Establishment of smart education system in modern universities: concept, technologies and challenges

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***Abstract*—**The revolutionary digital transformations of society have led to the need for formulating a smart higher education system, adequate to modern conditions and based on the integrated use of intelligent digital solutions. The paper substantiates that the creations of such systems requires the solution of a whole complex of technological, institutional, organizational, economic and managerial issues. In accordance with this, the main tasks for the digital transformation of universities are studied, including: the formation of basic digital competencies, the incorporation of the digital agenda in research, the substantial modernization of bachelor's and master's programs, as well as programs of additional professional education. The paper identifies various levels of introducing ICT into everyday practice and creating the so-called "smart education" system from the perspective of a process approach. The article reveals the possibilities of applying the paradigm of knowledge engineering for the intellectualisation of the higher education system. The article also shows how the methods, approaches and methodologies of knowledge engineering (KE) can be used for the development of intelligent learning systems and smart tutoring systems (STSs). It is proved that the convergence of artificial intelligence (AI), web science (WS) and data science (DS) allows for the creation of a new generation of web intelligent systems for all educational and training tasks. One of the main objectives of this study is to determine and explore the benefits and advantages of such computational paradigms to increase the effectiveness and enhance the efficiency of smart tutoring systems. The key advantages and challenges of the use of modern intelligent systems and technologies in universities are identified, taking into account the characteristics of specific ICTs.Decisions are determined at different levels of the economic hierarchy, the adoption of which is essential for the institutionalisation of smart higher education systems.It is established that the creation of a smart education system requires funding from government agencies and educational institutions themselves and their partners in the ICT sector, as well as stimulating the demand for relevant technological innovations in the educational sector.

***Keywords*—**Artificial intelligence in education, Smart education, Smart tutoring systems, Computational intelligence, Machine learning in education.

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I. Introduction

THE digital transformations currently taking place in society are revolutionary in their scale, speed of change and breadth coverage [1]. In this case, attention is paid to not only the penetration of digital technologies into all economic subsystems, but also to changing the paradigm and models of formation, functioning and development of economic systems at different levels of the hierarchy as a result of digital transformation. The blurring of interdisciplinary and sectoral boundaries, the compression of the innovation cycle, the emergence of open innovation models and contemporary models of digital business, the development of electronic governments, the creation of digital counterparts and cyber-physical systems in industry, the emergence of smart cities - is not a complete list of areas and directions of change that are associated with the new level of digitalization of society. At the same time, the ongoing changes bring new opportunities as well as new risks and challenges. As an example, the change in the content of labor, the emergence of new, and the loss of existing professions, changes in demand patterns for hard skills and soft skills. All these factors lead to the urgent need to create a system of higher education, adequate to the new conditions of the digital development of socio-economic systems. In this case, this is due to the digital transformation of the higher education system itself. The main subjects of this process are universities. Moreover, the huge amounts of information handled by modern universities and the complexity of such tasks, require the formation of not just digital, but smart education for an adequate response to global and local challenges, as well as risks and training of personnel suitable and able to act effectively in these new environments. The formation of such a system requires an interconnected solution of a wide range of technological, organizational, managerial and economic problems.

II. Theoretical Background

Smart education (SE) represents a collection of e-services that employ digital media and information and communication technologies (ICT) for supporting all educational processes. SE is interdisciplinary area, encompassing many aspects of the educational technologies that cover instruction, training, teaching, learning, pedagogy, communication and collaboration.

The concept of smart education in scientific research is considered as the most relevant and important stage of digitalization of the educational sphere. In contrast to the previous stages (distance learning, e-learning, m-learning), smart education involves the provision of student-centered learning through interaction with learning materials using intelligent information systems, as well as the inclusion of non-formal learning opportunities and professional communities [2]. Smart education involves a comprehensive modernization of all educational processes, as well as methods and technologies used into this process. The term "smart" is often associated with the technological aspect and the emergence of smart technologies in education, including smart board, smart screens, smart course [3,4], and a wide range of tools combined in the concept of “smart technologies” [5].

