Experience with An Interdisciplinary Approach To Removing Barriers Related To IT Personalized Support For Teachers In The Creation And Transmission Of Educational Content

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Abstract—Research on IT integration into teaching is an interdisciplinary field that has both educational (didactics) and informatics components. In particular, the situation with the Covid 19 pandemic has forced a push to address personal IT support for teachers in distance education. However, this runs into the problem of the lack of personal educational software, so that in practice the teacher has to adapt to existing technology and test how it can be used for teaching. In this context, the work of a university teacher requires the mass creation of educational content, its transfer between offline computers (laptop, classroom computers) and online environments (web, virtual learning environments, academic information systems, clouds, networks). Given the nature of university teaching, IT support solutions for self-study also face a challenge. However, no single technology covers such a broad scope, so there is a lack of universal solutions. The authors minimize this gap by programming universal software tailored to the needs of the teacher and by building a combined offline/online IT infrastructure on which to conduct the research. Collaborative research by an international team using the infrastructure is a solution to automate the creation of educational packages, including the multi-

lingual support. The article clarifies the categories of barriers that the team had to overcome, either from a didactic or an informatics perspective. Here, a new paradigm using a specific data structure (called virtual knowledge) for the rapid reduction and concentration of educational content was proven to simulate virtually any teacher activity. Therefore, the goal of further research is to use the results and experiences to date to build a multilingual learning portal.

Keywords—IT integration, distance learning educational software, collaboratively research, multilingual educational portal

1 Introduction

A common feature of the integration IT (Information Technology) in teaching is that teachers have to constantly face obstacles and IT challenges related to the incompatibility of computer formats, software and hardware, including their short life cycle, which is shorter than a teacher's career. A key issue is that content creation requires the mass processing of information, knowledge and computer files, but current IT technologies are not suited to supporting teachers in person. In recent years, many sources of literature have been published focusing on IT support for education, e.g. [1, 2, 3, 4, 5], but these (with the exception of [1]) prefer either an educational or an informatics perspective, even though this is an interdisciplinary education-informatics field. Also unanswered is the question of the appropriate definition of knowledge that should respect this interdisiplinarity. This is one of the reasons why it is possible to encounter an emphasis on the so-called Technological Pedagogical Content Knowledge (TPACK) [5, 6, 7].

While content creation is relatively well mastered, teachers must use dozens of software and interfaces to create curriculum; universal educational software is absent [8], as well as appropriate theoretical approaches [9]. Similarly, the problem of transmitting educational content is less described in the literature between off-line environments (classroom, personal computers) and virtual environments (web, clouds). This paper describes a simple, inexpensive solution that is based on an interdisciplinary approach which is possible to solve by using the universal in-house educational WPad software, which simulates educational knowledge by so called virtual knowledge. The following sections describe the conceptual framework, the research approach examples and existing informatics, didactics and interdisciplinary barriers, including an explanation of how they are overcome.

2 Conceptual Framework

In practice, the university teacher is constantly flooded with a huge amount of information and has to use dozens of software, Internet services, several browsers, hundreds of computer formats, or thousands of resources with educational content, whether offline or on networks and clouds. If we compare the content of a teacher's computer before the year 2000 with today, a typical teacher figuratively speaking has

a small internet on his computer. The presented research approach assumes that generic computer software cannot cover all the activities that a teacher performs, therefore he needs a personal all-in-one tool. As for it the in-house developed WPad educational software can address these things whether for teaching, research or any teacher's activities. The software controls the so-called virtual knowledge, which allows for the creation of simple WPad tables with selective educational content and, if necessary, a personal knowledge base from these tables. This approach enables building an all-in-one educational technology tailored for teachers and students that allows for rapid learning content processing. Fig. 1. illustrates the WPad table (virtual knowledge) named "may2022" (the table contains useful information to ICL 2022 in the columns and text area with the text related to submission of this paper).

