

The Universal IT Support Design for Engineering Education

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Abstract—In terms of integrating IT into teaching, current technologies do not provide a universal solution for teachers' personal support and have a shorter lifespan than teachers and educational processes need. As a result, technology does not adapt to a wide range of teaching activities, but teachers have to adapt to technology. The paper presents such a universal solution based on 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. From the virtual knowledge, educational tables are created using WPad educational software, which allows simultaneous generation into html-format and placement on the faculty or WEB. The paper describes its use and how it works on the IT infrastructure developed for the integration of IT in teaching. The automation of the teacher's work (including visually impaired) on the creation of educational packages is also described, which will also be the subject of further research.

Keywords—*technology-enhanced learning, educational software, educational content, virtual knowledge*

I. INTRODUCTION

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 exercise. 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, inform, 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). So, another and 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.

Jednotlivé sekcie to približujú v rámci nasledujúcich sekcií s conceptual framework (princíp využitia osobného edukačného softvéru WPad), actual outcomes, examples of creating educational packages and communication channels (PIKS), some aspect from teaching blind and visually impaired.

II. CONCEPTUAL FRAMEWORK

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 didactic/pedagogical algorithms. In real life, there is a very diverse range of the algorithms, which are different in engineering teaching, different in humanities and, for example, completely different in visually impaired teaching. This logic requires writing tailor-made computer/informatics algorithms for each individual case. In this context, 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.

A. Principle of educational software development

The authors managed to solve these contradictions precisely by designing 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, ie 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 WPad 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 some educational activity, ie not only work on the creation of learning content but also its transmission. 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, ie 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 exercise. So, communication channels passing through the classroom with the online environment were programmed as an Internet application (they were used to exchange information even for testing). All this allowed for a progressive approach and an awareness of the fact that any IT integration requires the synchronization of pedagogical and IT algorithms and 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 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 education.

B. Software adaptation for teaching undergraduates

It should be emphasized here that WPad has evolved over the years according to what has been required to teach in the classroom with undergraduates in order to create them quality teaching material for exercises and lectures and self-study in the virtual educational space of the faculty. The user menu gradually grew to hundreds of items, and suddenly it became clear that there was no similar software on the market - just because students and teachers could switch between the Internet and folders and files on their computers from the same WPad spreadsheet environment. Also the highlights were that the number of clicks decreased. And the biggest advantage for a teacher, graduate or doctoral student who designs some educational content was that they use WPad as their Notebook. And using the CTRL-F1 keyboard shortcut, a mirror html page of the WPad table is created. Thus, eLearning scripts for several subjects were then created from individual tables and placed on the faculty server so that students could access from home or classroom. In other words, WPad works not only as a simple text editor but also as a simple html-editor (the user does not need to know the html codes or the program for creating WEB pages).

It can also be noted that WPad originally began to develop in industrial R&D research at a time when the Internet was not yet commonplace. In the testing laboratory, the program and tables were also used as an information system for the ISO 9001 quality standard. It was interesting that in the offline mode, ie without internet access, the Opera browser was used. Ordinary users do not know that browsers can also be used offline, i. on a personal computer. Here, it is especially convenient to use IExplorer or Edge browsers, which switch to Windows Explorer, which users are used to (after other browsers do not allow this), after entering the offline path on the computer.

In addition to mastering the mass creation of teaching content, it was necessary to program communication channels. We could call them chat-html-sites in which students could communicate with each other and with the teacher, who gave them instructions, tasks, teaching content.

The problem at the time was that the students did not know what to communicate and what to write in the communication channels. So the teacher had to give them instructions (eg write the name of the semester work, your names and identification data). In practice, this means that the teacher or student can have their own communication paths. Although communication channels were introduced into teaching about ten years ago, the current state of technology allows them to be better used. Screenshot in FIG. 1 illustrates the current use of the PIKS (Personal Information and Knowledge System) communication channel, which functions as an additional Internet application with the same structure as WPad (just the contents of the tables are on a database server with MariaDB).