A research framework of smart education, including the definition and evolution of smart education, key features of smart learning environments, main smart educational technologies and opportunities of such technologies implementation in the educational sphere are proposed in a large number of papers over recent years[6,7]. From the technological point of view, smart education can be considered as technology-enhanced learning. Technologies can play role of media or tools for accessing learning content [8], communication and collaboration, construction, expression and evaluation [9]. With the development of smart technologies, learning platform got an opportunity to reacts to individual learner data and adapts educational resource based on cloud computing, artificial intelligent and learning analytics, and help to design of demanded curricula using big data [10]. Moreover, the field of artificial intelligence in education (AID) has become the most challenging area in the last several years. It includes the disciplines: cognitive and social psychology, computer science, empirical psychology, intelligent software and knowledge engineering. The goal of the field is to deliver knowledge-based software which can be used in real teaching, learning and training situations. Using AI concepts theories and techniques, new forms of smart educational software can be created that allow the computer to act as a smart tutor. Such AI-based smart tutoring system (STS) can adjust its tutorial to the student’s knowledge, experience, strengths, and weaknesses. It may even be able to carry on a natural language dialogue. In addition, automatic generation of exercises and tests is an important feature of STS. Moreover, STS systems are complex to build and complex to maintain.

From the organization point of view, smart learning is considering as Self-directed, Motivated, Adaptive, Resource-enriched, and Technology-embedded [11]. Smart educational systems have a high potential in the field of content customization and individualization of learning paths, provides students with an opportunity to implement their own leaning style [12]. Moreover, the educational process thanks to modern intelligent solutions can be carried out anytime, anywhere in the smart education context by using the intelligent devices [13].

In turn, from a managerial point of view, the development of smart technologies leads to the emergence of new educational strategies and models as well as development of smart and adaptive learning environment [14] in order to increase the quality of education. Different countries design various strategies of smart education development with the purpose to improve position in the global digital competitive environment [15].

Taking into account the variety and novelty of smart technologies, the establishment of an effective system of smart education requires an understanding of the features, functional purposes, advantages and challenges of various ITC solutions, as well as integrated consideration of technological, institutional, organizational and economic aspects of their implementation in educational sphere.

III. Levels and Functional Areas of Digital Transformation in Higher Education Institutions

The modernization of the model of higher education institutions based on digital solutions affects both contextual and procedural aspects. The content side of the digital transformation of higher education is on the one hand, connected with the solution of the problem of personnel training for the digital economy, training of highly qualified specialists who are well versed in the digital environment and understand how to apply the latest technologies. On the other hand, the introduction of digital solutions should transform not only the approaches and technologies of knowledge transfer, but also improve the quality of education in general. To solve these problems, it is necessary to implement a digital transformation of the higher education system, which includes a number of actions:

1. The formation of basic student digital competencies (including general, professional, complementary competencies and skills of using digital economy services) and specialized trajectories of their development, implemented through:

– the formation of broad (wide profile) competencies in the application of information communication technologies (ICT);

– the formation of competencies in solving professional activity objectives with the use of specialized software packages;

– the implementation of project studies that require the use of modern analytical tools by students;

– reviewing the content of disciplines and modules to meet the requirements of the digital economy;

– the development of existing and the launch of new specialized bachelor's, graduate and master's programs focused on training human resources for the digital economy;

– the broad integration of disciplines for the formation of digital competencies in bachelor’s, graduate and master's programs;

– the introduction of additional specialized professional education programs

2. Conducting fundamental and applied scientific research for solving specific objectives in order to establish programs that ensure adequately skilled personnel for the digital economy through:

−interaction with employers to embed demanded competencies in educational programs, formulation of project research subjects, research and qualifying papers;

−implementation of specialized research in the field of digital economy. In particular, within the framework of the broader “Economics and Management” group, the contents of which are generally associated with labour market transformations influenced by: digitalization; the emergence and loss of certain professions; changes in issues that motivate workers and employers; the formation of organizational and economic mechanisms for the development of “smart” enterprises and “smart” cities; and the search for new competitive factors in the digital economy.