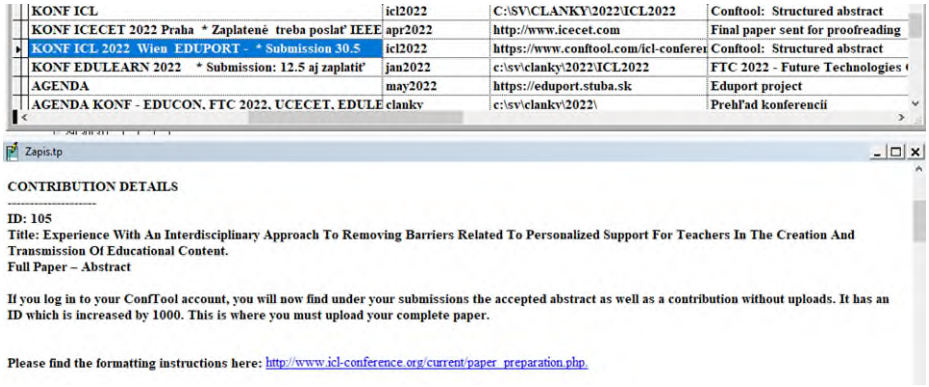

Fig. 1. Part of WPad month's table "may2022" (virtual knowledge) with notes for ICL 2022

Although the solution is very simple, since WPad tables can be produced even by individuals with low IT skills, a similar solution is not described in the literature. This is associated with the fact that although it is a database application WPad is developed on a non-relational paradigm; the novelty of the solution is confirmed by the registration of the utility model 8787 at the patent office [10]. As a result, simulating knowledge using WPad tables allows educational-informatics solutions to be applied to teaching and research, which are being continually published (details can be found, e.g., in [11, 12, 13, 14]).

3 The Research Approach Examples

WPad was designed as a personal IT support tool for research areas such as Learning Analytics, Digital Libraries, Cracking language barriers, Computer Supported Collaborative Learning (CSCL). Although some CSCL issues could be addressed in collaboration with students offline (e.g., students created collaborative e-learning material to address knowledge gaps in chemistry), it was also necessary in the research to address the collaboration of an international team of teachers. Coincidentally, this team was formed within the ICL 2018 conference. For the

purpose of the CSCL, the WPad was tested on a Virtual Machine running Windows 2010, i.e., teachers used it as an online shared computer. In terms of purpose and goals, it should be emphasized that WPad is a special software that uses simple tables into which the teacher, researcher and/or students manually, by copying or automatically insert educational content. The key point here is that, unlike text-based computer files (doc, pdf), they work only with selected content needed for lectures, exercises and self-study. The content is also stored in files (dbf) that can be transferred between each other, sent, stored on clouds and produce html-files for e-learning.

In the framework of the international project V4+ACARDC, a research team from the V4 countries and Ukraine modelled the automatic creation of educational packages and multilingual language support on the virtual machine. Fig. 2-left illustrates how in the WPad table titled "V4" information is being inserted. A hypertext principle is used both for online links and offline paths as seen from the text-field bottom window. Fig. 2–right illustrates how educational packages are being created from WPad tables. Files from online and offline resources were copied to a MIX-Folder from which WPad tables (EDU-PACKS – Educational Packages) were created using menu items of WPad software, as well, converted to-HTML format.