CATEGORY	TOPIC	Sub-Category	Date	DATE TIME	CONTENT	
PUBLISHING	Publikovaný článok do Forum manažéra	JOURNALS	Výstup z rámci riešenia projektu VEGA 1/0101/18	2021-02-20	AP	SELECTED ASPECTS OF THE DESIGN OF INSI OF MANAGEMENT PROCESSES OF MONITOR WORK ENVIRONMENT FACTORS IN MACHIN

Fig. 1

C. Comparison of WPad software with other solutions

Although the articles of all the well-known scientific publishers (Springer, Wiley, Science Direct, Emerald) were examined, no software was found that would allow to cover so many educational activities together. Or it allowed activities that other software did not allow at the time - e.g. the English teacher entered the sentences into a WPad spreadsheet, generated an html page, and after clicking on the sentences, a computer from the American server I am Translator spoke to them (around 2007, TTS technology was not as common as translators allow today).

The result of the back-analysis was that the software works as an all-in-one system due to the specific data structure of the table. Based on this, a utility model was submitted and later successfully registered as a technical solution. It uses this specific structure not only for content creation but also for the transfer of tables within an off-line or off-line and on-line environment [UV 7340]. In the following research, the software was also installed and tested on a faculty virtual machine. This allows tables to be transferred between a server with a virtual machine and a computer that has the same WPad software installed.

It should also be emphasized that if the tables contain manually entered notes or copied selected text, then WPad actually acts as a tacit knowledge converter (the term tacit knowledge is used in Knowledge management). From a practical point of view, the advantage was that the students used the installed WPad, so the content could be collected and combined from their computers and the teacher could more easily evaluate and use them for collaborative activities. For example, undergraduates had insufficient knowledge of chemistry, which required teaching the subject Background of environmental protection (in industry). So each student was given a task in the WPad spreadsheet to do an Internet search on topics such as oxidation, reduction, pH, amino acids, etc. and make an internet multi-search with WPad (multi means that how many words are written to the table as many windows search engine opens).

The registration of a utility model has opened up a new phase of endless possibilities for processing knowledge (didactic content in tables) and information (general content

in computer files). I assume that from the previous description there should be a clear difference between the WPad table with the selected reduced content and computer text files (pdf, doc, txt, html), which contain unreduced content. This difference is more difficult to explain to an educator than to an IT professional, because in the IT field, the WPad function is understood as knowledge management, while working with files as information management (the BOX cloud service refers to this as content management).

It is important to understand that no common software allows, as in the case of WPad, the concentration of offline and online content by processing knowledge and files in virtual knowledge tables, as well as the generation of html outputs. This also made it possible to start developing application menus and various sophisticated activities. Application menu means creating menu items that combine several simple menu items into one sequence and perform them with a single click. In other words, from the point of view of the teacher and the user, it works like a black box.

III. 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 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, ie 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 (eg, Background of environmental protection, chemistry, Occupational health and safety, Programming languages, Simulation modeling,...) 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)

1. Virtual Machines with Windows (for WPad)
2. Learning WEB-space (for FTP transmission and PIKS)

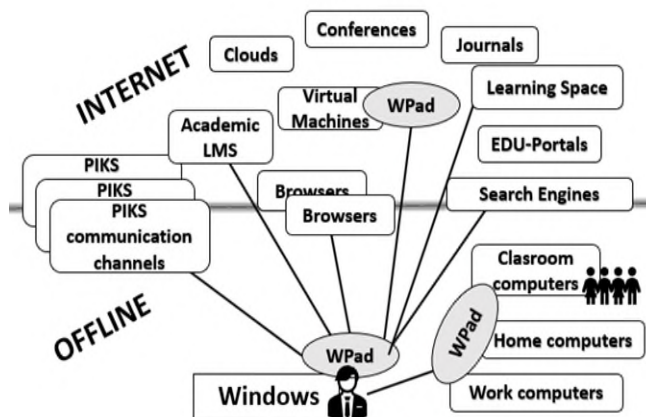


Fig. 1 Teachers personal IT infrastructure

IV. ACTUAL OUTCOMES

The basis of working on a personal computer is the use of folders and computer files in offline mode, where the user uses Windows Explorer to access them. He uses browsers such as IE, Edge, Chrome, Firefox, Opera, Safari and the like to work on the Internet. In this case, each browser is a complex software that has a myriad of features built into it. In practice, this means that the user can use it for internet search, write paths in the top line, can create a system of links to sites they visit regularly (favorites) and the like.

When working with the Windows operating system, this way of working is illustrated in the left part of Fig. 2.

