of professional competencies is the ability to integrate knowledge from different academic disciplines and areas of training. Integrated IS management enables applying knowledge in software engineering, systems analysis, databases, information security, project management, and quality assurance within a single complex task. As a result, students gain experience working on interdisciplinary problems, which meets the real requirements of professional practice in the IT industry.

In addition, an integrated approach to information systems life cycle management contributes to the development of practical skills in planning and organizing teamwork, assigning roles and responsibilities, and controlling the execution of tasks at different stages of the project. This allows future IT specialists to gain experience in professional interaction and to prepare for work in a collective environment, a characteristic feature of modern IT projects.

Thus, the development of professional competencies within the integrated management of the IS life cycle occurs not as a set of individual skills and abilities, but as a holistic system of professional readiness. Such a system meets the current needs of the IT industry. It provides training for specialists who can effectively perform professional functions at all stages of the creation, implementation, and maintenance of information systems in the modern digital environment.

Table 1 summarizes the correspondence between the key practices of integrated management of the information systems life cycle, pedagogical mechanisms for their implementation in the educational process and learning outcomes in the form of formed professional and meta-competences. The table demonstrates that each stage of the IS life cycle can be purposefully integrated into the educational process using appropriate pedagogical technologies, ensuring the comprehensive nature of the professional training of future IT specialists.

Table 1

Compliance of integrated information systems management practices with pedagogical mechanisms and learning outcomes

IS Lifecycle Management Practices	Pedagogical Implementation Mechanisms	Professional Competencies	Metacompetences
Requirements and domain analysis	Case-based learning	Requirements formulation and refinement, systems analysis	Critical thinking
IS Architecture Design	Educational Projects	Architectural Thinking, Design Solutions	Systems Thinking
Development Management	Learning Projects, Teamwork	Planning, Coordination, Quality Control	Team Interaction
Quality Assurance	Digital IS Management Tools	Testing, Quality Control	Responsibility
Support and development of IS	Project and reflective activities	Support and modernization of IS	Self-organization, lifelong learning

The presented generalization confirms the feasibility of using integrated information systems management as a pedagogical tool that combines training content with real practices in the IT industry and contributes to the formation of a holistic system of competencies.

Along with the development of professional competencies, integrated information systems life-cycle management has significant pedagogical potential for the development of meta-competences, which determine a specialist's ability to effectively operate in conditions of uncertainty, complexity, and constant change in the technological environment. Unlike specialized professional skills, meta-competences are universal and equip individuals with readiness for adaptation, self-development, and interdisciplinary interaction throughout the entire professional path. The key meta-competences developed within the framework of integrated IS management include systemic and critical thinking, self-organization, effective team interaction, reflection, and continuous learning.

Considering information systems as complex socio-technical objects contributes to the development of systems thinking, which consists of the ability to see the relationships between individual components of the IS, analyze cause-and-effect relationships, and predict the consequences of decisions. Critical thinking is developed through evaluating alternative technical and management solutions, analyzing risks, and justifying the selection of tools and methods for developing and maintaining information systems. In this context, students learn not only to apply known solutions, but also to critically reflect on their feasibility in specific conditions.

Involving students in the management of complex educational projects that simulate real processes of creating and maintaining information systems creates favorable conditions for the development of self-organizational skills and for taking responsibility for the results of activities. In the process of working on such projects, students must plan their own activities, allocate time and resources, make decisions under constraints and uncertainty, and evaluate the long-term consequences of their decisions. This contributes to the formation of a conscious attitude towards professional activity and the development of the ability to make independent decisions.

An important component of the development of meta-competences is the formation of team interaction and interpersonal communication skills. Integrated management of the IS life cycle involves collective effort, coordination among team members, and joint responsibility for achieving results. In such an educational environment, students gain experience in distributing roles, resolving conflict situations, and coordinating individual and collective goals, which are important components of the professional maturity of future IT specialists.