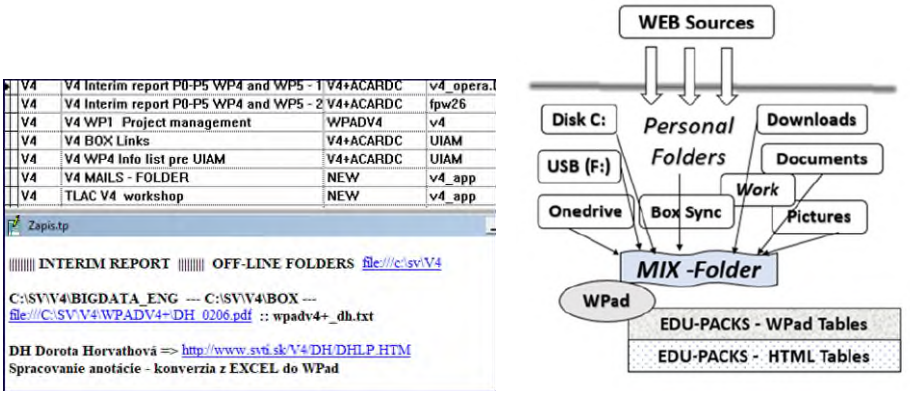

Fig. 2. Left: Screenshot of WPad table "V4". Right: Scheme of creating edu-packages

Fig. 3 illustrates such educational package which was created from PNG-files (screenshots of learning texts), i.e., inserted into WPad table and then converted to the browsable HTML table; after clicking with mouse to record 11 students can see learning text. This example explains interdisciplinarity of research so from the educational-informatic approach. That means, firstly a learning activity must be performed and then learning outputs and adaptation to software/hardware/networks to be solved.

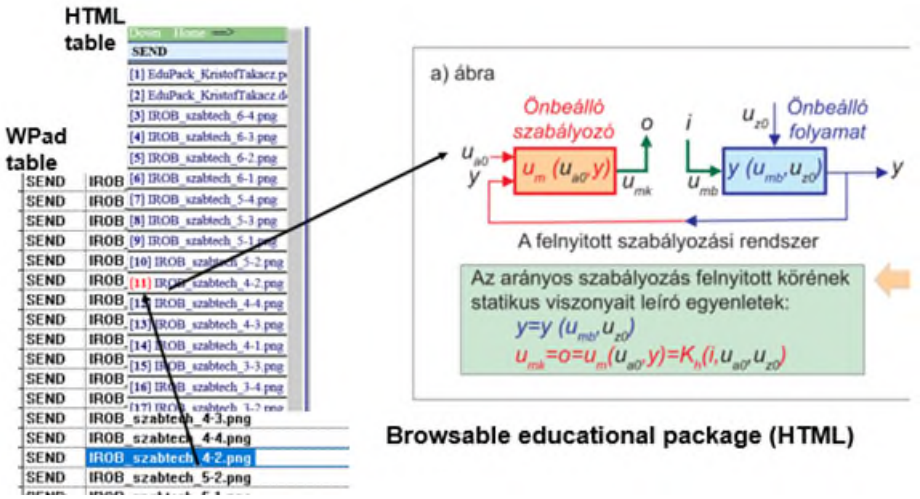

Fig. 3. Scheme of creating a browsable educational package

In the context of interdisciplinarity, a multi-lingual support was solved within the V4+ACARDC project. The learning text related to machine learning was created by the Czech partner in English (En) and Czech language (Cz) as DOC-file. This was translated using Google translator and checked by partners to evaluate quality of the translation in Polish (Pl), Hungarian (Hu), Slovak (Sk) and Ukrainian (Ua) language and delivered as DOC files. But there was a time-wasting problem with diacritics of these six languages when testing outputs as TXT, DOC, and HTML format. It was evaluated that this problem can be eliminated by using PDF format. Because the learning text for Machine learning had around two pages there was a question how to place it to the computer screen. Thus, simply the browsable HTML educational package was created using WPad software as illustrated Fig. 4.

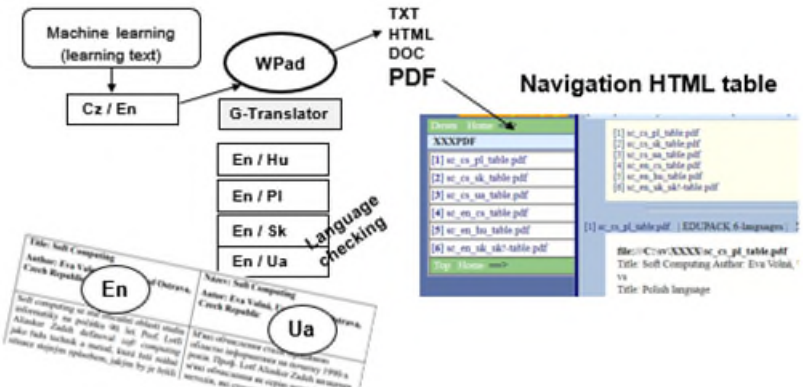

Fig. 4. Part of WPad month's table "may2022" (virtual knowledge) with notes for ICL 2022

