APPLICATION OF THE INFORMATION SYSTEM FOR THE IMPROVEMENT OF THE TEACHING OF UNDERGRADUATE STUDIES

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Abstract: The paper presents an analysis of the impact of the Information System (IS) on the improvement of the teaching of undergraduate studies. This research is based on the survey methodology on the application of IS in teaching, methods and techniques of analysis and systematization of knowledge. According to the data of the research described in the paper, it is possible to investigate the correlation between IT competences of teachers and the assessment of their impact on the achievements or teaching efficiency of students. Besides, we are particularly interested in investigating the degree to which IS impacts the undergraduate students' motivation and satisfaction in the teaching process. The impact of e-communication on gaining knowledge, monitoring, evaluation and reporting on the undergraduate students' improvement is analysed. The paper also presents the analysis of the research results on the application of IS and its impact on gaining knowledge as well as the undergraduate students' motivation and satisfaction increase.
The main objectives of the research include:

- phase development of IS for applications in ICS areas of Information Technologies;
- investigating basic knowledge of the IS application in the teaching process of undergraduate studies among students in academic and vocational studies at the Faculty of Technical Sciences (FTS) in Čačak, University of Kragujevac;
- identifying the respondents' interest in IS if they do not recognize the IS application;
- recognizing the possibilities of applying IS in the teaching process and their impact on the improvement of teachers' skills and competneces, i.e. on education and improvement of the teaching process;
- activating social groups with specific educational needs, which includes gaining knowledge and the About the comparison of opinions from two involved parties (teachers and students) in the teaching process presents autor presents in the his paper [Iljazi T., 2022].
- development of lifelong learning and education.

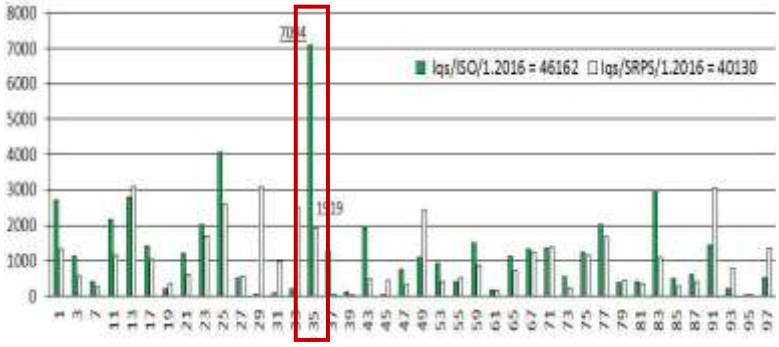
The questionnaire is used to collect the data necessary for the research. It was organized to identify the level of knowledge about the application of IS when teaching students of the Information Technology study programme at the academic and vocational studies at FTS in Čačak, the University of Kragujevac. The research was realised within IT subjects with first-year and second-year students of FTS in Čačak.
According to the International Classification of Standards (ICS) IT has 15 subfields of ICS2, one of which is software development (ICS2 = 35,080). Students' involvement in the IS application is considered to be the most important element of the teaching process improvement, especially in the fields of Information Technologies ICS1 = 35. Precautionary measures are the most important part of the whole process and it takes a lot of time to realise them. The period of realisation is different depending on the person who is in charge of realisation as well as the means for their implementation. These measures can affect students in great measure and if they are conducted appropriately, they will enable the best possible results.
The model of the IS impact on the improvement of the teaching process has been presented as an important factor for directing learners towards IS application.
Keywords: Information System (IS), knowledge, teaching process, undergraduate studies.

1. INTRODUCTION

Standardization refers to the connection of knowledge that would lead to the identification of potential differences and the establishment of the measures for IT improvement. Figure 1 shows 40 hierarchically organized areas of standardization covered by the International Classification for Standards (ICS) [Ružičić et al., 2022], [ISO, Standards Catalogue ICS]. ICS is a hierarchical classification consisting of three levels [ISS, Institute for Standardization of Serbia].

The first level (ICS1) covers 40 areas of activity in standardization. The field of Information Technology (IT, ICS1=35) has 15 sub-areas of ICS2, one of them is Software Development (35.080). The analysis includes monitoring the frequency of innovativeness in the fields of knowledge and its sources, trends, knowledge of each expert as well as knowledge bases updating [ISS, Institute for Standardization of Serbia].

Figure 1. Comparative overview (ISO-SRPS) of the total amount of knowledge sources on ICS platform, January 2016



The role of the teacher and his responsibility is of great importance, and therefore there should be continuous and adequate additional education [Bajrami and Kurejsepi, 2022]. The most important implications of the paper concern the use of IS in the teaching process which promotes its improvement in academic and vocational studies. The process of finding a solution within IT implementation in the educational process which is based on development model of Information System (IS) is the most influential element, in the PDCA concept, for on the improvement of the teaching process of undergraduate studies.