3. The implementation of meaningful modernisation of educational programs, including the incorporation of the appropriate tools of the digital economy in education processes. For example, there is a new and high demand for the development of mechanisms for the exchange and distribution of various types of goods (private, public, mixed, trust, club etc.). Such mechanisms are developed within the framework of a new academic field – the design of economic mechanisms (Nobel prize in Economics 2007 (Eric S. Maskin) and 2012 (Alvin E. Roth) using the potential of digital (network, information) technologies. Within the framework of the design of economic mechanisms, new approaches are being formed to study the process of organizing auctions (for both private and public goods), as well as approaches to justifying the effectiveness of the distribution of labor resources, etc.

In addition to the content side of the digital transformation of higher education, the process component, which is associated with the development of the infrastructure of educational organizations, ensuring the expansion of the scope of the use of digital technologies in the educational process, plays an equally important role. The process component can be decomposed into levels of implementation in order to introduce ICT into everyday practice and create the so-called “smart education” system.

The first level, the so-called subject, is represented by research and teaching staff, students, industrial and academic partners of the university, graduates and applicants. These are, in fact, internal and external stakeholders of the university. The fulfillment of their interests largelydepends on the overall success of the whole concept of digitalization of higher education.

The second level is represented by basic information services. Their task is to create a common information space for digital interaction within educational organisations. Such services (video screens for lectures and seminars, wireless communications throughout the university, cloud storage and data exchange etc.) are necessary for the development of information infrastructure.

The third level includes the services necessary for the successful implementation of the tasks of “smart education”. This is typically a digital library, student and teacher personal accounts system, an electronic dean's office, etc.The development of these services allows the implementation of the educational process, regardless of location and time of day. In addition, digital services can effectively organize and support research activities. Digital scientometry consists ofmonitoring, accumulation and analysis of scientometric information using modern methods of storage and processing of large data sets. All this will assist the development of perspective directions of research and to measure current performance of publication activity.

The fourth level is the most resource-intensive and consists of services such as digital marketing, research project management, procurement management, interaction with applicants and students. Digital marketing is a set of activities for organizing the interaction of all participants in a process (auxiliary staff, teachers, students, applicants, graduates) using the entire modern spectrum of digital communication channels.

The management of research projects requires the introduction of modern digital services for monitoring the performance of scientific activity. Interaction with applicants and students should be based on the use of digital tools for document management, accepting applications, taking exams (proctoring), and various communication channels. Specific digital services include:

– online courses (both proprietary developments of higher education institutions, as well as those already featured on dedicated digital platforms);

– personal offices, electronic library systems, electronic rating systems, online registration for disciplines and events, etc.;

– technological and infrastructural support of the educational process (student offices, electronic dean's office);

– new teaching methods, including the organization of cognitive, practical, design and research activities of a student in an electronic educational environment;

– artificial intelligence technologies in the educational process (systems of smart tutoring, data mining, case studies).

Separately, it is advisable to focus on the importance of creating a smart, intelligent system of higher education, which will, on the one hand, improve the quality of training of university graduates due to the complete use of the potential of modern digital solutions. On the other hand, this will increase the efficiency of the educational institutions themselves. In this study, the terms “intelligent”, “intellectual”, “smart” education are used synonymously. Given the diversity and novelty of intellectual technologies, the formation of an effective system of smart education in higher education requires an understanding of the features, functional goals, advantages and objectives of various IT-solutions. The realization of all the benefits and applications of smart educational technologies includes not only engineering aspects but also the institutional, organizational and economic issues of their development. This also depends on the integration of such applications into existing educational environments as well as the comprehensive modernisation of such an innovative educational environment.