This example presents not only interdisciplinarity of the IT integration but emphasizes that technology was adapted on teacher activities and not in contrary as is common in state-of-the-art.

4 Barriers in research

To address issues related to technology-enhanced learning in a university setting, according to [1], it is characteristic that the teacher conducts what is called participatory action research for which he chooses the appropriate technology. In this context, the first author of this paper, after joining the university as a teacher, researcher and programmer in one person, developed his own technology for the purpose of teaching undergraduates. In addition to the operative programming of tutorials and tests, he started to develop a WPad database application that students had installed and used it to produce e-learning teaching materials. Parallel to teaching, he improved WPad in his research and project activities and developed a universal WPad to function as an all-in-one educational software. For the sake of describing the barrier, it should be emphasized that the above system of IT integration in teaching has been practiced for about 15 years. Unlike humanities research where teachers use some existing external technology (software) the technology (WPad) is designed directly according to the requirements of classroom teaching or collaborative research activities. This makes it possible to describe different categories of barriers whether from an informatics, didactic or interdisciplinary perspective. To add to this, classroom teaching with computing was done at a regional faculty relocation site where there was no IT department. Thus, all situations, whether in the classroom or in the virtual learning space, were handled by the teacher.

4.1 Informatics Barriers

In terms of IT barriers, it is important to realize that while a university teacher is teaching for at least 10-20 years, the lifetime of technology is only a few years. In that time, both hardware and software will change radically. Practically, this means that a lot of teaching materials, application deliverables and programs will become unusable. Therefore, it is very important to address teacher computer support in a way that is as independent of these changes as possible. Some obstacles have already been discussed in [11]. In our case, for example, the following situations occurred (computers were used by hundreds of students from several courses):

- The twelve computers in the classroom had Windows XP installed; this was upgraded to Windows 7, so working with web browsers was radically slowed down; it was not possible to upgrade to Windows 10.
- Opera version 9.27 was used with excellent didactic features (Sessions), but the company changed the higher versions to Google compatible and this made some applications for classroom teaching unusable ; in addition, the start-up time and internet search slowed down.

- Changing the university server from Windows to Unix, which is case sensitive, forced the rewriting of hundreds of links to the faculty learning environment.
- The faculty portal used the PHP version 3.0 web application language. When PHP was upgraded to higher versions, the application stopped working and hundreds of source codes had to be rewritten.
- A serious problem was the technical end of life of the faculty server after ten years, making the virtual learning environment unusable (part of it was migrated to another server).
- While a common Windows notebook and Internet connection is sufficient for classroom use and e-Learning creation, the use of clouds, virtual machines and repositories requires equipping the teacher and students with IT infrastructure and interaction with administrators from IT departments (unless the teacher does it all himself, as is the case with the first author of this article).

The above cases are only part of the problems, because the most difficult part is programming the adaptation of educational software to the operating system, software, networks and the web. It can be said that in view of the successfulness of the IT integration solution, this represents up to about 60-70% of the activities. A specific case is the programming modification for the blind and visually impaired (BVI). The essential point is that all their activities on the computer must be triggered by keystrokes or a combination of keystrokes. Also, a problem is that the screen reader that BVIs must use sometimes does not read text fields.