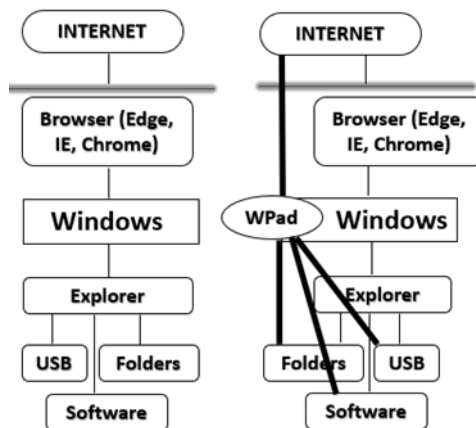


Fig. 2

On the right is a demonstration of using the WPad software. As you can see, a user can bypass Explorer and the browser and open files, folders or websites directly from the WPad spreadsheets. This saves you a huge amount of clicks between offline and online environments, so an individual saves thousands to tens of thousands of mouse clicks a year when using WPad. The teacher can thus create his own system and automate his activities, for example by creating a set of favorites in his tables.

A. Teacher

It should be emphasized here that WPad has been developing for years primarily to automate any teacher's activities, which can be divided into content creation, lecture and exercise support, publishing, research but also his self-study and other work-related activities, including administration. So the creation of favorite sets is only one of the application possibilities of using the research outputs of IT integration into teaching and teacher adaptation to the Windows operating system and built combined offline / online IT infrastructure (software, virtual machine, WEB-space with vVirtual learning space / environment, communication channels). The principle of automation is very simple, ie if the teacher does something regularly on the computer, it is solved with the new source code, which is built into the user menu of the WPad program.

However, an important consideration of the teacher's adaptation to technology is that the teacher must also adapt to the technology in order to use all its possibilities. The teacher must therefore create his own didactic-informatics algorithms in order to facilitate the work of the computer. This is not only about organizing folders, etc., but also creating your own way of working using WPad software and virtual knowledge tables.

As an example for using the schemes in FIG. 1 and FIG. 2 can be given from the teaching of undergraduates, where the teacher taught several study courses and had all the necessary data available to the university LMS - Academic Information System (AIS). There are already a hundred lines of various categories at the head of the entrance to AIS. In addition to the internal university e-mail, the teacher most often used the space for the relevant study course. There are available student names, circles and can write them grades. In this case, the WPad educational software made it possible to copy to the knowledge tables all the AIS routes the teacher goes to and connect from them to the system (for example, he can copy with CTRL-A / CTRL-C / CTRL-V the names of all his students and from one line create a one-click spreadsheet where each student is in one row).

As part of the research, the teacher usually taught five to a hundred students at a time and created his own way of working in the study programs as needed. For example, when he taught a hundred students, he had each student in one row of the table and used the information to classify students into blocks as needed. During the semester, he kept the necessary records in knowledge tables, which proved very useful during the final examination of students at the end of the semester. The teacher simply copied into it from the AIS group of students who signed up for the exam and compared it with how the student worked during the semester (from the table he directly clicked on their semester works, tests, emails).

When the teacher uses the WPad educational software, he creates a main table with plain text. This usually has 20-30 rows and has stored information and knowledge in the given regions of the table. Such an "educational" knowledge table should be imagined as an educational package in which the teacher has everything. The table can be transferred from work to a home computer, laptop using a USB key or uploaded to its virtual learning space. If someone sees a resemblance to information systems, LMS (AIS, Blackboard,) so yes, it is teachers' personal IT tool that performs their function, but dozens of others (LMS system, for example, does not allow

you to search a personal computer, run software, use Internet search, etc.).

Software development is focused on the creation of educational packages (see next text), but in this case it will not be a set of educational knowledge stored in the WPad table but a set created from a large number of computer files in which teachers have some educational content (linked via the WPad table) . These things are difficult to explain to colleagues or even IT professionals who have never encountered this personalized IT paradigm. They simply cannot understand that the relational database paradigm is not used. So they do not understand that this is a new way of transferring human knowledge, whether between people or between man and machine. Namely, the teacher inserts tacit knowledge into the tables (as well as explicit knowledge by copying texts from documents), so it is a selective didactic content. And understanding is also hindered by the fact that people exchange and send information to each other as computer files such as txt, html, pdf, doc, png, jpg, mp3 - that is, unreduced content without added didactic value. The non-reduced content is thus e.g., pdf-file with proceedings, but in the WPad knowledge tables the teacher chooses only what he needs (didactic content).