IV. Smart Educational Technologies

A. *Smart Tutoring Systems (STSs)*

STS is knowledge based software that act as an intelligent tutor used in real teaching. STS is also used in learning, and training situations. From the technical point of view, STS is composed of the following software components: (a) expert model, (b) student mode, (c) instructional module, (d) interface and (e) knowledge acquisition module. STS components are complex to build and complex to maintain. For more technical information, see [16]. Fig. 1 and Fig. 2 show the main features and benefits of the STSs from the educational point of view.

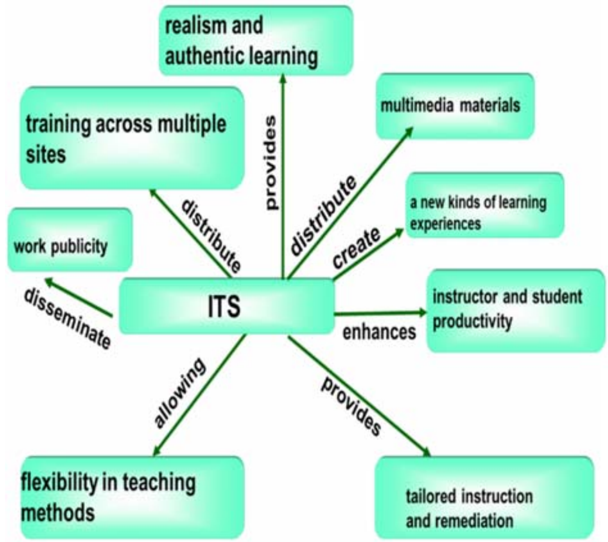

Fig. 1 main features of STS

From the knowledge engineering perspective, the main two components in developing an efficient and intelligent learning/educational system in any domain are the "knowledge base" and the "inference mechanism/engine".

- Adjust its tutorial to the student's knowledge, experience, strengths, and weaknesses.
- Use of pedagogical knowledge.
- Organize its knowledge in a lesson-oriented manner according to student models.
- Use of rhetorical knowledge (or rules) for natural language text generation.
- Addition of new knowledge is simple due to the structured object-oriented knowledge representation language.
- Generates exercises and test.
- Generates programs for illustration purposes.
- Evaluates student results for tests.
- Tireless teacher which adapts to the learners cognitive particularities and his individual progress.
- Based around a large amount of knowledge from the teaching domain.
- Learner's particularities and his progress are stored in the "student model".
- Carry on a natural language dialogues and explanations.
- Generate a highly structured collection of web pages.

Fig. 2 benefits of STS

Concerning the knowledge base, there are many knowledge representation and management techniques, e.g.; lists, trees, semantic networks, frames, scripts, production rules, cases, and ontologies. The key to the success of such systems is the selection of the appropriate technique that best fits the domain knowledge and the problem to be solved. That choice is depends on the experience of the knowledge engineer.

Regarding the inference engine, there are many methodologies and approaches of reasoning, e.g.: automated reasoning, case-based reasoning, commonsense reasoning, fuzzy reasoning, geometric reasoning, non-monotonic reasoning, model-based reasoning, probabilistic reasoning, causal reasoning, qualitative reasoning, spatial reasoning and temporal reasoning [17]. In fact these methodologies receive increasing attention within the community of AI-based smart tutoring systems industry [18,19,20]. Therefore, developing of STS for specific task face the knowledge-acquisition difficulty. So, efficiency of STS is based on the selection and determination of the appropriate knowledge representation techniques and reasoning methodologies.

B. *Intelligent Authoring Shells and Tools*

Intelligent authoring shells allow a course instructor to easily enter domain and other knowledge without requiring computer programming skills. The authoring shell automatically generates an ITS/IeLS focusing on the specified knowledge. It also facilitates the entry of examples/exercises, including problem descriptions, solutions steps, and explanations. The examples may be in the form of scenarios or simulations. It allows organized entry of the course principles and the integration of multi-media courseware (developed with well-known authoring tools) which includes descriptions of the principles or motivational passages. In addition to course knowledge, the instructor specifies pedagogical knowledge (how best to teach a particular student), and student modeling knowledge (how to assess actions and determine mastery).

