

# EXPERIENCE WITH THE IMPLEMENTATION OF PERSONAL IT SUPPORT FOR TEACHERS IN TEACHING, RESEARCH, PUBLISHING AND E-LEARNING USING IN-HOUSE EDUCATIONAL SOFTWARE

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## Abstract

The practice of a university teacher is extremely rich and varied, so there are no general-purpose software or IT solutions specifically focused on the person of the teacher. The typical teacher lectures, practices, makes assessment, publishes, collaborates on research, solves knowledge management, creates educational content, and performs a plethora of other related activities, including self-study in his area of expertise. All these activities of a teacher have one shared element and that is working with educational content or knowledge. The authors address the digital transformation of education as an interdisciplinary problem with a focus on the synchronization of pedagogical and IT activities. The basis of the research approach is that educational processes are based on educational knowledge, so they can be automated, respectively. mass processing (technically, knowledge is a parameter of educational processes). As part of long-term research, they have developed the WPad educational software, which uses the so-called virtual knowledge, which takes the form of a simple database table, so that an individual (teacher, researcher, student) can fill it with educational content in natural language. This software was initially applied to teaching in the classroom and creating e-Learning for undergraduates. It has gradually spread to academic research (e.g., computer-assisted collaborative learning, knowledge management, learning analytics). The article describes the multipurpose use of WPad as an all-in-one teaching tool (aid) on a combined offline and online IT infrastructure using examples from teaching and research. Further development will be focused on the mass creation of educational packages and multilingual support within the framework of international cooperation with output testing also on the educational portal.

Keywords: Digital transformation of education, e-Learning, educational software, computer supported collaborative learning, knowledge management

## 1 INTRODUCTION

In solving the digital transformation of education, the fact is underestimated that computers were not developed for education but for computing, so the computer does not know what human knowledge is. For this reason, no educational technology or artificial intelligence can cover all the educational activities of teachers, researchers, and students. This is because the current state of IT can only address data, but teachers and individuals work with human knowledge. The result is that solution of digital transformation of education (integration of IT into teaching) lacks universal educational software. Although there are several monographs that focus on areas such as technology enhanced learning and educational technology, e.g. [1, 2, 3, 4], only [1] best describes the requirements for IT support of teachers. The lack of educational software is also mentioned in [5], where the absence of software engineering approaches is mentioned, similarly in [6] the lack of theoretical approaches is also mentioned. As a result, the criticism of IT integration in education is quite frequent, sources [7, 8, 9,10,11] can be mentioned. Some areas are covered by online software, but basically, it's about working with files that contain some educational information and content. It is possible to mention various Learning Management Systems (Moodle, Blackboard, Academic Information Systems), collaborative and educational portals (global, regional). During the pandemic, online platforms (Zoom, Google Meets, Microsoft Teams, Webex) began also to be used for communication, however they function in principle as virtual classes, because an individual teacher must deal with the same activities as if in a normal physical class. In real practice, there is no all-in-one tool focused on IT support of common activities of teachers, such as teaching, learning, e-Learning, self-study, assessment, grading, publishing, research. Within the authors' research, these issues were solved thanks to the design of the so-called virtual knowledge. It is a common data structure in the form of a

database table, into which human knowledge is inserted as meta-information and educational content. The computer can quickly process it as a suitable representation of knowledge. The authors' long-term research is based on the fact that for every activity of teachers and students, a way is sought to apply this virtual knowledge to them. Unlike conventional computer files of various formats, in which individuals exchange knowledge, individuals in this case only work with reduced content, that is, with their tacit knowledge and selective educational content. Virtual knowledge tables are controlled by the in-house developed WPad software. The interdisciplinarity of research lies in the fact that educational algorithms are first identified and then the source codes of the software are written. The authors continuously publish the findings of their research on teachers' personal support in teaching and research. It can be mentioned [12, 13, 14, 15]. Although, in view of the above, despite an intensive literature review, a similar research approach - the development of educational software aimed universally at IT support for individuals - could not be found in the literature. However, it can be stated that virtual knowledge design is related to knowledge models such as "Technological pedagogical content knowledge" [16, 17], even WPad can be used as an IT tool to model them in practice. Practical examples from the research results are given in the individual sections of this paper (e-Learning, teaching, research). Research is currently focused on synchronizing pedagogical and IT activities to automate the activities of teachers in university teaching and research.

