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Keywords
(separated by '-')

Learning technologies - Technology-enhanced learning - Educational software - Human-centered computing - Educational knowledge management



A Universal IT Support System for Teachers for Educational Processes, Publishing and Academic Research Using All-in-One Educational Software

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Abstract. Current learning technologies do not meet the needs of teachers and individuals. There is an information overload and the academic field has also become technology driven. Rather than technology operating according to the teacher's needs, individuals are required to adapt to the existing software. Due to the incompatibilities between software, hardware and the formats of computer files, information chaos is growing to huge proportions. Unless educational algorithms (i.e., what is done with educational content) are defined, computer algorithms, software, and systems for the integration of IT into teaching cannot be designed. As part of our research into the automation of knowledge-based processes, which includes educational processes, we have managed to solve the problem of how to simulate human knowledge and pass it on to a computer, so that it can 'understand' it. Our solution is a model of virtual knowledge that can be processed quickly by a computer. The computer 'understands' this as a universal representation of knowledge, while from a teacher's point of view, it is an ordinary table into which the teacher inserts educational content. This virtual knowledge (having the structure of a database table) acts a kind of knowledge container that isomorphically connects the mental processes of the teacher with the physical processes of the computer. Our WPad educational software is programmed to control the structure (content), so, it is possible to create educational knowledge tables and personal knowledge base for any activity that the teacher performs during teaching, or research. The teacher does not need to adapt to the technology; instead, the technology adapts to the teacher's activities. Since the software runs on every Windows computer and works as a multiple-in-one educational IT tool for a variety of lessons, it is probably the most efficient and cheapest technology solution. It is used to support the integration of technology into classroom and distance learning. Future research will focus on the creation of multilingual educational packages.

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Keywords: Learning technologies · Technology-enhanced learning · Educational software · Human-centered computing · Educational knowledge management

1 Introduction

The automation of teacher activities and the integration of IT into teaching forms a complex interdisciplinary problem. Terms such as e-learning, learning technology, technology-enhanced learning, educational technology, technology in education, and digital learning can be encountered in the scientific literature, and these differ in principle based on whether a technology-driven or educationally driven approach is emphasized. Unlike in the recent past, a university teacher now needs to bulk process a much larger volume of educational content in digital form and with more software that was not developed for educational purposes. The automation of these activities is hampered by information overload and the incompatibility between current software, hardware, and computer files in various formats (such as text, image, audio, and video files). The practical impact on educational processes is that the teacher, and in fact users in general, must adapt to technology rather than the technology being used as a support tool to automate learning processes, i.e., for the fastest possible and most efficient processing of educational content.

From general sources can be mentioned, how it is written in the Edutopia “It is sometimes difficult to describe how technology can impact learning because the term technology integration is such a broad umbrella that covers so many varied tools and practices” [1]. However, from the teacher’s point of view, the use of these tools is based on a technology-driven approach rather than an educationally driven one. The same case is when a reader reads that “Learning technology encompasses the full range of tools and media that can be used to facilitate teaching and learning” [2]. The web page for the Learning Technology Toolkit of the University of Saskatchewan lists over 20 technological items (e.g., Microsoft 365, One drive, Canvas, Mobius, Zoom). In terms of a different division of technology categories, the university has Approved Academic Tools by Function, which is more understandable to the university teacher, e.g., assessment, course management, content creation, STEM student practice, or open textbook creation/sharing.

For comparison, the ICT-22-2016 call from the European Union Research program “Technologies for Learning and Skills”, the focus of this call was on “innovation of learning technology” and a challenge “to create an innovation ecosystem that will facilitate use of digital content, tools and services for personalized learning and teaching.”

From this short introduction, we can see that there is considerable chaos and inconsistency in the definitions of technologies that are suitable for IT integration. Although attempts have been made to highlight the differences between terms, e.g. “The difference between technology of education and technology in education,” as in [3], ambiguities are also observed in general sources; for example, the link to technology-enhanced learning on Wikipedia redirects the user to the page on educational technology [4], which states that this term “is not restricted to high technology but is anything that enhances classroom learning in the utilization of blended, face to face, or online learning.”

In other words, these are basically only synonyms from the point of view of the average teacher, i.e., the same technology is referred to as e-learning, technology-enhanced learning, learning technology, digital learning, or educational technology. The average teacher needs to choose only a few tailor-made supporting tools from a wide portfolio of existing technological tools and needs to focus on those that will allow for the creation,

management, and communication of educational content, and can automate teaching or the activities performed at a given time in the classroom or digital space.

Useful information on the integration of IT into teaching is provided by several scientific monographs that have focused on technology-enhanced learning or educational technology [5–9]. These consider real pedagogical practice, in which the educational technology is subordinated to the teacher and serves as a support tool for streamlining his activities and expertise. According to Stošič [10], educational technology has three domains of use: (1) as a tutor (where a computer gives instructions and guides the user); (2) as a teaching tool; and (3) as a learning tool, while simultaneously emphasizing the importance and use of educational technology in the classroom. It should be noted that technology is not a panacea and should be derived primarily from education [5, 7]. Namely, the current technocentric approach to technology-enhanced learning means that teachers and students should adapt to existing technologies and test whether they can be used for teaching. Martens also highlights the lack of educational software in the field of technology-enhanced learning [11]. Such techno-centrism has also been the target of relatively frequent criticism in scientific publications [12–16], which have emphasized that technology should reflect so-called Technological Pedagogical Content Knowledge (TPACK) [7, 17]. From this point of view, the all-in-one educational software WPad can also be considered to be TPACK software teaching and academic research.