2. MATERIALS AND METHODS

The following methods and techniques are applied in the work: statistical data analysis method, knowledge analysis and systematization methods and techniques, knowledge presentation techniques and knowledge presentation techniques.

The first stage in the statistical study of the population is the selection of the sample to be observed and for which the necessary data will be collected. The volume of the sample (n elements) of statistical units is extracted from the population. The probability of the accuracy of the conclusion about the population is higher if the sample better represents the population, and such a sample is a representative sample.

In the second phase (statistical observation of the selected sample), measurements are made on the elements from the sample (survey), with the aim of collecting data. This phase in the statistical research is followed by the requirement for accuracy, truthfulness and completeness of the collected data of the students.

On the standardization platform, from the population of volume Iqs1.2015 = 80763 sources of knowledge of one time series, a representative sample of the volume $Iqs_{ICS1/\ ICS2/\ ICS3}$ was separated for the analysis of different ICS1/ ICS2/ ICS3 areas/ sub-areas, with the aim of determining trends, innovation clusters, material pgrspra etc. The analysis of survey research data includes a representative sample or sub-sample (students of basic academic and professional studies) of N = 72.

In the third phase of statistical research (grouping and presentation of data from samples), the collected data are arranged/grouped and presented in several ways (tabular, graphical, ...). The collected data on the observed product or phenomenon represent the material that needs to be processed and refined.

The fourth phase of statistical research (statistical data analysis) includes statistical processing of data, scientific analysis of results and drawing conclusions about the population. In the phase of statistical research of some population, the starting point is the individual values of the characteristics.

3. RESULTS

Concept of IS for aaplication in ICS areas and the improvement of the teaching of undergraduate studies

The phased development of Information System (IS) for applications in the ICS areas of Information Technologies is a model of a real business system, the main purpose of which is to help in decision-making, analysis, coordination and control, as well as help in creating new product. Modeling the system involves determining the set of components (from which the IS will be developed) and defining the connections (which should exist between the

components). Research is directed towards modeling, development, design, testing, implementation and management of systems. The development of models and software takes place in a standardized manner through the development, control, management, documentation and implementation of projects. Given that there are numerous ICS areas with a high intensity of innovation, as well as society's need for innovation monitoring, the rapid realization of the model would significantly contribute to the innovation of knowledge. The concept of model formation and phased development of IS refers to applications in all areas of creativity (ICS1 = 01, 03, ... to 99). By modeling knowledge in order to form a model for the development of IS, the characteristics, properties, mutual connections of components are determined and the documentation of the system for its functioning is formed.

During the development of the IS model, standardized characteristics grouped into 12 user functions were taken into account. The development of the model for IS is directed towards the phase modeling of the planning for softvare - IS in the PDCA concept, for applications in all ICS areas, especially in areas of high innovation [Ružičić and Micić, 2020]. In contrast to the classical approach to IS development, based on the specification of system functions, the object-oriented approach to IS model development is based on the fact that the system represents a set of interconnected objects. Objects are objects that are described in the system through their properties (attributes) and that make a set of operations available to the environment. Properties of objects (ICS area) in the system are modeled as properties, and operations on objects as realization of system functions. In the communication model for IS, the connections between objects and the system's connection with the environment are realized through the exchange of information. The effect of the environment on the system is the "input", and the effect of the system on the environment is the "output" of the system. Attributes essential for internal qualgages affect the attributes of external objects, and they further affect the quality attributes from the aspect of use. Modeling of the relationship for the organization relies on three interrelated aspects of the organization:

- external factors - determined by the overall external characteristics of software, which is also performed during testing in a simulated environment with data, using external product quality metrics [ISO/IEC, TR 9126-2:2003];
- internal factors - determined by the overall internal characteristics of the software, which can be improved during coding, review and testing [ISO/IEC, TR 9126-3:2003];
- factors from the aspect of use – the user's view of rotevgp, which is in use in a given environment [ISO/IEC, TR 9126-4:2004].