## **2 RESEARCH APPROACH AND METHODOLOGY**

The authors' long-standing research has accepted the idea that the processes carried out by teachers and students are knowledge-based, i.e., knowledge is a key parameter if their personal activities are to be automated, with a separate category being the activities of individuals on personal computers, university learning environments, networks and clouds. Based on this hypothesis, a data structure, called virtual knowledge, has been proposed that can be read by both computer and human because it has form of a simple database table. In such a table, an individual inserts meta-information and any educational content. This allows the teacher to create a set of tables for different teaching topics or activities. In this context, the main author of this paper has been developing WPad educational software for over a decade to create and manage these tables. Since educational content is an abstract matter, it is a universal knowledge processing principle, so WPad can be used for all areas of digital transformation of learning or to support the creation of e-Learning and any kind of learning whether face-to-face, blended, collaborative and distance learning. From a teacher's point of view, it therefore represents a personal all-in-one educational tool. As an illustration, the application use of this educational software so far covers dozens of topics and subtopics of this conference, so that one could list a large number of applications that have been implemented in e-Learning and teaching undergraduates, or within collaborative research projects and an international network.

It can be said that the offline application of WPad and the web-based application of PIKS-channels (Personal Information and Communication System), which is the subject of the current research, can cover all academic activities of a teacher, including distance learning, in the time of the COVID pandemic. At the same time, the basic solution is very inexpensive, as all that is needed is a Windows system and an Internet connection. Moreover, if the university runs a virtual machine on the cloud, WPad can be used by teachers or researchers together on one remote computer.

In this context, it should be emphasized that a computer with a Windows operating system and a WPad installed is sufficient for all these activities. In addition to working in its environment, it is possible to convert tables to HTML format and the inputs are automatically opened by the default browser. So this is probably the cheapest solution that exists. And it's also because there is most likely no software on the market that allows all the activities described like this all-in-one WPad application. In addition, the big advantage is that WPad allows the teacher to work in a combined offline / online mode, while most educational software only works as online tools (e.g., Learning Management Systems).

## **3 RESULTS**

This approach makes it possible to address interdisciplinary solutions for the integration of IT into teaching, which is based on the fact that the basis is the identification of the pedagogical situation and activity. Based on this, it addresses how to insert information and educational content into virtual knowledge (WPad tables) and which combinations from the user menu of the WPad software to use. New algorithms are formulated as needed. So unlike situations where teachers have to adapt to technology, technology addresses what they need. There are a number of situations in the actual

practice of each teacher, so several categories of outcomes were found in the research. In this section, some outputs will be described.

### 3.1 E-learning

The WPad educational software began to be tested and applied to automate the creation of e-Learning for several bachelor's degree programs. At that time, the Internet was not yet widely used and it was necessary for undergraduates to produce and prepare study materials quickly and to place them on the faculty server. Thus, each subject had its own virtual knowledge, its own table, and the curriculum texts were written into individual lines manually or the texts were copied. Because the designer, the teacher and the researcher, in one person, also knew how to write html-scripts in the table, the conversion of the table created html-learning sets, which were placed on the educational environment of the faculty server [habilitačka]. Thus, both the teacher and the students were able to view the educational content from the computers in the classroom or from the home computers. As e-Learning materials were created for various STEM subjects (Background of Environmental Processes, Basic of Chemistry, Industrial Management, Programming languages, Occupational Health and Safety), valuable IT-pedagogical experience was gained that some subjects require mostly word processing and another content visualization solution. As the Faculty of Education operated at the faculty at the time, pre-service teachers tested the use of WPad to create e-Learning in their diploma theses (Thread Production, Manual for the new version of Windows, Cutting fluids). WPad also proved to be very suitable for creating personal teacher preparations for the lesson. Fig 1. provides an example of e-Learning creation for production of threads made by a pre-service teacher. As you can see, the student described in the rows of the WPad table various topics, such as 1-lesson, 2-objective, 3-structure lesson, or 11-purpose machines, 12-thread grinding.