The most common authoring shells are DIAG, RIDES-VIVIDS, XAIDA, REDEEM, EON, INTELLIGENT TUTOR, D3 TRAINER, CALAT, INTERBOOK, and PERSUADE [16]. Some tools were meant for select authors or students and others were designed for a wide set of authors. Some tools were designed to work with a limited area of domain expertise, and some were designed for a wide range of domains. Some tools had one main instructional strategy, but others had many. Each tool had their own way of representing the student's knowledge and understanding of the material being taught. Some tools generated instruction directly from domain knowledge. Some relied on pedagogical knowledge about the domain to create instruction. Some provided simulation environments for practice and exploration.

V. Computational Intelligence Techniques for Developing STS

A. Case Based Reasoning (CBR) Approach

CBR is an analogical reasoning method provides both a methodology for problem solving and a cognitive model of people [21]. CBR means reasoning from experiences or "old cases" in an effort to solve problems, critique solutions, and explain anomalous situations. It is consistent with much that psychologist have observed in the natural problem solving that people do. People tend to be comfortable using CBR methodology for decision making, in dynamically changing situations and other situations were much is unknown and when solutions are not clear.

From knowledge engineering point of view, the “case” is a list of features that lead to a particular outcome. (*e.g. The information on a patient history and the associated diagnosis*). Fig 3 shows the contents of one "case" of a live cancer case.

Patient: 65-years old female not working, with nausea and vomiting.

Medical History: cancer head of pancreas .

Physical Exam: tender hepatomgaly liver, large amount of inflammatory about 3 liters, multiple liver pyogenic abscesses and large pancreatic head mass.

Laboratory Findings: total bilrubin 1.3 mg/dl, direct bilrubin 0.4 mg/dl, sgot (ast) 28 IU/L, sgpt (alt) 26 IU/L.

Fig. 3 live cancer "case " description

Determining the appropriate case features is the main knowledge engineering task in developing case-based IeLS. This task involves defining the terminology of the domain and gathering representative cases of problem solving by the experts. Representation of cases can be in any of several forms (*predicate, frames, scribes*).From the computational point of view, CBR refers to a number of algorithms and techniques that can be used to record and index cases and then search them to identify the ones that might be useful in solving new cases when they are presented. In addition, there are techniques that can be used to modify earlier cases to better match new cases and other techniques to synthesize new cases when they are needed. CBR has already been applied in a number of different applications in many domains, e.g., medicine, industry, law, banking [21, 22, 23].

The “Case” composed of three major parts: (a) problem description, (b) solution, and (c) outcome. "Problem description" refers to the state of the world at the time the case is happening. "Case solution" refers to the stated or retrieved solution to the problem specified in the *problem description.* "Case outcome" defines the resulting state of the world when the solution was carried out. Depending on the case structure, the case can be used for a variety of purposes.

In e-learning systems, the case can include: (a) A multi-media description of the problem, (b) A description of the correct actions to take including optimal and alternative steps, (c) A multi-media explanation of why these steps are correct, and (d) A list of methods to determine whether students correctly executed the steps.Determining the appropriate case features is the main knowledge engineering task in case-based AI software. This task involves defining the terminology of the domain and gathering representative cases of problem solving by the expert Representation of cased can be in any of several forms (predicate, frames, scribes).

B. Ontological Engineering approach

The term “ontology” is inherited from philosophy, in which it is a branch of metaphysics concerned with the nature of being. The main objective of using ontologies is to share knowledge between computers or computers and human. Computers are capable to transmit and present the information stored in files with different formats, but they are not yet compatible to interpret them. To facilitate communication and intelligent processing of information, it is necessary that all actors of the digital space (computers and humans) have the same vocabulary. Ontologies are the foundation of cooperation and the semantical understanding between computers (running a lot of nonhomogenous software programs) and of the cooperation between computers and humans.