4.2 Huma factors: Students and Teachers

In real teaching, one has to take into account that most students do not have sufficient IT skills to work offline or online, and even if they do, they do not routinely master these activities, which will take up some lecture or tutorial time (students can browse but cannot create something). It should also be taken into account that some students will always be messing around with their mobiles or surfing the internet during the class. The following cases can also be mentioned, which can take 5-10 minutes out of a class with computers:

- Instead of using the browser set by the teacher, students started installing Google, Firefox, etc. on the classroom computer.
- Many students are unable to type a web link without errors due to lack of concentration.
- They have problems when searching for learning topics on the Internet if the search is in English.
- If the teacher does not set up the computers in advance of the lesson and has not prepared the lesson methodically in time, chaos ensues, which in turn takes time away from the lesson.
- If students are given short assignments during class - e.g., jump on the university's Academic Information System; send an email; send me an email; switch to a communication channel and read the instructions, etc. - if there

are 20 students in the class, the students' work is slow and slows down the others.

Similar problems identified during the COVID 19 pandemic are published in [15]. In the case of WPad use, these obstacles can only be eliminated if the teacher has prepared the time-management perfectly and sets up the computers in the classroom before the lesson so that the students cannot speculate and set up their browsers or programs.

In terms of research, when teaching undergraduates, so logically it is not possible to design advanced research activities. However, it is possible to do simple collaborative research. For example, a case was solved where students were instructed to do an internet search in WPad tables for specified definitions from basic chemistry (due to their poor knowledge of chemistry). After combining their tables, the result was a self-study material that they had on the faculty virtual learning space.

Programming the WPad for research purposes requires collaboration and beta testing of the software by teachers. There, however, one runs into the difficult problem of how to motivate colleague teachers to help test the software. In practice, it is the case that even 80% of those approached will automatically reply that they don't have the time, or that they use Google, Moodle or have their own system to do it. And they usually start convincing the designer that designing educational software is not a point because it can't work in teaching. Surprisingly, even journal reviewers will express this opinion. The authors have even encountered the fact that although they described and illustrated with screenshots how it has been used for years in teaching, the journal reviewers labelled it "a model that cannot work in practice". Fortunately, sophisticated activities (e.g., automating the creation of educational packages) were tested by the international V4+ACARDC team, which consisted of researchers from the V4 countries and Ukraine.

4.3 Interdisciplinary barriers

When dealing with the integration of IT into education, it is forgotten that it is an interdisciplinary issue. Ordinary people think that computers can do everything and do not realise that a computer can only work according to certain rules - algorithms that describe an educational activity. It is only according to these rules that computer algorithms can be formulated, source code written and applications tested. From an interdisciplinary point of view, it is therefore a basic requirement that the teacher first identifies and formulates the didactic algorithm (sub-steps) and the goal he wants to achieve (the creation of educational content and what to do with it). Teachers solve these things using some generic software and investigate whether it is suitable for this. A special case is IT support for collaborative activities, which is dealt with in the separate area of Computer Supported Collaborative Learning (CSCL). In the case of CSCL, support without existing didactic algorithms is unthinkable. And an additional problem is that there are many potential variants of didactic steps for collaborative activities. This fact is key to understanding the requirement of synchronizing didactic and informatics activities. In other words, it is necessary to write informatics

algorithms according to what the immediate didactic situation requires. This is also the programming principle of the WPad educational software.

The secondary requirement of synchronizing didactic and informatics algorithms to address IT integration results from the fact that educational content must be transferred between teacher and students through multiple computers. The requirements are different for blended learning, and different for distance learning or also for self-study. Here, more computer-intensive activities are involved, as this requires the transfer of knowledge tables or computer files between offline and online environments. It is already required to build an IT infrastructure over which the educational content "moves". If we look at the problem of automating knowledge-based processes involving educational activities from this point of view, it is clear that educational and informatics activities have to happen simultaneously. This synchronisation is the basis of the vision to make the WPad table function as an intelligent structure.