B. Students

As part of technology-enhanced learning research, WPad was also used in teaching undergraduates. Each pair of students had one computer with a WPad installed on the classroom. The teacher gave them instructions, for example: "Open the WPad by clicking on the icon on the desktop and enter the name of the semester, your names, year in the table row. And use the keyboard shortcut CTRL-F1 and the browser will open the table in html format". Or gave them a task, do an online multi-search for a few keywords selected with some didactic intent. E.g. In the subject Basics of Environmental Studies, each student had to search the Internet for learning content such as oxidation, reduction, free enthalpy, amino acids, photosynthesis. Multi-search means that students entered the words listed in the table, clicked on the user menu, and opened as many windows in the browser with outputs as there were keywords (OPERA version 9.27 was used at the time). Students copied selected texts into tables, which the teacher merged into one table, made a pdf file and transferred the teaching content to a virtual learning space for students to dispose of (the teacher designed an eLearning space for them on the faculty server). In this way, a tutoring material from chemistry was collaboratively created, which was then used in the following years by other students for self-study (note - the knowledge of chemistry students was very weak and without them they would not be able to master the subject matter). During the ten years of research into the integration of IT into teaching, even students with low IT skills had no problem using WPad. Unlike the students, surprisingly, the teachers - colleagues did not know how to use WPad at all to create eLearning or to teach. And they didn't have the motivation to test the WPad, arguing that they were using Google and Microsoft Office.

C. Black Box Principle

WPad was tested by ten teachers - researchers as part of the V4 + ACARD project. In the project, several used a common computer on a faculty virtual machine, on which a version of WPadV4 was installed. Together they solved the pilot modeling of the creation of educational packages and modeled multilingual support. However, even in this case, the

use of WPad was problematic. The only exception was a Polish researcher who tested him visually impaired in addition to the project. The WPad designer (the main author of this article) could not explain this paradox. How is it possible that smart colleagues with much better IT skills than most students can't use WPad and students with low IT skills have never had a problem. Finally, the explanation is simple, related to the human-computer relationship. The point is that students do not decide whether the program is complex or simple, but simply follow the instructions exactly as the teacher gives them. As far as teachers are concerned, no one gives instructions, so they don't know why to use WPad, because it takes time to train new software anyway.

This paradox was very useful for further software development, because it changed the programming style, which further focused on creating application menus. The application menu means that a sequence of simple menu items is combined into one item. In other words, for the teacher, resp. The user's program works like a black box and therefore if the teacher performs the necessary activity with one click. Teachers-researchers no longer had a problem with the application menu because they don't have to create content, but they know exactly what the program will do. It then decides whether or not the teacher needs the didactic activity. This fact is important in explaining the need to synchronize didactic and computer algorithms when writing the program, that is, the technology (the program adapts to the teacher and not vice versa). The principle was used in the project for the pilot creation of educational packages, as will be explained in the next section.

To illustrate, there are several examples of application menus, resp. what to do in one click:

- the entire IEEE Computing Edge Magazine will be displayed or the monthly issue will be downloaded
- • after entering the teacher's name, an overview of publications will be displayed from the university database (eg for each faculty teacher)
- • after entering an English keyword, all sentences from the proceedings or text source that contain the keyword will be displayed
- • after entering the file name and format type, e.g. extract and table of all pdf-files on C-disk, USB.
- after writing the PHP source code in the text field of the table, the result is automatically displayed in the browser
- after entering the keyword, the browser automatically opens the result from the search engine and the teacher can copy the educational text and write notes from it in the rows of the table and use the table as a repository
- other options, such as direct opening of the communication channels with the possibility of uploading files from a computer; synchronization with cloud services, e.g. BOX (Cloud Content Management), MS OneDrive.

Even a non-interested person will understand that these solutions could be covered by autonomous software. However, if standard software development solutions were used, then WPad could not be an all-in-one system and the same features would not be achieved for several years. In this

context, it is therefore a challenge to identify the most common educational situations in the classroom and to create additional application menu items from them. It is important that the teacher also helps the computer by structuring the content, so he chooses the names and organization of the files appropriately and uses his own navigation tags in the tables as an analogy to html-tags.