In addition, an integrated approach to information systems life cycle management contributes to the formation of readiness for continuous learning as one of the key meta-competences of a modern specialist. Awareness of the dynamism of the IT sphere and the need for constant updating of knowledge and skills forms in students the motivation for professional self-development and adaptation to new technological challenges.

Thus, the development of meta-competences in the context of integrated IS management prepares future IT specialists for effective professional activity in a complex and changing digital environment.

A special place in the structure of the pedagogical potential of integrated management of the life cycle of information systems is occupied by the formation of systems thinking as a key meta-competence of a modern IT specialist. In the context of the increasing complexity of digital solutions and their deep integration into organizational and social processes, the ability to conduct system analysis becomes a necessary prerequisite for

effective professional activity. Integrated management of IS creates methodological and didactic conditions for the development of this type of thinking by considering information systems as a unity of technical, organizational, and social components.

Considering information systems as integral socio-technical objects contributes to students' ability to analyze complex systems, identify relationships among their elements, and identify cause-and-effect relationships between decisions made and the results of IS functioning. Within the framework of integrated lifecycle management of IS, students learn to consider the influence of architectural decisions, organizational constraints, the human factor, and the external environment on the quality, reliability, and efficiency of information systems. This approach conveys the multidimensionality of professional tasks and the need for an integrated approach to their solution.

The development of systems thinking also involves the ability to predict and evaluate the long-term consequences of professional activity. Orientation to the full life cycle of an information system allows students to realize that decisions made at the early stages of design and development directly affect the further operation, maintenance and development opportunities of IS. As a result, future IT specialists gain experience in strategic thinking and a responsible attitude to professional decisions.

Systems thinking, developed through studying the principles of integrated IS life cycle management, ensures future specialists are ready to work with complex digital solutions, make sound technical and managerial decisions, and effectively adapt to changes in the professional environment. It contributes to the ability to integrate knowledge from different industries, work in interdisciplinary teams, and take into account the needs of various stakeholders in the creation and maintenance of information systems.

In this way, integrated information systems management acts not only as an object of study, but also as an effective pedagogical tool for the formation of systems thinking, which, in turn, ensures the development of both professional and meta-competences of IT education students and improves the quality of their preparation for real professional activity.

To generalize the theoretical provisions on the pedagogical potential of integrated information systems' life-cycle management in the formation of professional and meta-competences of future IT specialists, Fig. 1 presents a structural and logical model of the corresponding process. The proposed scheme reflects the relationship between integrated IS life cycle management, pedagogical mechanisms for its implementation in the educational process, the resulting competencies, and the transformation of the educational environment of a higher education institution.

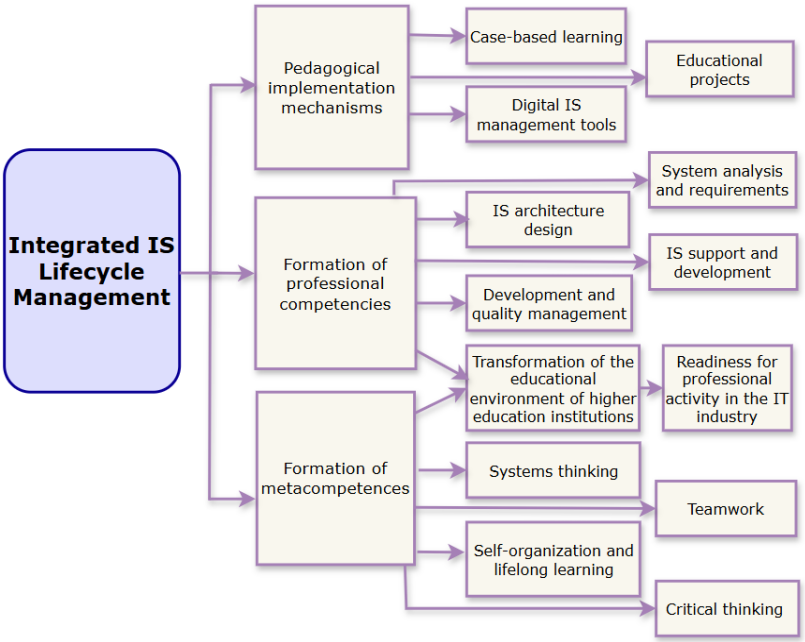

Fig. 1. Pedagogical potential of integrated IS life cycle management in the formation of competencies

In Figure 1, integrated information systems life cycle management is presented as a central system-forming element that determines the logic of organizing the educational process and the direction of professional training of future IT specialists. It is this approach that provides a holistic vision of the processes of development, implementation, support, and maintenance of information systems and serves as the methodological basis for the formation of modern educational outcomes.