Because the automation of teacher activities represents an interdisciplinary issue that combines pedagogy (didactics) and informatics (information technologies), our research deals with issues such as batch processing of educational information and knowledge, the creation of educational packages, adaption to existing software, hardware, networks, and clouds. Since similar approaches have not been described in the literature, references cannot be given, meaning that only general comparisons can be made. In addition, there is no similar educational all-in-one software as described here (its novelty is confirmed by the registration of our two utility models with the Slovak Patent Office).

In the following sections, we discuss pedagogical aspects of the use of technology, motivation and research focus on technology integration, research outcomes, explaining the universal approach for IT support using WPad educational software (design of virtual knowledge and knowledge tables, basic and advanced levels of IT support using WPad, basic classroom support: a combination of face-to-face and online teaching, advanced level of IT support using WPad and IT infrastructure).

2 Pedagogical Aspects of the Use of Technology in Education

It is interesting that no interdisciplinary approach to the application of technology in education appears in the scientific literature (based on a search of Springer, Wiley, Science Direct, and Emerald), although this is an area in which pedagogy (didactics) and technology intersect. The technology-driven approach is preferred over an educationally driven one. In this context, one very useful monograph on Technology Enhanced Learning (TEL) with such an interdisciplinary approach should be mentioned [5]. Although it was written 20 years ago, its conclusions on the integration of technology are still valid today. The scientific monograph emphasizes that “learning, not technology, should be the driver of any educational innovation”, and “the design is not driven by technology

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but by the painstaking analysis of human learning processes and of the requirements of a particular task.” The ineffective implementation of technology-related change is also mentioned, in relation to “resistance to change from students, professors, administrators”. In the context of educational software, the authors mention that future software applications should be concerned with three aspects of learning: lectures, laboratories, and libraries. Particularly pertinent is the statement: “That is why we find it necessary to have a design and technology team behind every professor.” Exactly the same view is put forward today by the authors of [6], who state that “learning support services are extremely important, so the instructors or tutors have to understand the learning difficulties and the learning environment of the learners so as to have effective communication with them.” It is also interesting to argue that “with the advent of visual technologies, students lose the motivation to make their own notes.” A similar approach is found in another monograph [7], which emphasizes that technology is not a simple panacea for education and that a teacher is always a key player in the process of teaching and learning, in terms of creating and managing educational content. Specific emphasis is placed on the TPACK model, which introduced the concept of Technological and Pedagogical Content Knowledge (TPACK) as a framework for “integrating technology in teachers’ knowledge.” According to Mishra and Koehler, TPACK is an emergent form of knowledge that goes beyond all three components (content, pedagogy, and technology), and is “different from knowledge of a disciplinary or technology expert and also from the general pedagogical knowledge shared by teachers across disciplines.”

The TPACK framework, with its seven types of knowledge, is still popular in educational technology, and is explained by many of the internet sources for the educational community (see for example in the literature review in [18]). In regard to the TPACK model, the authors of [7] emphasize that “teachers not only need to know the content they are teaching but also must recognize how to integrate technology into pedagogy to achieve greatest impact on desired outcomes.” Another model of classroom-based scenario is discussed in [8] and is called the “Turn around Technology Integration Pedagogy and Planning” (TTIPP) model; this includes phases based on the analysis of learning and teaching assets and needs, design of the integration framework, and post-instruction analysis and revisions. A great deal of attention is paid to a specific integrating technology across certain disciplines (e.g., science, engineering, mathematics, second and foreign languages). The principle of the TPACK model is aligned with Laurillard’s statement [9] that the optimal solution to technology-enhanced learning can be achieved in practice if the teacher, researcher and designer work closely with each other.

In a paper on educational technology [6], which is mainly related to the area of learning activity design it is emphasized that from the perspective of learners, each learning activity includes four aspects: (1) the learning tasks (which allow the learners to explicitly understand what they should do); (2) learning resources (non-digital and digital materials that provide the learner with the necessary information and content); (3) evaluation methods (which should allow for adequate examination of the completion of learning activities); and (4) learning support services (where the instructors or tutors should understand the learning difficulties and environment of the learners, in order to facilitate effective communication with them). Several theories have been put forward on the better design of learning activities, such as Bloom’s taxonomy, Sweller’s cognitive

load theory, and Mayer's principles of multimedia learning. In the last approach, the idea is that students can learn more deeply with multimedia than they could have with words or pictures alone, and that multimedia instruction should "encourage the learner to construct a coherent mental representation of the material" in order to "construct new knowledge" [19]. One important argument is that "a technology need not be a specific device, as a technology could be generally understood to be a systematic and disciplined application of knowledge". This question of knowledge is a key aspect of the all-in-one software WPad, which can be considered an adaptive learning software. The cybernetics idea on which the software is based was published in an AI journal, as it allows for knowledge extraction and representation, even in natural language, usable by lay users [20]. As will be explained, WPad is based on a specific model of knowledge representation, while, but in the mentioned monograph [7] the knowledge representation is discussed only in general and without any definition. The use of sensors, graphs, drawing and painting programs, hypermedia is declared as technologies which represent knowledge. However, computers do not know what knowledge is and how to use it if it is not computer-defined. Such a representation of knowledge presents, e.g., Syed [21] for next generation knowledge machines, when he represents the knowledge in the form of graphs as a quantifiable and dimensioned entity. This is only a theory and is far removed from the work of a teacher in the realm of natural language within educational settings.