V. EXAMPLES FROM TEACHING AND RESEARCH

Treba ešte raz zopakovať, že výskum integrácie IT prebieha už okolo 15 rokov v prostredí výučby hlavne undergraduates. Jeho základným motívom je počítačova činnosť učiteľa ako kľúčovej osoby v procesch výučby a research je focusovaný na automatizáciu knowledge-based proceses (štartujúci pod dáždnikom technology-enhanced learning). V počiatočnej fáze sa riešila automatizácia tvorby edukačného obsahu, ktorej výstupom boli eLearningové materiály a edukačnej repository. Po zvládnutí tvorby obsahu sa výskum orientoval na IT podporu aktivít učiteľa, ináč povedané, čo s tým obsahom robiť v rámci prednášok, cvičení a samoštúdiá. No a kľúčovým highlight bolo, že je nutné riešiť softvérovú adaptáciu na operačný systém Window, WEB, virtuálne stroje a cloudy, čiže IT infraštruktúru v súčinnosti so state-of-the-art v tejto oblasti. V rámci kontinúálneho publikovania autori zdôraznili, že úroveň počítačovej podpory učiteľov a študentov je nedostatočná kvôli krátkej životnosti hardvéru a softvéru. Bežný univerzitný učiteľ potrebuje riešenia, ktoré mu fungujú 10-15 rokov, a túto požiadavku súčasná technológia nespĺňa.

V porovnaní so state-of-the-art popisované riešenie je zamerané na rýchle vkladanie edukačného obsahu do tabuliek WPadu, rýchla prístupnosť, jeho rýchle spracovanie vďaka koncentrovaniu obsahu do aplikačných časových výstupov pre všetky druhy činností, ktoré učiteľ vykonáva. Čiže učiteľ opotrebuje univerzálny all-in-one software, ktorý to dokáže, lebo ináč by musel používať desiatku softvérov. Z tohto hľadiska základné riešenie pre tvorbu obsahu je asi najlacnejším a najefektívnejším riešením, pretože učiteľovi, či užívateľovi stačí mať notebook s nainštalovaným WPadom.

Aktuálny výskum ukázal navyše, že základom adaptácie na technológie je paralelná a synchronná tvorba didaktických a infromatických algoritmov. Tento fakt sa vo vedeckej literature nezdieľuje a nezdôrazňuje. V tomto kontexte sa začalo riešiť modelovanie tvorby edukačných balíkov. Na rozdiel od bežného používania WPad na tvorbu hromadného edukačného obsahu a informácií do knowledge tabuliek, v tomto prípade bolo potrebné začať riešiť hromadné spracovanie počítačových súborov. Každý učiteľ totiž sin a počítači vytvára zostavy súborov, ktoré má v rôznych priečinkoch počítača a často ide o stovky súborov v desiatkach počítačových formátoch (texty, obrázky, zvukové súbory). No a málokto si uvedomuje, že bežný učiteľ má na svojom počítači obrazne povedané malý internet. NA ilustráciu možno uviesť, že na notebook užívateľa je okolo 600 tisíc súborov. Samozrejme, do toho patria aj súbory Windows a softvérov, avšak z hľadiska najbežnejších formátov ako sú txt, pdf, doc, ide rádo o desiatky tisíc. No a edukačný obsah má práve v nich. Takže vývoj softvéru musel tieto veci zohľadniť. Z tohto hľadiska bolo dôležitým míľnikom začať využívať virtuálne stroje na cloudoch (nainštalovanie WPad) a cloud content management (BOX cloud – zdieľanie dokumentov). Tomu bežný učiteľ nerozumie, takže išlo o to, že fakultní IT staff nám poskytol diaľkový prístup na počítač s Windows 10. A tento počítač spoločne používalo okolo

desať učiteľov z piatich krajín. Tým sa riešilo aj to, že je ťažké motivovať kolegov, aby si nainštalovali WPad na svoj počítač. Čiže v tomto prípade používali všetci vzdialený počítač a na ňom bol nainštalovaný WPad. Takže mohli spoločne modelovať viacjazyčnú podporu a teda tvorbu edukačných balíkov.

Fig. 3 ilustruje princíp tvorby edukačných balíkov. Ten je založený na tom, že učiteľ má uložený edukačný obsah v rôznych priečiňkách a počítačových súboroch rôzneho formátu. Tieto si manuálne preniesie do default folder (na obrázku Mix-Folder) a z menu WPad si vyberá možnosti na tvorbu Edu-Pack.