Most of the usages of ontologies in the field of computer science are related to knowledge based systems and intelligent systems. These types of ontologies include a small number of concepts and their main objective is to facilitate reasoning. For example, in multi-agent systems, the knowledge representation is accomplished through a basic ontology, privates ontologies and a knowledge base. Private ontologies of the agents are derived from the basic ontology. The names of the concepts used in private ontologies of the agents are unknown, but their definitions use terms from the basic ontology. During the last decade, increasing attention has been focused on ontologies [24]. At present, there are applications of ontologies with commercial, industrial, medical, academicals and research focuses [25, 26, 27, 28].

C. Data Mining and Knowledge discovery approach

Data mining methodology aims to extract useful knowledge and discover some hidden patterns from huge amount of databases which statistical approaches cannot discover. It is a multidisciplinary field of research includes: machine learning, databases, statistics, expert systems, visualization, high performance computing, rough sets, fuzzy logic, neural networks, and knowledge representation. Data mining techniques aim at providing intelligent computational methods for accumulating, changing and updating knowledge in intelligent systems, and in particular learning mechanisms that will help us to induce knowledge from information or data.

Knowledge discovery in databases (KDD) process involves the following processes; (a) using the database along with any required selection, preprocessing, sub-sampling, and transformations of it, (b) applying data mining methods (algorithms) to enumerate patterns from it, and (c) evaluating the products of data mining to identify the subset of the enumerated patterns deemed knowledge. The data mining components of the KDD process is concerned with the algorithmic means by which patterns are extracted and enumerated from data. The overall KDD process includes the evaluation and possible interpretation of the mined patterns to determine which patterns can be considered new knowledge. Data mining is supported by a host that captures the character of data in several different ways, e.g. clustring, classification, link analysis, sequence analysis, regression models, summarization, text mining, sequential pattern mining, association rules mining. In addition there are a lot of intelligent techniques to perform these tasks e.g. neural networks, support vector machines, decision trees, genetic algorithms, k-means and others. For more details we refer to the books [29, 30]. Table 1 shows the DM tasks and the appropriate techniques for each task.

Table 1. Data Mining Tasks and Techniques

Data Mining Task	Data Mining Algorithm & Technique
Clustering	K-means
Classification	Support Vector Machines Decision Trees, Neural Network, Rule induction , Genetic Algorithm
Regression and prediction	Support Vector Machine, Decision Trees, Rule induction, NN
Association and Link Analysis (finding correlation between items in a dataset)	Association Rule Mining
Summarization	Multivariate Visualization

D. Agent-based approaches for STSs

Intelligent agents (IAs) are artificial entities that have several intelligent features, such as being autonomous, responding adequately to changes in their environment, persistently pursuing goals, flexible, robust, and social by interacting with other agents. IA mimics human interaction types, such as negotiation, coordination, cooperation, and teamwork. IAs are defined as computer systems situated in an environment and that are able to achieve their objectives by: (i) acting autonomously, i.e. by deciding themselves what to do, and (ii) being sociable, i.e. by interacting with other software agents. Agents are often seen as incarnations of various forms of AI including machine learning, reasoning and data mining. Research interests in agent systems are spanning various topics like modeling, design and development of advanced software systems that are appealing for a number of computer applications.

During the last decade, agent technologies were proposed to enhance e-learning systems across at least two dimensions: (i) agents as a modeling and design paradigm for advanced human-computer interaction and (ii) agents for smart functional decomposition of complex systems. Firstly, agents have been described as entities that exhibit several interesting properties that are very appealing for the modeling and design of advanced user interfaces encountered in e-learning systems: teachers, tutors and students. Secondly, generic agent types proven to be effective for the appropriate functional decomposition of e-learning systems. Dynamic and interoperability characteristics of agents are very suitable for supporting maintainability and extensibility of e-learning systems.