The related pedagogical context can also be selected from a newer monograph of the design of technology-enhanced learning [8]. The TPACK framework approach is emphasized, as in previous studies, and the pedagogical aspects of technology-enhanced learning are also clarified. From the point of view of the function of the WPad educational software, the important aspect of representing and sharing content is mentioned in relation to conceptualizing content in the Anderson-Krathwohl taxonomy of learning, teaching, and assessing. In the Anderson-Krathwohl taxonomy (i.e., a revised Bloom's taxonomy), factual, conceptual, procedural, and metacognitive knowledge are taken into consideration [22].

The pedagogical aspects discussed above are rarely followed in practice, since computers were invented for calculations rather than for teaching. As a result, the current state of the technology has not yet reached the level required to support the teacher. Existing technologies are still not optimal for practical teaching; users have to adapt to the technology, and to check whether it is suitable for their educational needs. As set out in the introduction, such a huge range of technological tools is now available that ordinary teachers are likely to find this disorienting.

3 Purpose/Goal

3.1 Motivation and Research Focus on Technology Integration

Technology that is suitable for integration into teaching and selected pedagogical aspects is discussed here to clarify the purposes and goals of our research. As mentioned above, our approach focuses on several interdisciplinary elements that are not described elsewhere in the scientific literature. Although the scientific monographs discussed above are very useful, from the point of view of the teacher or researcher, it is interesting that they do not pay more attention to the factor of time, i.e., the speed of processing

educational knowledge and content, which is a key element in solving the automation of any educational process and fundamentally affect a teacher's performance, and hence the learning outcomes in general. In addition, it is well known that if a teacher creates educational materials, these need to be updated after a certain time, which poses a significant problem in practice. There is also little mention of the fact that although teachers typically work for 10–20 years, the lifespan of software and hardware is only a few years (for example, laptops and mobile phones often fail after 2–3 years, a programming language may change, and operating systems and software are continually updated). These practical issues are mentioned because a universal software must be 'resistant' to any changes in software and hardware. In this respect, there was a particular focus in the development of WPad software on adaptation to the Windows operating system and the most common Internet browsers. Compatibility with Microsoft Office packages and other software used in education and the ability to switch from the program environment to other software and online portals and environments are also advantageous.

From our point of view, however, the issue of mass processing of information and knowledge is much more important, and this is not mentioned in the related scientific literature. This issue formed the basis of our vision, published in 2007–2008, that a knowledge worker (such as a teacher or researcher) needs to process such a large amount of information in the course of teaching and research that they need to be technologically equipped like a "contemporary soldier" [23]. Since no suitable software was on the market at the time, the designer of WPad began developing an all-in-one software for undergraduates, based on a batch information and knowledge processing paradigm. The progress made in terms of integrating technology into teaching was a subject on which we continuously published papers in conferences and scientific journals in the field of technology-enhanced learning. Our original empirical research (which was initially based on a technology-driven approach and then an educationally driven one) was transformed into the current interdisciplinary research, including the registration with the Slovak patent office of a utility model for the conversion of uncertain and unstructured data into semi-structured data. This is related to our model of virtual knowledge, i.e., a specific data structure operating on the cybernetic principle of isomorphism of physical computer processes and mental activities [24].

In the context of finding solutions for future learning technologies, our motivation and focus is presently on the automation of knowledge-based educational processes (based on our academic research). In practice, when a teacher aims to develop various training activities, this mainly requires solving the following key issues:

- Accelerating the transfer of educational knowledge to computers (due to the lack of switching between mental processes and machine).
- Customizing computer outputs in publishing teaching, research (in terms of form and compatibility).
- Solving the problem of the concentration of knowledge so that it is immediately usable (for a given purpose and specific activity).
- Managing knowledge, exchanging it and transferring it between offline and online environments (laptops, clouds, networks, Internet services, file repositories).
- Dealing with adaptation to operating systems, software, and hardware (for Windows, Internet browsers, Web portals, Internet resources, clouds, and networks).

- Creating educational algorithms and synchronizing them with computer algorithms (without defined teaching algorithms, it is impossible to write programs).
- Turning a typical users' work with a computer into bulk work with information and knowledge (i.e., making it easier for the computer to work by using the naturally marking content and files and multitasking).

The main aim of this paper is to give an overview of how all these key elements have been addressed in our academic research over about 15 years, with a focus on the integration of IT into teaching to support the teacher (researcher, designer) as a key player in the educational process. The secondary objectives are to exchange experience with the academic community and to outline the challenges for solutions of future technologies. In the following sections, several outcomes will be presented based on case study examples drawn from academic practice.