Pedagogical mechanisms for implementing integrated IS management in the educational process include educational projects, case-based learning and the use of digital information systems management tools. These mechanisms ensure a practice-oriented nature of training, the modeling of real professional situations, and the active involvement of students in managing the processes of creating and supporting IS.

Within the model, a block of professional competence formation is identified separately, covering system analysis and requirements formulation, information systems architecture design, management of development processes and quality assurance, and IS support and

development. These competencies reflect the key functional components of the professional activity of a modern IT specialist and are formed in close connection with the logic of the information system life cycle.

Along with professional competencies, the model demonstrates the formation of meta-competences, in particular, systemic and critical thinking, the ability to team interaction, self-organization and lifelong learning. It is these universal abilities that ensure the readiness of future specialists to work in conditions of uncertainty, rapid technological changes and interdisciplinary interaction.

The final element of the model is the transformation of the educational environment of a higher education institution, which occurs under the influence of the integration of IS life cycle management practices. The educational environment acquires the features of a professionally oriented space of active activity, which directly contributes to the formation of the readiness of education seekers for professional activity in the IT industry.

3. Integration of IS development and maintenance management practices into the educational environment of a higher education institution

The modern educational environment of a higher education institution is increasingly transforming into an open, dynamic and multi-level system focused on recreating the real conditions of professional activity of future specialists. In the context of the digitalization of society and the growing role of information technologies, the educational environment of higher education institutions ceases to serve solely the function of knowledge transfer. It acquires the characteristics of an interactive space of professional developmen[6]. In this context, the integration of management practices for the development and support of information systems is considered an important factor in improving the quality of IT specialist training and aligning the educational process with the real needs of the IT industry.

The educational environment of higher education institutions, focused on integrating IS management practices, acquires the features of a professionally oriented space, in which educational activities are organically combined with elements of design, management, and analytical work. Students are involved in solving complex tasks that reflect the real processes of creating, implementing, and supporting information systems, and teachers serve as mentors and facilitators of professional development. Such an

[6] Розвиток інформаційних систем управління освітою як інструмент реалізації державної освітньої політики : монографія / за ред. С. Л. Лондара ; ДНУ «Інститут освітньої аналітики». Київ, 2020. 258 с. Режим доступу: https://iea.gov.ua/wp-content/uploads/2025/04/monograph_2020_fin_.pdf

organization of the educational environment contributes to the activation of cognitive activity of education seekers and the formation of responsibility for the results of their own professional activity.

Integration of IS management practices into the educational process involves adapting educational programs to the logic of the information systems life cycle, ensuring consistency between training content and the current requirements of the IT industry. Educational disciplines are structured to consistently reflect the stages of the IS life cycle and their interconnections, enabling students to develop a holistic understanding of professional activity. As a result, educational outcomes take on a practical orientation, and education seekers have the opportunity to apply the knowledge and skills they acquire in conditions close to reality.

In addition, the educational environment of HEIs, as a space for integrating IS management practices, creates conditions for the development of interdisciplinary interaction and partnerships with representatives of the IT industry. The involvement of external experts, the use of real cases and projects, and the integration of digital management tools contribute to increasing the authenticity of the educational process and to the development of students' readiness for professional activity.

Thus, the educational environment of HEIs serves not only as a place for acquiring knowledge but also as a space for the development of professional and meta-competences of future IT specialists in the context of integrated information systems management.