VI. Benefits of Intelligent Techniques Smart Tutoring Systems

This section discusses the benefits of the previous techniques for STS

A. Benefits of CBR Approach to STSs

The idea of CBR is becoming popular in developing intelligent eLearning/tutoring systems because it automates applications that are based on precedent or that contain incomplete causal models. Research reveals that students learn best when they are presented with examples of problem-solving knowledge and are then required applying the knowledge to real situations. The case-memory of examples and exercises capture realistic problem-solving situations and presents them to the students as virtual simulations.

On the other hand, there are several benefits where students/learners should be able to perform better using CBR methodology, e.g.With more cases available, students will be able to recognize more situations and the solutions that go with these cases include failure cases, students will be able to benefit from the failures of others.

Retrieval cases will allow students to better recognize what is important in a new situation. Cases indexed by experts would recall and will show the student ways of looking at a problem that he might not have the expertise for without the system.

Student will have access to obscure cases that they otherwise would not able to make use of. These obscure cases can help with any of the tasks previously listed.

During a training period CBR system provides the student with a model of the way decision making ought to be done, for example, what things ought to be considered and provides them with concrete examples on which to hang their more abstract knowledge.

For tasks where there is much to remember, CBR systems can augment the memories of even educators. Also, both educators and students tend to focus on too few possibilities when reasoning analogically or to focus on the wrong cases.

B. Benefits of Ontology Paradigm to STSs

Ontologies' usage in educational systems may be approached from various points of view: as a common vocabulary for multi-agent system, as a chain between heterogeneous educational systems, ontologies for pedagogical resources sharing or for sharing data and ontologies used to mediate the search of the learning materials on the internet [31].

The abstract specification of a system is composed of functional interconnected elements. These elements communicate using an interface and a common vocabulary. The online instructional process can be implemented successfully using artificial Intelligence techniques. Sophistical software programs with the following features give the intelligence of the machine: adaptability, flexibility. Learning capacity, reactive capacity, autonomy, and collaboration and understanding capacity. This approach enables to solve the complexity and the incertitude of the instructional systems. An intelligent learning system based on a multi-agent approach consists in a set of intelligent agents, which have to communicate. They collaborate through messages. Software agents can understand and interpret the messages due to a common ontology or the interoperability of the private ontologies.

C. Benefits of data mining paradigm to STSs

This section presents the applications of some of the data mining methods and tasks in smart education and learning. Further details and other applications can be found in [19]. The following paragraph presents the main aspects of data mining paradigms namely, Information Visualization and Clustering.

Information visualization (IV) can be used to graphically render complex, multidimensional student tracking data collected by web-based learning/educational systems. The IV in e-learning can be used in the following educational tasks; admitted questions, complementary assignments, exam scores, etc. Moreover visualization tools (e.g., GISMOCourseVis) enable instructors to manipulate the graphical representations generated, which allow them to gain an understanding of their learners and become aware of what is happening in distance classes.

Clustering approach has been used in smart education and learning for the following tasks:

- Finding clusters of students with similar learning characteristics and to promote group-based collaborative learning as well as to provide incremental learner diagnosis.
- Discovering patterns reflecting user behaviors and for collaboration management to characterize similar behavior groups in unstructured collaboration spaces.
- Grouping students and personalized itineraries for courses based on learning objects.
- Grouping students in order to give them differentiated guiding according to their skills and other characteristics.
- Grouping tests and questions into related groups based on the data in the score matrix.

VII. Institutional and Organizational Aspects of Smart Educational Technologies Development and Application

At the same time, the realization of all the advantages and areas of application of smart educational technologies is associated not only with engineering and technological aspects, but also with institutional, organizational and economic issues of their development and integration into the existing educational environment, as well as a comprehensive innovative modernization of the educational environment.

From an institutional perspective, it is necessary to provide a legitimate basis, establish strategies and development programs, create favorable institutional environment, and establish rules and procedures for the designing and using of innovative intellectual educational technologies. The point is that it is important to institutionalize smart education.