Development of IS for application in ICS areas with an object-oriented approach

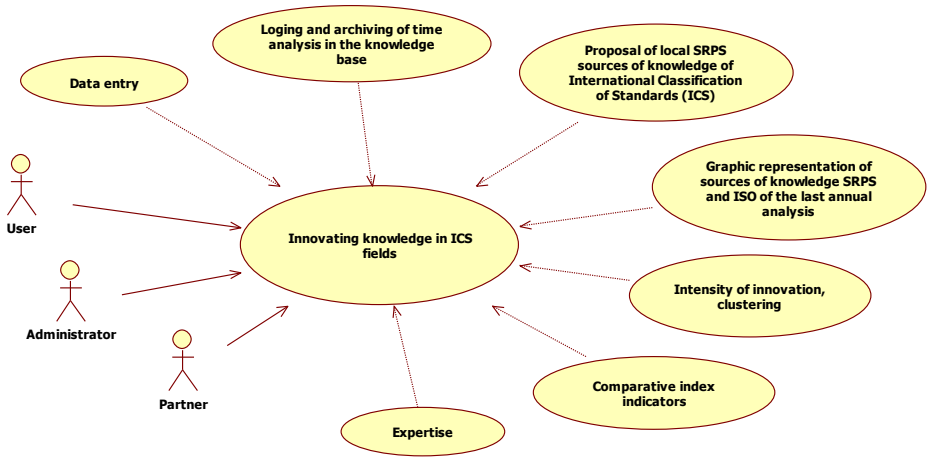
Based on the previously defined logical model of business functions, a physical model for IS is designed, which includes the development stages of the organizational and technological environment. The development of a knowledge model for IS with an object-oriented approach is realized through four basic phases (in the PDCA concept):

- defining user requirements (*Plan phase*);
- object-oriented analysis (*Do phase*);
- object-oriented design (*Check phase*);
- software implementation (*Act phase*).

Defining user requirements of the IS model (*Plan phase*) - Defining user requirements is a very important stage in the development of any IS. High-quality definition of requirements is the basic prerequisite for IS to be successfully modeled, in the sense that it satisfies all user needs. Although the definition of requirements is the first step in the development of a model for IS, it should be emphasized that it must be continuously applied during the entire modeling, with the constant cooperation of the designer and future users. From this collaboration, the designer has the idea of developing a model for IS, which is constantly being developed and improved. A software product is developed based on a model for IS that fully meets the needs of users.

Defining requirements enables the connection of the classic IDEF0 methodology, which performs functional modeling, with elements of the UML methodology, which performs object modeling [Veljović A., 2004]. This phase includes the creation of a logical model of functions and the creation of a physical model of business plans. By defining the initial requirements and collecting opinions, the development of the model for IS is enabled, where the equipment that is used for that purpose and the people who deal with it are the main parameters. Use case diagrams show which participants (actors) initiate certain use cases, as well as which participants receive žntopmafžjg from certain user functions. These diagrams show the interaction between the user functions and the participants in the rzregms. To create use case diagrams, the CASE software tool WhiteStarUML for object-oriented modeling, which supports UML notation, is used [WhiteStarUML 5.6.6.0]. A diagram of the use cases of model innovation for IS and application in ICS areas shows the interaction of actors and user functions (Fig. 2).

Figure 2: Use case diagram of knowledge model innovation for IS and applications in ICS fields



In addition to the IS model development use case diagram, a detailed description of all individual use cases should be performed. This includes describing the use case, specifying the actors, defining the conditions/prerequisites that must be met before executing the user function.

Object-oriented analysis (OOA) of models for IS (*Do phase*) - In the OOA phase, key concepts are defined, with the help of which the modeling of the objects of the real system and their mutual connections is realized. Introduction OOA is a conceptual model for IS. Object-oriented analysis is the most critical phase in the process of IS modeling, since it is necessary to correctly identify the objects that exist in the system, specify their functions and their mutual interaction. The focus of this analysis is researching the problem, finding and describing the objects or concepts within the problem, while not describing how the solutions are defined. Realization of the OOA phase leads to a complete and clear model of the real system, which is a requirement for the implementation of the IS model.

Sequence diagrams belong to the group of interaction diagrams and from a dynamic aspect they describe the IS to be modeled, the operations to be performed, and the messages to be sent. For each use case of the time sequence of events generated by the participants in the system, sequence diagrams are graphically displayed. Sequence diagrams have two dimensions: vertical, which represents time, and horizontal, which represents a collection of objects. A sequence diagram represents communication between a set of objects, and communication is realized by messages that objects exchange with each other in order to achieve the expected behavior.

Object-oriented design (OOD) of models for IS (*Check phase*) - The OOD model phase for IS involves the logical and physical decomposition of the system that is modeled through software elements. This phase includes the specification of the static and dynamic aspects of the program. The static aspects of the system are modeled using class diagrams and object diagrams, which provide a visual representation of the elements that exist in the system. The dynamic aspects of the system are modeled using collaboration diagrams and state diagrams, which represent the exchange of messages between a set of objects in the IS. The object-oriented design of the model for IS includes the following steps:

- adding new classes that serve to implement use cases;
- adding new attributes and operations needed to implement use cases;
- specification of details;
- adding relations between classes, required for implementation;
- fulfilling the functional requirements of rotevgpa, based on the decomposition of classes or objects;
- specification of the implementation details of all elements in the previously mentioned steps.