In order to generalize approaches to the integration of information systems lifecycle management practices into the educational process of a higher education institution, Fig. 2 presents a structural and functional model of the interaction of the educational environment, the requirements of the IT industry, and pedagogical mechanisms for the formation of learning outcomes. The proposed model reflects the logic of including information systems development and maintenance management practices in the professionally oriented educational environment of higher education institutions and their impact on the training of future IT specialists.

Figure 2 presents a model for integrating information systems lifecycle management practices into the educational environment of a higher education institution, based on a combination of IT industry requirements and the pedagogical capabilities of the educational process. The upper part of the diagram shows two key external factors: IS lifecycle management practices (analysis, development, support) and IT industry requirements, which determine the content and direction of professional training for future specialists.

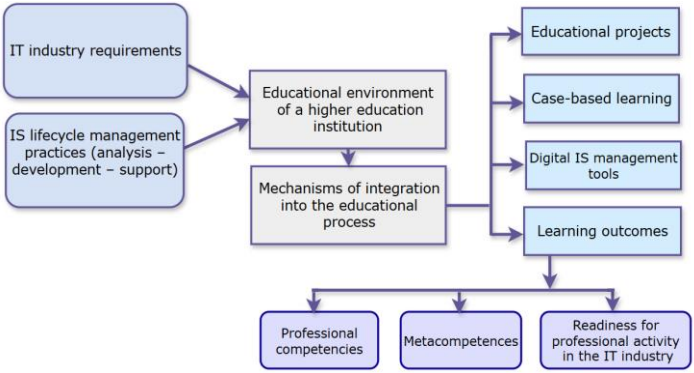

Fig. 2. Integration of information systems life cycle management practices into the educational process of a higher education institution

The central element of the model is the educational environment of a higher education institution, which acts as an integration space for combining external requirements and internal pedagogical resources. It is within this environment that IS management practices are adapted to educational goals, professional standards are transformed into learning outcomes, and conditions are created for active, professionally oriented student activities.

The next level of the model concerns mechanisms for integrating IS management practices into the educational process, including educational projects, case-based learning, and the use of digital tools for information systems management. These mechanisms ensure the practice-oriented nature of training, the modeling of real professional situations, and the development of experience in teamwork and management.

The implementation of these mechanisms results in learning outcomes that cover professional competencies, meta-competencies, and the readiness of education seekers for professional activity in the IT industry. Thus, the model demonstrates the cause-and-effect relationship between integrating IS life cycle management practices into the educational environments of higher education institutions and training competitive IT specialists capable of operating effectively in the modern digital environment.

To specify the mechanisms for implementing integrated information systems life-cycle management into the educational process of a higher education institution, it is advisable to generalize the correspondence between the components of the educational environment, IS management practices, and expected educational results. Such a generalization is presented in Table 2, which allows us to systematize approaches to integrating management practices into the educational activities of IT education students.

Table 2 summarizes the correspondence between the key practices of integrated information systems life cycle management, pedagogical mechanisms for their implementation in the educational process, and learning outcomes in the form of formed professional and meta-competences.

Table 2

Integration of information systems life cycle management practices into the educational environment of a higher education institution

Components of the educational environment of higher education institutions	**Integrated IS management practices**	**Forms of implementation in the educational process**	**Educational outcomes**
Educational programs and disciplines	Full IS lifecycle management	Modular course structure	A holistic vision of professional activity
Навчальна діяльність студентів	Analysis, development, and support of IS	Educational projects	Professional competencies
Organizing teamwork	Project and process management	Case-based learning	Team interaction
Digital Infrastructure of Higher Education Institutions	Quality Control and IS Support	Digital IS Management Tool	Digital Culture
Pedagogical interaction	Change management and improvement	Reflective activity	Metacompetences

The table demonstrates that each stage of the IS life cycle can be purposefully integrated into the educational process using appropriate pedagogical technologies, ensuring the comprehensive nature of the professional training of future IT specialists.

The presented generalization confirms the feasibility of using integrated information systems management as a pedagogical tool that combines the content of training with real practices of the IT industry and contributes to the formation of a holistic system of competencies.