This involves making a set of decisions [32]:

– at the country level, covering: the inclusion of digitalization in a broad sense and intellectual technologies in particular in the scientific and technological priorities of the national economic system; support for educational programs in the ICT sphere, the promotion of digitalization and intellectualization of educational processes; the creation of favorable conditions for the development of networks and partnerships between educational institutions, between educational institutions with state authorities and industrial partners;

- at the regional and sectoral level: establishment of a regulatory framework and institutional conditions for the accumulation, exchange and use of adequate information for creation of content for smart educational technologies, the development of expert platforms and institutions for the designing of smart education;

- at the level of educational institutions: the rules and procedures for the design and incorporation of smart technologies into the educational process and their integrated .

This will ensure the widespread introduction of smart technologies in the educational process and will lead to positive synergetic and multiplicative effects.

In turn, speaking about the development of smart education in the economic context, it is important to note the need for appropriate resources. This requires multi-channel funding for smart educational technologies (in terms of designing, development, dissemination and implementation) from both government agencies and educational institutions themselves and their partners in the real sector and the ICT sector of the economy. Equally important is the promotion of demand for appropriate technological innovations in education.

Finally, we cannot leave out of the consideration the organizational and managerial aspect, which is revealed in the range of questions from the creation of a motivational mechanism for employees to develop and implement smart educational technologies that are most applicable in a particular field of knowledge for solving certain tasks to the modernization of the entire model of strategic development of universities based on the potential of smart digital solutions.

VIII. Challenges of Smart Education

Recognizing all the advantages of a smart higher education system based on intelligent digital solutions, it is also necessary to focus on the risks and challenges. Some of the major open problems that must be addressed to ensure the success of developing robust intelligent e-learning systems were identified as a result of the analysis [32]. The development of intelligent e-Learning/educational systems is a very difficult and complex process that raises a lot of technological and research challenges that have to be addressed in an interdisciplinary way. Today's the fusion of computational intelligence and machine learning techniques with the knowledge acquisition techniques solves many of the technical problems and difficulties in designing new generation of intelligent e-Learning/educational systems. Further research however is needed to convergence the knowledge engineering, artificial intelligence, machine learning, educational technology with the web science. Such convergence will create a new generation of web-based intelligent e-learning and tutoring systems. The web based of such systems can enhance the online education/ learning/training processes through the web. On the other hand, Intelligent agents technology, as a modern version of AI, where knowledge representation is enhanced with learning and social interaction. In the current environment of global wired and wireless networks, IAs may play the role of a universal carrier of distributed AI. So, the integration of software agents approaches and educational technologies is beneficial for designing efficient, robust and intelligent e-learning systems. In addition, ensuring the success of such systems to the cloud is an important challenge.

IX. CONCLUSIONS

As such, the formation of smart education system, on the one hand, solves a range of issues associated with improving the quality of education and training with a competency profile. This competency profile should be adequate enough for key trends in the digitalization of society.

On the other hand, the creation of such a system is in itself is a complex task, in combining a whole range of technological, organizational, managerial, institutional aspects of modern universities [33].

Moreover, each of these areas requires further research as there is a lack of ready-made universal solutions due to the innovative nature of modern digital transformations.

In fact, the article not only talks to the introduction of new intellectual technologies into the traditional educational process but also to changing the paradigm and model of higher education from the procedural and substantive points of view. This includes changing existing models of university management and the means of interaction among higher education subjects. That is precisely the creation of smart education. One of the distinctive features in this particular subject field is the very high speed of development and practical implementation of new technological solutions. This is connected, firstly, with the dynamic development of technologies, and secondly, with the awareness of digitalisation and intellectualisation as one of the key factors of competitiveness. Accordingly, in order to maintain or increase the potential of competitiveness in the modern global environment, universities need to develop a proactive strategy for creating smart education. This development should take into account the universal requirements and specific features of their particular operating conditions and strategic development objectives.

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