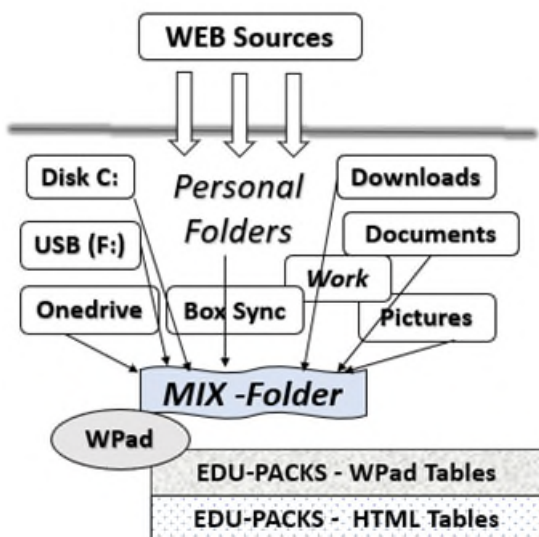


Fig. 3

Základná možnosť je, že sa vytvorí WPad tabuľka, ktorá má toľko riadkov, koľko súborov je v adresári. V jednotlivých riadkoch sa vyznačia názvy súborov a v textovom poli cesty. Po kliknutí na CTRL-F1 prehliadač automaticky otvorí html-zostavu, ktorá je prekonvertovanou WPad tabuľkou. Takže výsledok je, že učiteľ má skoncentrovaný obsah do jedného balíka, ktorý používa podľa potreby na notebook alebo uploaduje na virtuálny vzdelávací priestor fakulty alebo na verejne prístupný WEB. Aj keď takýto edukačný balík sadá a použije vo výučbe a je dostupný aj pre študentov, v reálnom živote učiteľ vykonáva viacero didaktických algoritmov a každý si vžaduje inú modifikáciu edukačného balíka. Prakticky to znamená, že tabuľku treba ešte upraviť podľa okamžitej potreby výučby. Z hľadiska programovania to však predstavuje širokú paletu potenciálnych riešení, napr. učiteľ:

- má už hotový edukačný obsah v súboroch, ktorých názvy sú zrozumiteľné
- nemá v súboroch kompletný edukačný materiál
- si chce do tabuľky natahnuť aj obsah neformátovaných textových súborov (plain text, html)
- si chce do tabuľky natahnuť aj obsah súborov viacerých formátov (texty, obrázky, audio) – tu potom záleží na počte súborov, pretože ak je veľa súborov, tak pamäť počítača nestačí
- chce vytvoriť edukačný materiál s vysokou didaktickou kvalitou – do tabuľky si musí dopísať

texty alebo aj html-texty (treba si uvedomiť, že každý riadok sa prekonvertuje na smaotatnú html-stránku, čiže tabuľka generuje množinu spojených html stránok)

- chce vytvoriť edukačný materiál vysokej informatickej kvality – prakticky to znamená, že obsah je koncentrovaný na jednej obrazovke počítača a umožňuje rýchlu navigáciu nahor aj nadol a obsahuje linky na priame otvorenie edukačných súborov a linky na edukačný obsah a portály na WEBe.

Tu je dôležité poznamenať, že sa radikálne zníži počet informatických algoritmov a jednoduchšie rieši adaptácia, ak aj užívateľ 'pomôže' počítaču zrozumiteľným označovaním názvov súborov a organizáciou knowledge tabuliek aj počítačových súborov (treba sa hlavne vyhnúť automatickému číslovaniu názvov, ak sa napr. hromadne spacovávajú stovky a tisíce súborov).

Ako príklad možno uviesť edukačný balík, ktorý riešil poľský výskumník v rámci projektu V4+ACARDC (napísal nasledujúcu sekciu). V jeho prípade mal hotový edukačný materiál – skriptá v pdf-súboroch. Takže do tabuľky sa natihali cesty k pdf-súborom a manuálne do textového poľa doplnil didaktický text. Fig. 4 je ukážkou z výstupu na WEB. Kliknutím na číslo záznamu alebo na wyk4.pdf (vyznačené ručičkou) sa otvorí časť textu skript k programovaniu v AJAX.