3.2 Summary of Research Outcomes

A milestone in our research and the key outcome was the invention of the informatics data structure mentioned above, which simulated human knowledge; this was predicted in the author's habilitation thesis, which focused on the mass construction of educational content and e-learning materials [25]. This virtual knowledge was invented by addressing the issue of how one computer program could function in academic practice as an all-in-one program that was suitable for teaching, research, and publishing. As mentioned in the previous section, it can replace numerous other software packages that the teacher would need to use for the same educational activities. For a lay person, this can be explained by the fact that it is sufficient for a teacher, student, researcher, or other user to find a way of transferring tacit and explicit human knowledge into virtual knowledge (which takes the form of an ordinary table containing plain text that can be edited). In this case, the computer can process the virtual knowledge extremely quickly and give the teacher the desired output in relation to classroom teaching or other educational activities. And in doing so, a never-ending story of hundreds of outputs began and is possible to perform. Numerous categories of activities of teachers can now be supported by the IT system of support using WPad at the personalized IT infrastructure regarding teaching, research, and publishing (at the level of personnel or collaborative outcomes, including distance learning).

Within our research, the different categories of educational activities were supported from the perspective of providing knowledge in teaching (lectures, exercises, self-study, collaborative learning) as follows:

- Learning content for several study programs (for which the outcomes were published in global conferences and scientific journals).
- Outcomes from cooperation with international consortia that have submitted proposals for projects related to the integration of IT into teaching (FP7 and Horizon 2020 calls for IT).
- The WPad educational software, a shared IT infrastructure (including WEB, cloud, virtual servers), communication channels, and a butch knowledge processing paradigm.

- Outcomes from the V4+ACARDC project of the International Visegrad Fund (including the collaborative creation of multilingual educational content).
- Outputs from current non-project research focused on human-centered computing.
- Teaching methodologies and a non-relational database paradigm that can be used for self-study, research, and publishing.

4 A Universal System for IT Support Using WPad Educational Software

4.1 Virtual Knowledge and Knowledge Tables

Universal IT support for educational processes, academic research and publishing is based on default data structure, known as a virtual knowledge, which is controlled by our WPad software. This structure simulates the way in which people understand human knowledge. Virtual knowledge is defined as meta-information, which identifies the content, and which is combined with the (educational) content within one row of the common database table as illustrated in Fig. 1. A set of rows forms a (virtual) knowledge table, so, a teacher or other user can create many categories of own knowledge tables and manage the tables in the same way as computer files (e.g., combining, selecting, transmitting, exchanging, copying, saving).

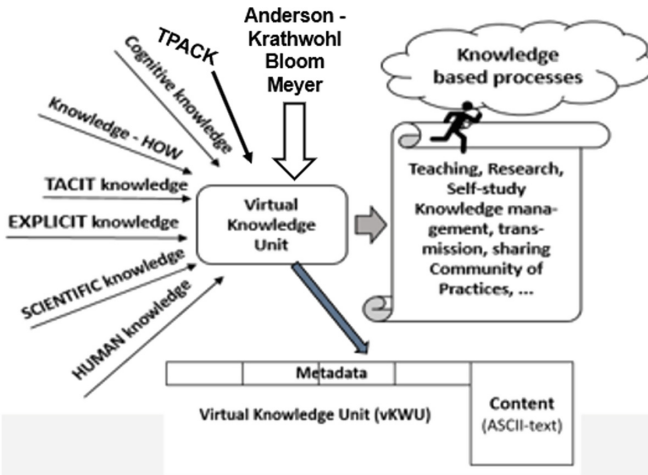


Fig. 1. Virtual knowledge representation for the automation of knowledge-based processes

Each user (a lay person, teacher, student, researcher, or expert) needs to find their own style and way of inserting their tacit or explicit knowledge into the knowledge tables using plain text. The content field of the table has a simple text editor, which enables a user to manually input shorter texts or to paste in a larger amount of text. It therefore functions as a container for the content and uses hypertext to directly connect the knowledge tables to the Internet and the personal folders on the user's computer. For

example, undergraduate students worked on computers in the classroom on which WPad had been installed and created their own learning tables when performing collaborative teaching tasks during lectures or exercises. From a pedagogical (didactic) point of view, the added value is the possibility of concentrating the teacher's or student's knowledge from many offline/online resources into one place and to process it very quickly.

The basic functions provided by WPad software are illustrated in Fig. 2. The table is interlinked with some other tables and has both offline and online links related to publishing using hypertext. The left-hand window shows part of the meta-information, while the right-hand window shows the related (educational) content.

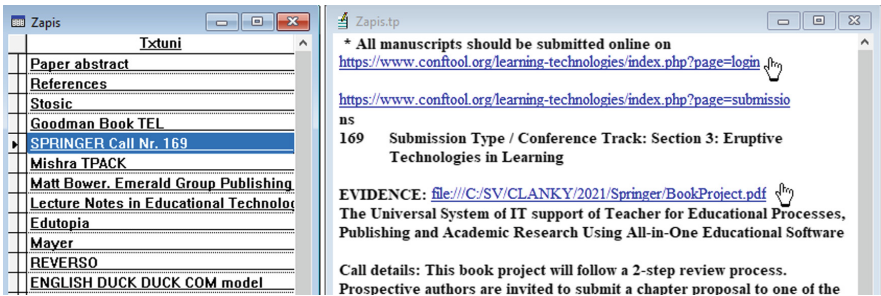


Fig. 2. Example of a (Virtual) knowledge table entitled PAPER, which is used to support publishing in a WPad work environment

From a user point of view, it is important using the hypertext link directly from the knowledge table both to folders on their personal computer and Internet paths without need to open browsers or Windows explorer for writing paths. WPad also functions as a simple HTML editor, so by simply clicking CTRL-F1, the table can be converted into mirrored HTML-format, as shown in Fig. 3.