A unique didactic output was the cooperation of a teacher with a student who taught her the C ++ programming language. She studied C # the next year, writing notes and source codes in a WPad table so that the teacher could learn another programming language. So this is a really specific case, because she produced e-Learning material for her teacher.



Fig. 1 Screenshot of creating e-Learning by pre-service teacher

### 3.2 Teaching - students

WPad software has begun to be developed as part of teaching undergraduates for several categories of educational activities. Simultaneously with the creation of e-Learning (the teacher inserted the learning content into the WPad tables), students in the classroom also started using WPad tables. In the classroom, a WPad was installed in each desk for a pair of students. After clicking on the WPad icon, a table with student enrollments from the previous lesson was automatically opened. They wrote identification data, teacher's instructions and personal notes in their tables during lectures and

exercises. The IT support for the subject Semester Projects can be highlighted here, the purpose of which was to write a project throughout the semester. The tables were used in such a way that students took notes in them on how to write an abstract, introduction, core of the work, evaluation, conclusion and references. By gradually inserting the content into the tables, each student then had a multi-line table at the end of the semester as a manuscript, which he completed in a text editor.

The tables were also used for internet multi-search when searching for literary sources. In practice, this required typing 5-10 keywords into the text box of the table, and after clicking on the corresponding menu item in the WPad program, 5-10 Opera browser windows with search results were automatically opened. The students then made notes from the results in a WPad table.

These and similar activities were done in the research, which in [2] is characterized as the so-called participatory action research, when the teacher chooses the appropriate technology according to the needs of his teaching. In our case, the teacher programmed the technology himself. Gradual programming of the source codes created a rich user menu and thus designed the educational software WPad. An unexpected pedagogical added value was the finding that due to the need to work with the WPad program and spreadsheets, students had to concentrate throughout the lesson (this also limited the use of mobile phones during the lesson). This was evident in the IT support for teaching programming languages, where students wrote C ++ source codes in table rows, which were automatically transferred to the DEV-C ++ external software environment and executed. The number of table rows at the end of the semester was the best proof of how much source codes the student had created. Prior to the end of the semester, the table had to have at least 30 rows (30 source codes). From the didactic point of view, it was significant that the teacher merged the student tables into one table, which was converted into html files and these were placed in a virtual learning space on the faculty server. As a result, self-study material was created, which was used by new students in the following semesters. In order for students to upload and download files during lectures and exercises or from home, an Internet application has been programmed for this purpose. This used an online table with the same structure as offline mode for inserting content. It should be added that in teaching subjects such as Background of environmental protection, students' attention was lower, because when working with tables they did not have to deal with source code, but only freely took notes. So it was more difficult to keep their attention for the whole hour. In any case, the positive effect was that some notes had to be taken and the teacher was able to assess the level of teaching (formative assessment) according to the quality and quantity of the content of the tables.

Such activities are referred to in the IT literature as CSCL, meaning that in this case the students produced the learning content collaboratively. Another example of CSCL was that students made collaborative study material from the basics of chemistry. Namely, it was found that new students undergraduates did not master the basic things of chemistry, which were an essential part of the subject Background of Environmental Protection. The IT support of the teaching was solved in such a way that each student received an online instruction in the form of several keywords, e.g. oxidation, reduction, amino acids, chemical laws. Students applied WPad to multi-search and wrote learning content from outputs such as Wikipedia and other portals. Subsequently, the tables of all students were combined, and material was generated on the faculty server, from where they could use it for self-study. This was then used by new students in the following semesters. Again, this is a specific pedagogical added value when students produce e-Learning for other students.

Of the interesting applications, the case where a student of the subject Programming Languages wrote the C++ source code for some interactive chemical calculation can also be mentioned. This was then used by students in the subject Background of Environmental Protection (Note - the student was in both study programs).