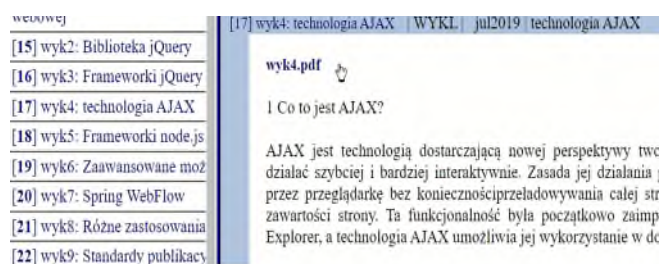


Fig. 4

Predchádzajúci popis ilustruje široké možnosti riešenia tvorby edukačných tabuliek pre špecifický učebný portál, kde teda je možné orientovať ďalší interdisciplinárny výskum. Toto možno doplniť ukážkou jedného zo spôsobov použitia tabuľky s názvom EDUCON pri písaní tohto článku, ako to ilustruje Fig. 6

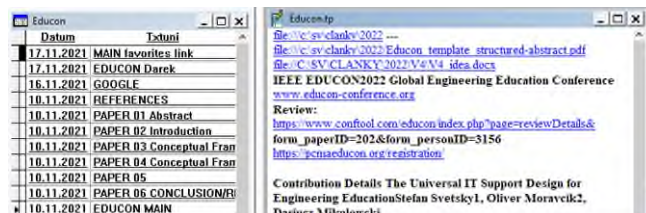


Fig. 6

VI. RESEARCH APPROACH FOR TEACHING BLIND AND VISUALLY IMPAIRED (BVI)

As everyone knows, there are currently many solutions supporting collaborative work, remote learning and entertainment. During the pandemic time, they turned out to be more necessary for multiple user groups and therefore

strongly developed. This situation applies to all people, but it has of particular importance to Blind and Visually Impaired (for short BVE).

We should to note here that BVE use the computer using specialized software that runs permanently in the background while they are using a computer. These software are called screen readers or screen magnifiers. They enable BVE to use a computer and any software which is installed on the machine. There are screen readers and magnifiers available for all operating systems and devices. For Windows we have a programs NVDA [nvda] Jaws [jaws] for Windows and for MacOS there are Voiceover [voiceover]. There are also native features built into the operating system such as magnifier or Narrator for Windows or Talkback for Android. All these programs work in the following way: a blind user works using a keyboard without using a mouse. During he performs different operations, he constantly can listen to voice messages sent to him by a screen reader. It reads what keys the user presses and what is focused on the screen. If the user has a braille display connected to the computer, the messages are also sent to the braille display where the user can read them as braille characters with his fingers. In the case of a partially sighted user, the fragment of the screen explored with the mouse or keyboard is automatically enlarged and sometimes it receives a different colour or contrast depending on the user's preferences set earlier.

Using these basic solutions, BVE can use standard office programs, browse the web, communicate, use listening and even editing software, etc. However, for this to be possible, these programs must be designed and implemented in accordance with the accessibility guidelines. For web solutions, such guidelines are the W3C WCAG2.1 [wcag] standard and the Accessible Reach Internet Application (ARIA) [aria]. The rules contained in WCAG should also be applied to desktop and mobile applications. Therefore, when programming such applications, developer should remember to use standard controls, use menus instead of toolbars and add keyboard shortcuts to each option that will allow for activation them.

As we know, large companies such as Google and Microsoft have their own platforms for creating online meetings, exchanging information or working together on documents or spreadsheets. Google provides applications such as a calendar, meet, classroom, google drive documents, etc. Unfortunately, they are only partially available for BVE, for example, a blind person cannot perform some operations in the Google classroom or read content of the tasks if they are published as a graphics. The situation is slightly worse in the case of solutions provided by Microsoft, i.e. Teams and Office 360. BVE may have difficulty with creating a Teams meetings, running screen split feature, etc. An example of the online meeting solution that is almost accessible for BVE is the Zoom platform although it requires of installation the software on users computer. Unfortunately, other less known platforms, clickMeeting [clickmeeting] Hubilo [hubilo] or Glisser [glisser], are even less accessible to a blind user.

The situation is the similar when we will take into account educational platforms, especially solutions related to teaching mathematics or foreign languages. For example, one of the most popular math teaching platforms GeoGebra [geogebra] is poorly available for BVE. An example of a solution that is accessible in this domain is Desmos, [desmos]. It offers special functions for the blind, such as the ability to write an

equation for a function and then draw and play its graph with sound. However, this seem to be an only positive exception.