One of the key mechanisms for integrating the practices of managing the development and maintenance of information systems into the educational environment of a higher education institution is the use of educational projects and case-based learning. The specified pedagogical technologies provide implementation of activity and practice-oriented approaches, within which the students are involved in active professionally directed activity.

The project form of organization of training allows to reproduce full or partial life cycle of information system – from needs analysis and requirements formation to design, implementation, implementation and support of software product.

Educational projects, built according to the logic of IS life cycle, contribute to formation of students' holistic idea about processes of creation and operation of information systems, and also allow to integrate knowledge from different academic disciplines within one complex task. In the process of implementation of such projects, the students acquire practical skills of work planning, distribution of roles and responsibilities in a team, resource management and control of activity results. This creates conditions for formation of both professional and managerial competencies necessary for future professional activity in IT sphere.

Case-based learning complements project activities by providing an analysis of specific situations that reflect real challenges and problems typical of the processes of developing and maintaining information systems. Involving students in solving complex cases that are close to real professional situations contributes to the development of decision-making skills under uncertainty, change management, risk assessment, and forecasting the consequences of implementing various managerial and technical solutions. Within the framework of case-based learning, students learn to defend their own position with arguments, critically evaluate alternative approaches, and work with incomplete or contradictory information.

The use of educational projects and case-based learning contributes to increasing the flexibility and interactivity of the educational process, as well as strengthening its focus on results. Theoretical knowledge acquires practical value, as it is applied in a real or simulated professional context. As a result, students gain experience close to real professional activity, which increases their level of preparedness for work in the IT industry and contributes to the formation of readiness for integrated management of the information systems life cycle.

An important component of integrating information systems development and maintenance management practices into the educational environment of a higher education institution is the targeted use of modern digital tools that support key stages of the IS life cycle. The involvement of such tools in the educational process allows you to model real work processes of IT teams, recreate professional roles and form practical skills in students to work with software tools used in the modern IT industry.

The use of project management systems, task planning and tracking tools, software development tools, and version control tools enables effective teamwork in the educational environment. In this format, students

gain experience in setting and decomposing tasks, estimating deadlines, managing priorities, and coordinating the activities of project participants. This raises awareness of the role of management decisions in ensuring the consistency and efficiency of information systems development processes.

A separate role in the educational process is played by digital tools for ensuring the quality of software products, in particular, testing tools, code analysis, and monitoring quality indicators. Their use allows students to familiarize themselves with quality control practices at different stages of the IS life cycle and to recognize the importance of preventive measures and continuous improvement of software solutions. As a result, an understanding of quality as an integral characteristic of an information system emerges, one that depends on the consistency of its technical and organizational processes.

The use of tools for monitoring the operation of information systems and analyzing their functioning allows modeling the stage of IS support and maintenance in the educational environment. This contributes to students' understanding of the continuous nature of the information system life cycle and the need for constant analysis of its condition, productivity, and reliability. Such experience increases students' readiness to work with real digital products after graduation.

Therefore, the use of digital tools for managing information systems in the educational process not only increases its practical orientation, but also contributes to the formation of a digital culture, the development of professional and meta-competences and the preparation of future IT specialists for effective activity in the modern digital environment.

The integration of practices for managing the development and maintenance of information systems leads to significant qualitative changes in the educational environment of a higher education institution, transforming it from a traditional space for knowledge transfer into an environment of active professionally oriented activity. In such an environment, students cease to be passive consumers of educational information and become full-fledged subjects of the educational process, involved in decision-making, planning activities, and evaluating the results of their own work. This contributes to increasing their educational autonomy and responsibility for achieving educational and professional goals.

The transformation of the educational environment of higher education institutions also occurs at the level of organizing the educational process and interaction between its participants. The integration of IS management practices involves the active use of team-based forms of work, project activities, and interdisciplinary interaction, which changes the role of the teacher from a knowledge carrier to a mentor, consultant, and coordinator of the educational process. As a result, a learning environment is created

in which cooperation, the exchange of experience, and the joint solution of complex professional tasks are stimulated.

