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STRUCTURED ABSTRACT

The Universal IT Support Design for Engineering Education

CONTEXT
The paper presents the authors' interdisciplinary approach to solving IT integration into university teaching and learning, self-study, publishing, research and all kind of personal activities performed by a teacher, including appropriate activities of students. It is based on the development of own in-house universal IT system (application software and combined offline / online infrastructure), which can be used for any category of engineering STEM teaching. The uniqueness of the solution is based on the design of the so-called virtual knowledge into which it is possible to insert in a suitable way concentrated educational content in the form of texts, images, audio and computer files.

PURPOSE OR GOAL
At present, every teacher is burdened with a huge amount of information in practice, which also applies to the creation of teaching content, because they must not only select the appropriate knowledge, but also create quality pedagogical content and teach within a limited time limit given by the length of lectures and exercises. And since state-of-art, despite the enormous progress of computer technology, does not provide suitable IT tools for mass processing of information and thus extensive educational content, the authors began to address this issue in the 7th Framework Program for technology-enhanced learning. As part of the empirical research, the primary goal was to develop all-in-one software that allows individuals with low IT skills to collectively process educational content that also uses Internet resources, which was installed in the classroom with computers as part of teaching undergraduates. Mastering this goal has made it possible to start working on the automation of knowledge-based processes, which also include teaching and learning. So other goals were to program communication channels so that teachers and students could exchange information, instruct, and communicate with each other. All this could be managed only thanks to the design of virtual knowledge as a specific database structure (it is registered with the patent office within the utility model). Another at the same time, current and future goal is to apply this structure to the creation and transfer of educational content in any educational processes, including such as assessment and various administrative activities.

APPROACH

The solution of IT integration into teaching and learning is based on the fact that it is a set of knowledge-based processes, which from a pedagogical point of view are represented by specific pedagogical algorithms. In real life, there is a very diverse range of didactic algorithms, which are different in engineering teaching, different in humanities and, for example, completely different in visually impaired teaching. This logically requires writing appropriated tailor-made computer algorithms for each individual case. For this reason too, there is no universal computer software on the market that is particularly suitable for supporting teachers or students as individuals. As a result, teachers must use existing software and technologies, test their suitability, and adapt. Ordinary teachers are not aware of these things, but computer experts simply explain that the computer as a machine lacks "knowledge representation". And this is compounded by the problem that the terms information and knowledge have different meanings in different scientific disciplines. The authors managed to solve these contradictions precisely by designing the “virtual knowledge”, which one sees in a common tabular form. An individual can put tacit knowledge into it in his natural language, while for a computer it is just some computer object that can process extremely quickly. In this case, the cybernetic principle is implemented, i.e., the virtual knowledge functions on the morphological principle as a switch between the mental processes of man and the physical processes of the machine. And because the machine works extremely fast, it can deliver the necessary output to the person (teacher) almost immediately and thus automate his activities. The software, written by one of the authors of this article, has been evolving over the years on the principle that source code must always simulate any educational activity, i.e., not only work on the creation of learning content but also its transmission within teaching. The progress of software applications for the automation of educational processes has been continuously published by the authors in recent years depending on what new functions have been added to the user menu. Mastering the creation and use of content in the teaching of undergraduates required solving how to integrate this content into activities connecting teachers with students, i.e., how to select content from the knowledge base (for example from the created virtual learning space on the faculty server) and use it directly in

lectures and exercises. So communication channels passing through the classroom with the online environment were programmed as an Internet application (also for evaluation and testing). All this allowed for a progressive approach and an awareness of the fact that any IT integration requires the synchronization of pedagogical/didactic and IT algorithms, moreover software must be designed to be compatible with Windows, computer networks and clouds (in other words, they must run on a specific IT infrastructure). The creation of a software system and IT infrastructure has taken research to a higher level, when the vision of the functioning of the virtual knowledge as an intelligent educational structure is already beginning to be realized. This developed approach will be presented in the article, for example, on the automatic creation of educational-packages (as knowledge-packaged categories) with special emphasis on applications for visually impaired students.

ACTUAL OR ANTICIPATED OUTCOMES

As follows from the previous explanation of the approach, IT integration into education is a very complex matter because it is an interdisciplinary area, and in our case a completely new technology is being developed within academic engineering education and research. The main output is therefore a universal IT system that can be applied to any activity of teachers, students or individuals and simulate educational processes as knowledge-based. Its theoretical basis is the above-mentioned virtual knowledge that governs the educational software being developed within a particular IT infrastructure. This functionally enables the switching of teachers' and students' computers with online environments, university LMS systems and Internet services, i.e., also within any category of teaching, e.g., blended learning, distance learning, assessment. Outcomes from many years of research enabled personal IT support within the teaching of study courses (Background of environmental protection, Chemistry, Occupational health and safety, Programming languages, Simulation modelling) and research (FP7 - Technology enhanced learning, Digital libraries, Learning analytics, Horizon - Cracking language barriers, V4 project - CSCL). As mentioned, the portfolio of pedagogical / didactic algorithms in real life is so huge that no artificial intelligence can do it. The presented IT support system can now be used to continue the elaborated outputs of the automatic creation of educational packages, language support for publishing and the solution of IT support for visually impaired education. In this context, it should be mentioned that on the basis of preliminary tests, the educational software can to some extent also be used for the blind, which will be addressed in this article in the sections from previous applications. Within the IT support design for engineering education, the outputs can be divided into the following items of the developed IT system:

IT integration SYSTEM = SOFTWARE + HARDWARE + IT INFRASTRUCTURE

- SOFTWARE: 1. WPad - educational software 2. PIKS - communication channels 3. A set of exe-tutorials or
- HARDWARE 1. Client computers with Windows 2. Notebooks with Windows 3. Mobile phones (for Virtual learning space browsing) 4. E-Sources - USB, CD, DVD
- EXTERNAL INFRASTRUCTURE (personal or faculty's IT equipment or Cloud-services)
  Virtual Machines with Windows (for WPad) 2. Learning WEB-space (for FTP transmission and PIKS)

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

The paper presented an interdisciplinary IT support design for engineering education, which is implemented in engineering education and is especially suitable for STEM teaching. Namely, the virtual knowledge enables work with texts, images, computer files and thus also to visualize educational content and activities, which is primarily in STEM, in contrast to managerial and humanities subjects, where text is used more. It has been explained that universality is given by the concept of the virtual knowledge, which the computer understands as a knowledge representation (as a kind of information - because the computer does not work with knowledge but information in the form of bytes). As part of a long-term solution of IT integration into teaching, a personal support system has been developed that can be used primarily by the teacher as an educational IT tool for any activity he performs (teaching, creating eLearning, research, publishing) and which can serve as an educational tool for his students. The paper presents examples from the creation of educational packages and support for visually impaired education and to continue programming with a vision of an intelligent educational structure. In terms of limits, it should be emphasized that IT integration is interdisciplinary and consists not only of pedagogical algorithm design and parallel IT design (didactic algorithms must be defined, otherwise they can not be programmed), but the most difficult thing is programming adaptation on Windows, networks and clouds, which is time the most demanding. It should be mentioned that this is a research of technology that has not existed before and its basic thesis is to solve a prototype of how thousands of educational activities can be simulated. The authors surprisingly encounter misunderstandings on the part of teachers, or even pedagogical journals, who do not accept this phase of research. In other words, they only recognize if some students work without a computer and part with a computer to test some hypothesis. From this point of view, the presented new technology can be following used also for PRE/ POST Academic Research (it cannot be used without technology).

KEYWORDS

Technology-enhanced learning, educational software, educational content, virtual knowledge