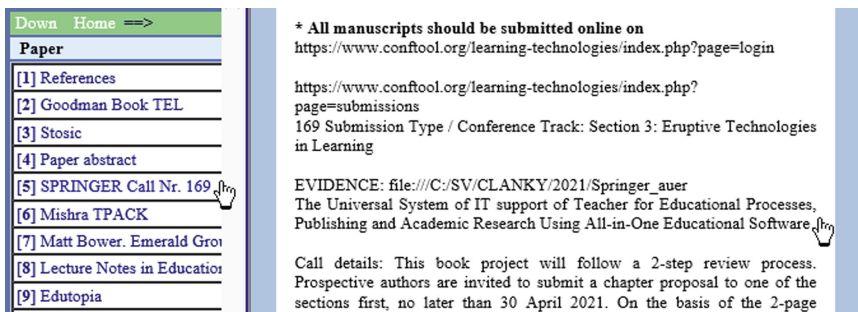


Fig. 3. Example of the conversion of a knowledge table entitled PAPER into HTML format

In other words, a user can produce HTML tables with concentrated content, where one row represents one Web page. Since the knowledge table can contain many rows, it enabled to develop the batch information and knowledge paradigm, i.e., a way of

applying mass processing to large amounts of educational content using a minimum number of interfaces at the level of an individual.

Figure 4 illustrates the plethora of different educational situations it is possible to solve using WPad and allows the reader to understand why and how WPad functions as a universal all-in-one tool. This means that this single software tool can perform activities for which a teacher or other user would normally have to use several types of software. Moreover, a teacher can use WPad to build a personal knowledge base in the form of a system of interconnected knowledge tables.

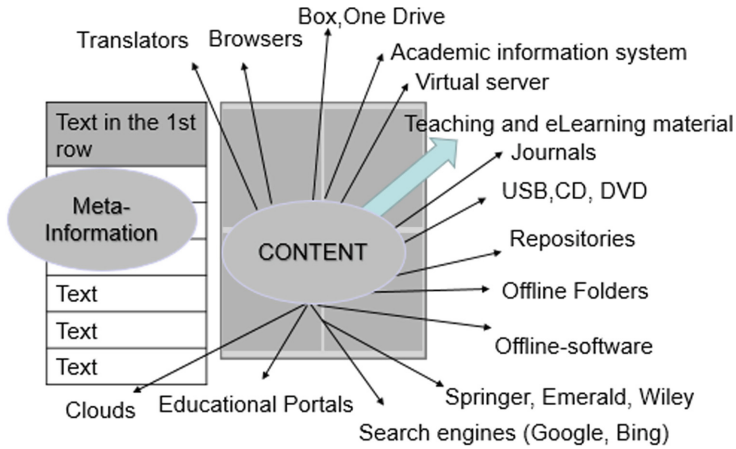


Fig. 4. Model of the virtual knowledge table function

The teacher inserts educational content into the table and the computer ‘understands’ it as an IT data type that can be processed extremely quickly, with outputs provided in a form that is comprehensible to humans. It should be emphasized that the computer does not perform the mental work in the place of humans, but simply supports our mental processes.

4.2 Basic and Advanced Levels of IT Support Using WPad

WPad can be used in either basic mode (for educational activities) as illustrated in Fig. 5, or in advanced mode (for research or publishing) as illustrated in Fig. 6.

Figure 5 shows that the software can be installed in the classroom on a regular Windows computer. If there is an Internet connection, it is also possible to use the communication channels and virtual educational environment on the faculty server, and there is a connection to the Academic Information System (AIS).

Figure 6 illustrates the advanced mode, in which all of the WPad functions and a combination of offline and online environments can be used, for example, to create e-learning content for a virtual learning environment, carry out collaborative activities on a virtual server, provide multilingual language support, work with many computer files (e.g., to create a content visualization for STEM), or to transfer (virtual) knowledge tables and computer files over the teacher’s offline/online IT infrastructure.

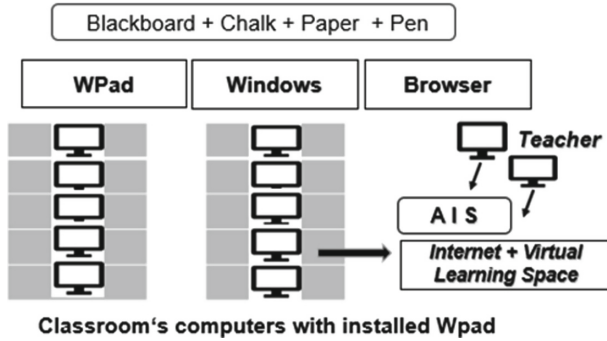


Fig. 5. Example of the basic level of WPad, as used in the classroom teaching of undergraduates