### **3.3 Teaching – teachers**

The previous sections explained how software and WPad spreadsheets were used for e-Learning and mostly in bachelor teaching. While students used only a few tables, at least one for each subject, the teacher created and used tables for all the activities he performed. As each table was for a different activity, the contents of the WPad table and activities changed, separate source codes were written for each of them, which were built into the WPad user menu (today the menu already contains hundreds of items, the WPad designer has thousands). The research results were continuously published at global conferences (ICL, FTC, IAENG, IEEE, ICICKM, WCECS). It is important to understand that the teacher has always had to suggest for the educational activity how to describe it and fill it in the table in a suitable way. For example, in one table he wrote texts for e-Learning, in another he copied lists of students from the University's Academic Information System (AIS), the source codes of programming

languages, as well as what he should provide, links to the WEB. He even created language dictionaries with sample sentences. To illustrate, there are some categories of use of WPad tables that support teachers:

- Direct connection of the table with the university AIS (in the table there were dozens of links to study programs, lists of students, their evaluation, registration for exams, internal e-mails)
- Assessment and grading of semester works (in each row of table was a link to file containing semestral work, with teacher's notes and instructions and notes for a block of semester work - Abstract, Introduction, ..., Summary)
- Internet search outputs for taught subjects (e.g., from Wikipedia and educational resources)
- Repository of source codes for teaching C++, C and self-study language for Internet application programming (PHP, MySQL, HTML)
- Chemical equations and examples that have been converted to PHP formats and functioned as interactive calculations in the faculty virtual learning space
- Knowledge management of individual research projects, including the use of tables for learning analytics and teacher research
- Various tables for personal notes, administration, but also for entertainment and hobbies.

From this brief description, it should be clear that a similar personal universal teaching tool such as WPad and its knowledge tables system does not seem to exist.

Figure 2 illustrates the situation of how a teacher used a program in classroom teaching (the program allows work without an Internet connection, tables are in WPad environment and HTML-tables created by their conversion automatically open the browser in offline mode - used Opera and the default Internet Explorer).

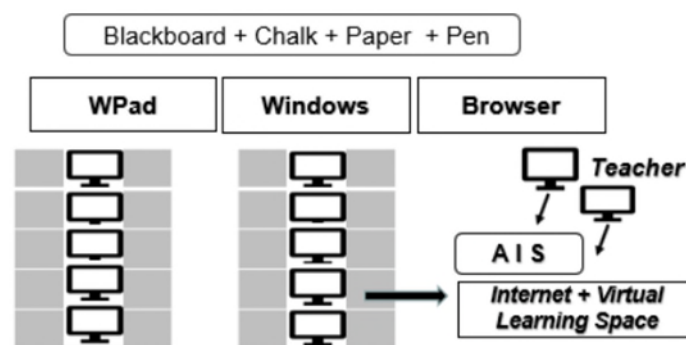


Fig. 2 Scheme of classroom offline/online teaching with installed WPad on students' computers

### 3.4 Research

The range of described learning outcomes was also achieved due to the fact that the integration of IT into teaching was addressed within internal projects and international cooperation (7th Framework Program, national projects APVV). It all started in 2006 with the idea that teachers are implementers of educational processes. The parameter of these processes is educational knowledge, so they can be automated, and some personal all-in-one software can be developed, which would be able to process a huge amount of educational content in bulk. The main author of this article defended a habilitation thesis focused on the mass construction of knowledge and e-Learning. Based on his bachelor's teaching experience, he declared that the WPad table works on everything universally because it allows for a specific data structure that can be patented. Indeed, in the following period, the data structure was incorporated into two utility models registered with the Slovak Patent Office. So, as a result, the information and knowledge processing paradigm has begun to be published, and the specific data structure is presented from a computer point of view as so-called virtual knowledge. From the teacher's point of view, it is a common "database table" in which he writes and inserts tacit knowledge and educational content. For example, WPad was used to support and knowledge management of the CSA submission of PanEULangNet and Satesel projects under the ICT 17 call of the EU Horizon research program (in other words, as a personal information system of the project leader, which connected 30 researchers from dozens of EU countries). As part of the solution, it was to operate on an EU portal as a black box to serve as a repository of multilingual technical texts for Automatic Machine Translation (teachers would supply technical texts for consortium partners developing Automated Machine Translation software).