The user interface model for IS defines access for users to enter data, create queries and obtain reports. One of the user interface standards is the graphical user interface (GUI). The advantages of GUI user interface are reflected in the fact that all elements (usually) are drawn in graphic form, and the programmer does not have to think about the code that takes care of their creation. The interface class diagram shows the layout of the user interface software model for IS and applications in ICS areas. In this diagram, the classes represent the user preferences of the

individual pages of the software, and the links between them represent the ability to move from one user interface to another.

Implementation of IS software model (*Act phase*) - Implementation of IS software model for applications in ICS areas is a phase defined through:

- development of software and
- defining the logic of the application and network architecture.

Development of software - IS and applications in ICS areas includes: development of user interface, development of benchmarks, as well as mapping, programming and translation. After the requirements definition, OOA and OOD phases have been completed, the implementation of the software model solution for IS is approached. This last phase provides the final summary of the development phases of the model, which is the desktop aplication/software Model IS. When choosing a tool for creating knowledge modeling for the development and application of the software Model IS information system, the following criteria were taken into account: the level of accuracy of the search engine and the transparency of the user interface.

4. DISCUSSIONS

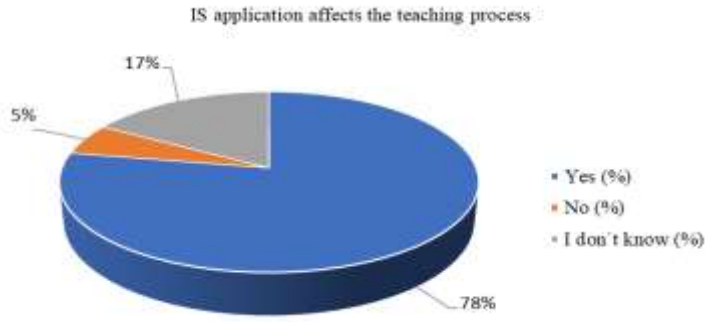
Taking into account the research goals and the stated criteria for software development, the Microsoft Visual Studio programming environment and C# .NET technology were chosen, and the database was created in the Access program. Initialization of the database (DB) part of the model for IS is a demanding processing activity, which, in addition to certain optimizations, always takes at least a few seconds. This only applies to loading the new DB of the last time series of the knowledge sources (KS), while all subsequent calls take incomparably less time. By generating the physical model and DB schema, a DB model is formed for IS and applications in ICS areas. The physical DB model is obtained by translating, based on the use case diagram, from the logical class diagram, from the logical class diagram, it is a diagram of nodes and their interconnections, which serves to model the DB scheme, on the basis of which the tables in the management system are generated.

The program code written in an object-oriented programming language represents the ultimate goal of the previously implemented phases (OOA and OOD). Based on the interface class diagram, which is defined in the OOD phase, the product class mapping of the corresponding component is realized. The object-oriented programming language C# was used to map the product design into the programming code. In addition to the specified object-oriented software interface (C#), WhiteStarUML also has the ability to generate program code in other object-oriented programming languages, such as Java and C++. In order to generate the program code of the selected object-oriented programming language, it is necessary to select a package within the created WhiteStarUML project, which contains a class diagram of the software interface. Application architecture is defined by modeling the software components that ensure the functioning of the software and the dependencies between the components. A component represents a physical module of code.

It is possible to establish a dependency operation between components, which indicates that one component must be compiled before the other.

The results of the conducted survey show that more than half of the respondents believe that the application of IS affects the improvement of the competence and motivation of teachers, as well as the improvement of the teaching process undergraduate studies (78%), Fig. 3.

Figure 3. Graphic presentation of the research results – IS application affescts the teaching process



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5. CONCLUSIONS

The environment, which implies the necessary IS application in the teaching process, had a strong impact on new generations of students. Traditional models of education are less motivating. Today, students prefer the application of multimedia content that will capture their attention and provide them with the opportunity to make contact with their teachers using modern communication methods. Practical application of the acquired knowledge is very important for students. Therefore, the teacher is expected to satisfy all their needs and to adapt to the modern environment and generations by continuous improvement of competences and skills, which has been confirmed by the research.

Based on the concept of phased model development, IS is applicable in all ICS areas. By generating the physical model and DB schema, a DB model is formed for IS and applications in ICS areas. The development of software according to the IS model will ensure the daily innovation of knowledge by accessing knowledge sources from higher education institutions. Based on the results of the analysis of survey research within the application of IS, it is concluded that greater availability of knowledge sources is needed to improve the teaching process by innovating knowledge.

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