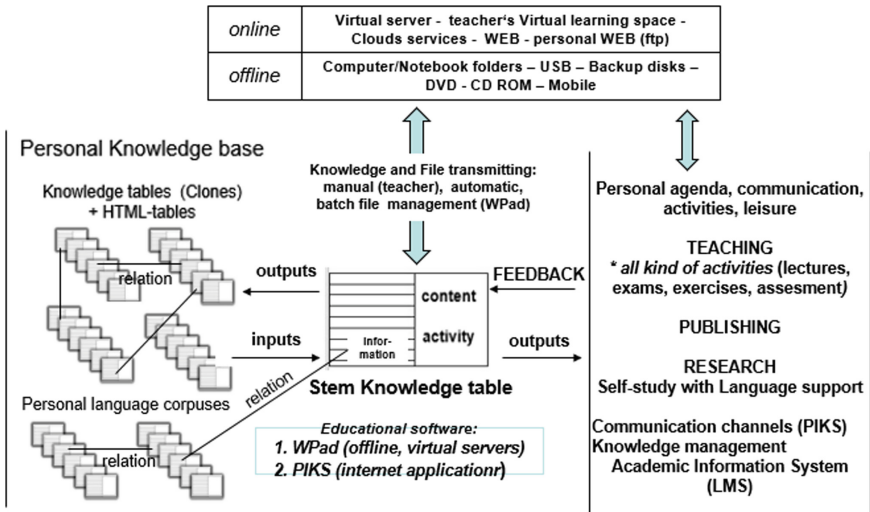


Fig. 6. A teacher's personal "hybrid" Offline/Online IT infrastructure, based on the advanced use of our educational WPad software, including a communication channel (PIKS)

4.2.1 Basic Classroom Support: A Combination of Face-To-Face and Online Teaching

The basic method of using our WPad educational software, as shown schematically in Fig. 5, evolved over several years of use in teaching undergraduates as part of multiple study programs. Our approach is probably the cheapest way of supporting teachers and students as an individual only need to use a computer with the Windows operating system and an installation of WPad. It is important that WPad works directly with Windows Explorer as well as the other Windows features that the teacher is familiar with. In practice, students typically use WPad in combination with an Internet browser and Microsoft Office programs. Thanks to its high compatibility with Windows, an individual can also create educational and e-learning sets for the Web in bulk and can interconnect the learning texts with images or audio files. etc. From a pedagogical point

of view, this is also in line with the Meyer model, which states that a student will understand learning material more quickly if the learning content is a combination of texts and images, and possibly in a multimedia format.

The teacher found that the WPad tables created by the students functioned as their notebooks; they made notes on lectures and exercises directly into the knowledge tables, and many of them would not take notes without using WPad as a supporting tool. Another pedagogical (didactic) advantage was that the teacher could collect and evaluate the students' notes from the class computers, or combine them into a single table, and placed it in the shared faculty's virtual learning space. So, a collaborative activity was used to create a new study material, which was also used for self-study by other undergraduates in the subsequent years.

4.2.2 Advanced Level of IT Support Using WPad and IT Infrastructure

As can be seen from Figs. 4, 5 and 6, it is possible to handle an infinite number of IT support situations using WPad. Our research has focused on the automation of knowledge-based processes, as university teaching relates to the creation, dissemination, presentation, and management of knowledge.

The advantage of (virtual) knowledge tables is that their data structure is not dependent on the database platform, so such tables can also be used in an online environment (WPad only offline or on the cloud with a virtual machine). This is also the focus of recent research, which has an application focus on the creation of PIKS channels that function as a PHP/MySQL web application. The difference is that while WPad runs on the Visual FoxPro database platform (which has its own programming language and the educational content is transferred with the spreadsheet), PIKS runs on the MySQL database platform and the content of the tables is controlled by PHP source codes (the disadvantage is thus that MySQL tables cannot be sent as regular computer files). On the other hand, the advantage is the possibility to create table content and to share tables on the Internet, i.e., for teachers and/or students to collaboratively insert learning content into the same table. This is also advantageous for addressing questions in the field of CSCL research (Computer Supported Collaborative Learning).

Unlike the basic level of technology integration using WPad, interdisciplinary research requires a sophisticated approach and a more comprehensive IT infrastructure that combines offline and online tools and environments. For example, the standard programming in which the user menu is positioned at the top of the screen is no longer optimal, as it already covers the entire screen. Since it contains numerous optional items, it can often be confusing, even for the author of the program. Therefore, a part of the user menu contains additional application menu items, i.e., the application menu is composed of sequences of simple menu items. Examples of simple menu items include Save/Save As, a search of the table, ordering or filtering rows, transferring a row to another tab, etc. The application menu can be understood as a sequence of simple menu items that are selected with one click, so that in practice they function as a black box. The function of the application menu can be illustrated by the following combinations of one-click activities:

- Go to the IEEE journal page, create a table with links to yearly issues of the journal, select the option to download it to a computer, open it, convert to HTML format, open it in the internet browser, or if necessary, synchronize the transfer to the BOX cloud, which is shared with several researchers.
- Copy the text from the conference proceedings to a row in the knowledge table, create a corpus table and enter search keywords, e.g., keywords or stylistic phrases to support writing an article in English.
- Copy the RTF output from the university's publication server to a row in the knowledge table (e.g., for the years 2010 to 2021), create a corpus table from it and search for a list of your publications or any publications from the department, institute, or the whole faculty
- Make a list of all PDF files on the computer, USB, or backup disk, and add them as a new line at the end of the opened table (SHIFT-F9).
- Write source code in a row of the table that will do something with the rows or content, so it can be used instead of the standard command window or console, and the user can enter the source code into the same table in which the educational content is stored.