A certain breakthrough in research on IT integration in the classroom was the activities within the international project V4+ACARDC (2018-2019), where pilot educational packages and multilingual publications were developed on a common computer model. A sample of the testing of the translator is temporarily available at <http://www.svti.sk/V4/EDUPACKS/EV/XXXPDFLP.HTM> (click on the record number to open the PDF-files).

In the following period, the outputs were also applied and modified for distance learning during a pandemic, for the creation of communication channels, the so-called PIKS (a new version of the Internet application designed for distance learning and online collaboration of researchers), on the development of WPad for the blind and visually impaired (a recent search for a bachelor thesis blind student can be mentioned). This development will not be discussed in more detail, as it is primarily the IT area of human-centered computing. From the didactic-pedagogical point of view, it is more interesting how the distance teaching of the subject in the field of computer simulation of technical processes was solved. Figure 3 illustrates a situation where a teacher has prepared a set of video tutorials for self-study with the help of tools used in research. They placed these on a Google drive and a WPad navigation table was made from which the teacher or students can switch to individual teaching videos. The navigation table does not have to be placed online, so users can also have it on their laptop and view video files on the cloud from it.

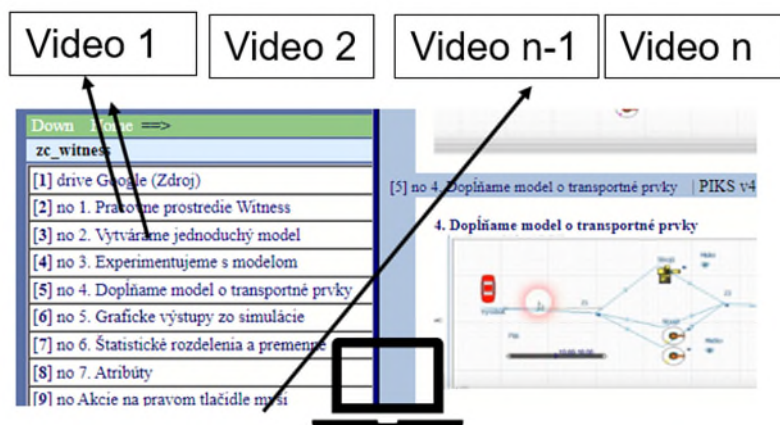


Fig. 3 Example from distance learning - browsing video tutorials from WPad (HTML) table

## 4 CONCLUSIONS

With a focus on the person of the teacher as a key player in educational processes, the paper explained, using examples from university teaching, the research methodology of integrating IT into teaching, research and related academic activities carried out by teachers and students. The teacher-researcher developed the educational software WPad, which became the basis for building a personal offline and online IT infrastructure. The transfer of educational content between teachers, students and researchers, both teaching and collaborative activities, takes place on this combined infrastructure. The interdisciplinary informatics-didactic approach was discussed with emphasis on the fact that technology adapts to the teacher according to what each learning activity requires. In practice, teachers have to adapt to the technology - they use a generic technology and try it out to see if it is suitable for their teaching. The WPad educational software works as an all-in-one tool for the individual, his or her personal teaching tool, which allows any activity to be supported (automated). It was explained that the key to automate teaching is working with educational spreadsheets, and that the success of Integrating IT into teaching depends only on how the teacher, student, researcher can insert the educational content or activity into the WPad spreadsheets. Therefore, the aim of this paper was to explain to the reader through a dozen case studies how WPad and knowledge tables have been used in teaching undergraduates, pre-service teachers, in research, and for IT support for publishing. In terms of future progression of the authors' research approach, this is essentially a never-ending story because it is based on simulating users' personal activities in knowledge-based processes. The building of the EDUPORT educational portal is under development in the framework of international cooperation of the V4 region countries.

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