After analyzing this situation, we can come to the conclusion that there is no one solution that would be suitable for mutual communication, knowledge exchange, joint learning or entertainment. Even more so, there is no such universal solution that would provide additional facilities for blind and visually impaired people. Taking this into account, in the V4+ACRD Consortium, we undertook work on adapting the already existing WPad knowledge exchange software for the needs of the blind. First, we analyzed the availability of the WPad software in the version installed on the local computer and in project's virtual machine. The experiment was to use the WPAD software with a screenreader in which data from various domains and topics were added to the tables. These were data such as information on publications and magazines, information on organizations supporting BVE, as well as educational materials in programming languages and web technologies intended for students. This work allowed us for gaining experience and determining the actual level of accessibility of the WPAD software for BVE. It turned out to be almost completely available to all screen readers, except for a few of the following use cases.

The WPad user interface is based on the logic of a database table where information is collected in columns and records. They can store human information such as entry date, subject, category, sub-category, content, links to other entries, etc. A blind individual can navigate through columns and records using standard keyboard shortcuts. During this operation the screen-reader reads the contents of the appropriate cells. Such a logic of information storage allows for the accumulation and structured knowledge so it is a kind of knowledge base similar to a simplified ontology. In addition, the program has a very extensive menu in which the user can find options in the database of necessary information, filtering, searching the resources of his own computer and even searching the Internet. Another useful feature is the ability to automatically generate web pages in static html directly from the data table in the WPad program. Thanks to this, a user also a blind or visually impaired teacher can easily generate educational packages for his students. During our investigations, such packages were also created with the support of a NVDA screen reader. These educational packages generated in the form of html pages, were then made available for use by students.

But there were a few accessibility problems. The biggest accessibility problem in the WPad software was that the screen-reader did not read the content of the text field intended for inserting large amounts of data, which was revealed while navigating through it. Moreover, while working with the program, error messages often appeared, which in the case of work of a blind user who is not very familiar with computer technologies, may be irritating to him. The accessibility status of the WPAD software is described in more detail in the article [svedski].

In the next stage of works, we made efforts to eliminate these problems and make the knowledge exchange system fully available for the blind user. The work on this issue is being continued until the current time.

In addition to the corrections of the problems mentioned above, the idea arose to implement the entire system in the

form of a WEB application. This is how the Personal Information and Knowledge System called PIKS was created. A big advantage of this idea is that they use the same table structure as WPad but is accessible via a web browser. In this way, the biggest problem related to the inaccessibility of a large text field has been eliminated because in PIKS it is already read correctly in the web browser by the screen-reader. So it can be freely edited by a blind user.

However, because html tables are quite tedious to view using a screenreader, the idea was born to build in PIKS a mechanism of various filters for the displayed data. Thanks to them, it is possible to display only data from a given category or subcategory.

After continuing and extending our work the PIKS system can become a portal where a visually impaired user can carry out many of his activities in one place. For example, he may have one table for his work, another for learning and sharing knowledge with others, and another for entertainment. Therefore, in the next stages of work, we will develop a category system for the user that will take into account his activities in such areas as work, science, entertainment, music or communication on social networks.

VII. CONCLUSION/RECOMMENDATION/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, virtual knowledge enables work with texts, images, computer files and thus also 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 virtual knowledge, which the computer understands as a representation of knowledge (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 / she 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 intention is 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 design (didactic algorithms must be defined, otherwise they cannot 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 presented new technology, educational software can be used e.g. In Humanities PRE * POST Academic Research. Logically,

however, they could not do it if there was no research to develop and supply this technology.

What is meant by knowledge representation?

Definition. Knowledge representation refers to the technical problem of encoding human knowledge and reasoning (Automated Reasoning) into a symbolic language that enables it to be processed by information systems.

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What is meant by knowledge representation?

We suggest that you use a text box to insert a graphic (which is ideally a 300 dpi TIFF or EPS file, with all fonts embedded) because, in an MSW document, this method is somewhat more stable than directly inserting a picture.

To have non-visible rules on your frame, use the MSWord "Format" pull-down menu, select Text Box > Colors and Lines to choose No Fill and No Line.

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