IT support for publishing is also being developed, which is based on inserting various content (e.g., multilingual annotations, links to journals, instructions for authors, pdf-articles, and various custom or e-resources) into the text field of the table. This advanced mode of operation is schematically illustrated in Fig. 7.

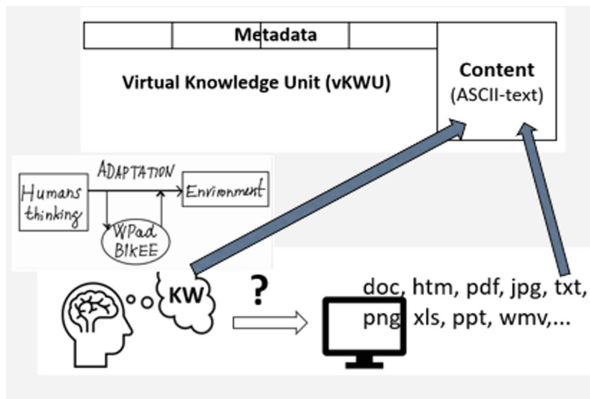


Fig. 7. Relationships between virtual knowledge/knowledge tables and computer files (after loading or linking files to an empty table, the tables contain a domain educational knowledge)

It should be emphasized that the transfer of WPad tables containing virtual knowledge between notebooks, client computer folders or online servers is radically different from the transfer of computer files as commonly used by teachers and other users. This is not generally understood by reviewers of scientific journals with a focus on educational technology and database specialists (as these users are familiar only with the relational

database paradigm) Computer files are processed in batches by file management methods, while in knowledge tables, the batches consist of groups of rows. The monthly manual table for individuals contains about 20–50 rows, whereas an automatically created table with WPad can have a million rows.

Figure 8 illustrates a content of the row 4887 from a table that has 676,896 rows. The table was created automatically and contains a list of paths to all the existing files in the teacher's notebook. These can be opened directly from the table; for example, after clicking on the path in this row, a picture of the Fe-C diagram from the STEM course will be displayed. This principle of offline hypertext, which can be used as a menu item of the user menu of WPad, represents added value in terms of file management in Windows.

In this content, Fig. 9 illustrates a file management process. The result table contains a list of files output from a search of the BOX folder; this folder is synchronized with the online BOX cloud, meaning that the researcher does not have to search in the BOX cloud and can instead search offline.

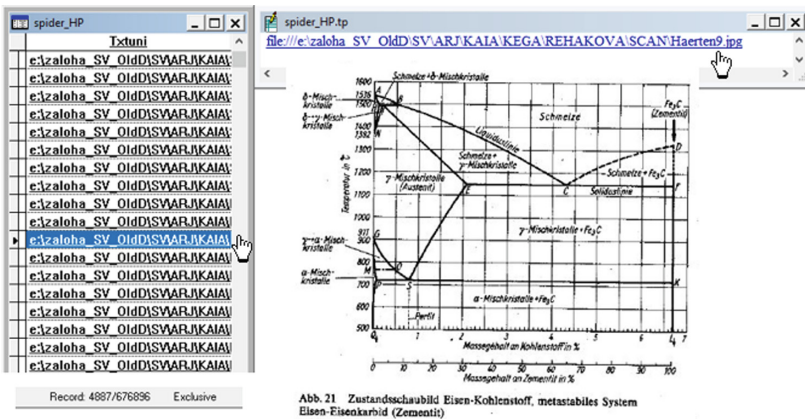


Fig. 8. Knowledge table automatically created from the backup folder of teacher's personal computer (knowledge base - 676,896 Rows, 800 MB, opening/closing takes 20–40 s)

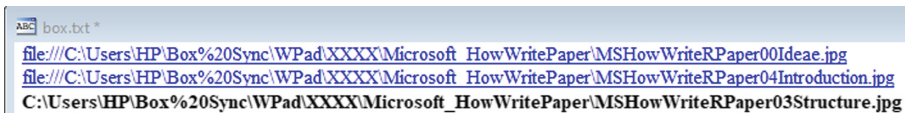


Fig. 9. Results of an offline search for an explanation of a file management function used in WPad

In our case, learning and teaching content can be stored both in the knowledge tables and in computer files with various formats (TXT, HTML, PDF, DOC, JPG, MP3, MP4, PHP, CPP, etc.). A regular user typically has many windows (different types of software, browsers, e-mail accounts, etc.) open at one point of time. User must use numerous computer files, interfaces, and switches between them by clicking with the mouse. In comparison, using the knowledge tables, the user can directly visit websites, local folders, open directly software or browsers, meaning that the number of mouse clicks required is significantly lower when using WPad. It can be estimated that an individual working with information and knowledge can save tens of thousands of clicks per year in this way. Since only selected learning content is inserted to the knowledge tables, the knowledge base consisting of the knowledge tables of individuals is drastically smaller than the size of the computer files. As WPad is an all-in-one software, it is not possible to describe all the cases that the authors have dealt with over the years of research. The following screenshots illustrate some of them.