These changes have a direct impact on the formation of professional and meta-competences of education seekers. In the process of integrated IS life cycle management, students develop systems thinking, critical analysis, communication, and organizational skills, and a willingness to continue learning. The practical orientation of the educational environment increases motivation to learn, as students realize the applied value of the knowledge and skills they acquire and their direct significance for future professional activities.

As a result of integrating information systems management practices, the educational environment of higher education institutions becomes innovative and open to continuous updating and improvement. It lays the foundation for training competitive IT specialists who can effectively develop, implement, and maintain information systems in real professional conditions, as well as adapt to changes in the digital environment and the requirements of the modern labor market.

CONCLUSIONS

The paper substantiates the feasibility of considering integrated information systems life cycle management as a conceptual and pedagogical basis for training future IT specialists in higher education institutions. It is shown that, in the context of digital transformation, information systems function as complex socio-technical objects, which necessitates a holistic vision of the processes of their development, implementation, and support among education seekers.

It is established that integrated IS life cycle management creates methodological prerequisites for the implementation of a competency-based approach in IT education, contributes to the coordination of theoretical training with the practical requirements of the IT industry and ensures the formation of professional and meta-competences of future specialists, in particular, systems thinking, the ability to team interaction and continuous professional development.

It has been proven that integrating management practices for the development and maintenance of information systems into the educational environment of a higher education institution leads to qualitative transformation and increases the practical focus of training and the level of graduates' readiness for professional activity in a modern digital environment.

SUMMARY

The integrated management of the life cycle of information systems is considered as a conceptual and pedagogical basis for the training of future IT specialists in higher education institutions.

The current trends in digital transformation are analyzed, which are driving the increasing role of information systems as complex socio-technical objects. The feasibility of transitioning from a narrow-technological model of IT education to a competency-based, system-oriented approach is substantiated. The pedagogical potential of integrated IS management in the formation of professional competencies related to requirements analysis, information system design, development, and maintenance is determined. The role of an integrated approach in the development of meta-competences, in particular systemic and critical thinking, the ability to interact in teams, and continuous learning, is shown. The didactic possibilities of using educational projects and case-based learning to reproduce real processes of IS life-cycle management are revealed.

The importance of digital tools for managing the development and maintenance of IS for increasing the practical orientation of the educational process is analyzed. The impact of integrating management practices on the transformation of the educational environment of a higher education institution is substantiated. It is concluded that integrated lifecycle management of information systems contributes to the training of competitive IT specialists who can operate effectively in a dynamic digital environment.

References

1. Інноваційні технології навчання в умовах модернізації сучасної освіти : монографія / за наук. ред. д-ра пед. наук, проф. Л. З. Ребухи. Тернопіль : ЗУНУ, 2022. 143 с.

2. Цифрова трансформація для України. DT4UA. Режим доступу: https://ega.ee/uk/project/dt4ua/

3. Державна цифрова трансформація: аналіз за 2019–2024 роки. Режим доступу: https://voxukraine.org/derzhavna-tsyfrova-transformatsiya-analiz-za-2019-2024-roky

4. Ярушак М. Застосування компетентнісного підходу у процесі підготовки фахівців закладів вищої освіти. *Молодь і ринок*. 2021. № 9/195. https://doi.org/10.24919/2308-4634.2021.243892

5. Скрипник Л.М. Педагогічні умови організації інформаційно-консультативного середовища закладу професійної освіти : дис. … д-ра філос. наук із спец. 015 Професійна освіта (цифрові технології). Кривий Ріг : Криворізький державний педагогічний університет. 2023. 275 с. https://doi.org/10.31812/123456789/7239

6. Розвиток інформаційних систем управління освітою як інструмент реалізації державної освітньої політики : монографія / за ред. С. Л. Лондара ; ДНУ «Інститут освітньої аналітики». Київ, 2020. 258 с. Режим доступу: https://iea.gov.ua/wp-content/uploads/2025/04/monograph_2020_fin_.pdf

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