Figure 10 shows some teacher's tables using WPad, i.e., tables with direct links to the academic information system without using a browser (shown at the top) and tables used for assessment, with automatic evaluation and grading (shown at the bottom). For the lower image in Fig. 10, it should be noted that at this time, handwritten work by students was scanned and evaluated by scoring three areas, meaning that the computer was able to automatically sum these and insert the result into the table (although the addition of the points was done in the text field).

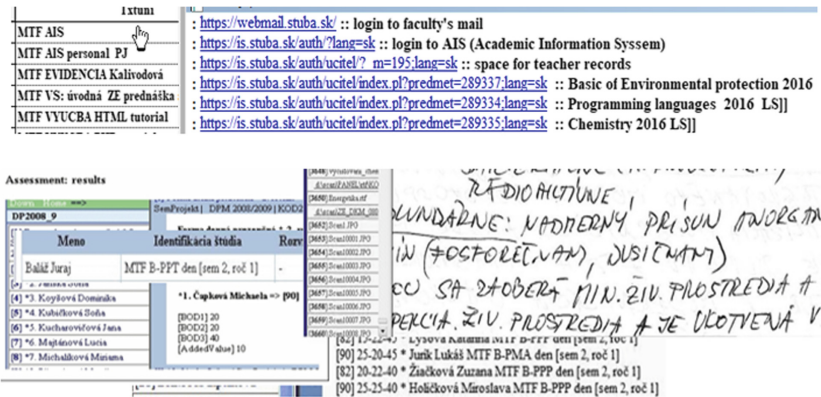


Fig. 10. Teacher's tables linking to the academic information system and student assessments

Figure 11 presents schematically two cases from research on speech recognition and modeling of the creation of educational packages by an international team.

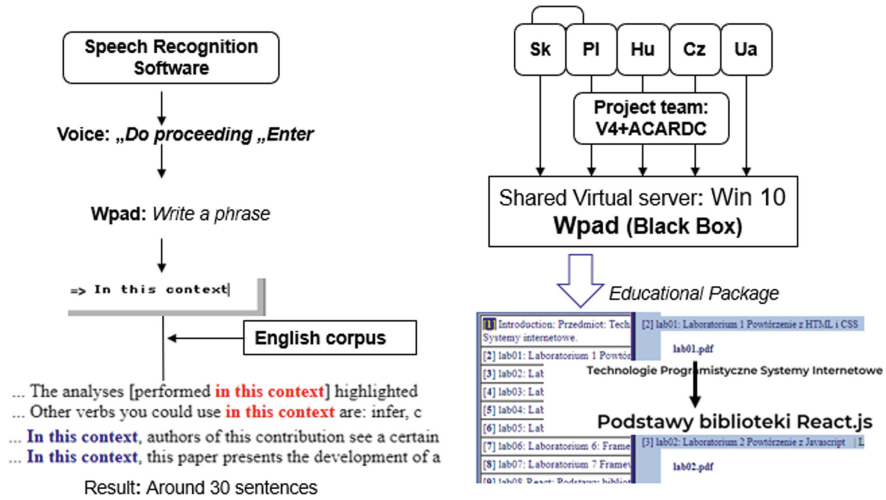


Fig. 11. Testing speech recognition software for controlling source code via voice (Left); scheme for educational packages creation by an international team (Right)

5 Conclusion

In this paper, we have described a solution for integrating IT into educational processes based on the design of own educational software that supports as a universal tool for all the common activities of a teacher in his teaching, publishing, and research. The teacher does not have to adapt to existing technology, but the software and the IT infrastructure are built according to the needs of the teacher and the students. WPad software was explained in terms of its use as a universal interdisciplinary all-in-one educational tool. From an informatics point of view, it can be used (1) for the processing of educational texts; (2) creating a large amount of e-learning and educational materials, as it also functions as a simple personal HTML editor; (3) as an editor and corpus when teaching programming languages (C++, C, PHP); and (4) as a supporting tool for pre-service teachers for their diploma theses, and in a wide variety of situations in the realm of teaching and learning.

As WPad allows the teacher to process large amounts of educational content, it has also been tested as a tool for processing large volumes of information contained in computer files. Indeed, thanks to today's technology, teachers have a "small internet" on their computers. Therefore, the research focuses on aggregating educational content from all offline/online sources and reducing it into a form of a personal knowledge base. This approach allows teachers to minimize the current information overload. There are also technological limitations, e.g., when transferring a very large amount of computer files between offline and online environments, or limitations related to the technology lifecycle, which is shorter than teachers need in practice. From a pedagogical point of view, it is important whether the teacher is able to formulate the educational algorithms needed to write the appropriate informatics algorithms. This is particularly important for automating the creation of educational content in the form of learning packages. Future

work could therefore focus on the design of a shared virtual server for teaching students, or the creation of an educational portal with language support. In terms of future plans, the research will focus on interdisciplinary aspects such as synchronization of teaching algorithms and computer algorithms. In this context, research is limited by the level of available technology (e.g., the planned use of Speech recognition technologies depends on the possibility of using it for languages other than English).

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