The basic barriers derive from the fact that the teacher must have both the objectives and the educational content didactically prepared and planned in detail how the learning will be used and transferred between the teacher and the students through the existing software, hardware and IT infrastructure. Since the design of the learning algorithm is a purely individual matter for each teacher and there are an infinite number of variations, there can logically exist no suitable technology. Therefore, even CSCL research in principle cannot be effective as long as teacher-researchers mechanically apply generic technology to didactic problems. Here, it is important to note that designing a didactic algorithm for collaborative learning activities is itself extremely challenging. This is also because the goal will need to be modified in the course of the solution. Without synchronization of didactic (pedagogical) and informatics activities, it is simply not possible.

It should also be mentioned that in the case of synchronization, but also the other barriers mentioned, the issue of time management is less discussed in the literature. In real teaching, however, a lesson lasts around 50 minutes, and the teacher has to cover all the teaching within that time. For an IT integration solution, this means that all IT activities must be fast, efficient, and done in the necessary time. Teaching undergraduates often requires going over several topics during a class period. Depending on what subject is being taught, more texts, images, or audio-visual situations are required to be processed. However, there is no general-purpose software to cover them completely. And from the side of the students, if they use IT tools, their routine use is demanded. In other words, a large number of high-quality didactic videos and e-learning materials are available today, but they usually last tens of minutes and are unusable in classroom and distance teaching. This is also why IT integration is a major challenge for computer science and information technology.

4.4 Overcoming and eliminating barriers

As the previous analysis of the various categories of barriers to successful integration of IT into teaching and academics shows, these are a wide range of issues. However, the difficulty of the solution lies in the fact that the lifespan of the

technology is only a few years, but the solution has to be functional for the entire period while the teacher is teaching and conducting research. Thanks to a specific strategy and a multifunctional approach, WPad educational software, which has been programmed in the academic environment for about 15 years, evolutionarily meets this requirement. The following text at least partially describes from a practical point of view a research approach for eliminating and overcoming barriers and obstacles (the description does not include a theoretical approach based on the virtual knowledge construct):

- WPad educational software runs on Windows, primarily uses the default browser, Explorer and other features (this ensures it will work as long as Windows exists), and works as an all-in-one tool replacing a dozen software
- Microsoft's Visual FoxPro platform, formerly, FoxPro for Windows 2.6a compatible with Microsoft programs, is the underlying offline working environment and is installed on both teacher and student computers
- WPad tables are used, which are portable as regular computer files; pressing a key combination creates HTML tables that are automatically opened offline by the browser (Internet Explorer or Edge)
- Only learning content created by the teacher (e-learning) or students (notes and workspace) is used in the classroom and is publicly available after transfer to the faculty server where a shared virtual learning space is created
- WPad is complemented by in-house web application using the same tables (PIKS channels) so that students can communicate with each other from class or home and upload and download WPad tables or files to their computer (suitable for distance learning - already introduced ten years ago)
- WPad allows both students and teacher to hypertext access to the university's Academic Information System (including exam registration) and internal university email, as well as to files and folders on personal computers
- WPad can run shared for research purposes from a virtual machine in the cloud (Microsoft Azure Windows 2016 server has been tested and the latest Windows 2022 -WebSupport)
- When programming applications, it often takes several years for usable technology to be available in the world (this is the case of Speech Recognition, formerly Text To Speech, which was tested a decade ago for language learning and is only now usable).
- WPad acts as a compatible switch between the user and the browser or any software, and the program also uses simple programming language instructions (HTML, command line, C++, PHP. MySQL); for the layman, it also acts as a simple editor for creating HTML tables
- WPad also provides file manager functions in the user menu, so it allows offline searches, transfers of thousands of files as well as bulk processing of educational content into WPad tables - these can be linked to each other (however, this is a different type of session than used in relational databases); a WPad table can have up to a million rows and the speed of browsing in it is time-efficient

- Only the fastest solution is programmed and implemented - if something is done faster by Windows or regular software, their functions are used from the WPad user menu
- Thanks to the hypertext access, the user basically does not notice the difference between online and offline environments, saving hundreds to tens of thousands of mouse clicks per year
- No errors are handled programmatically (when an error occurs, the program is run repeatedly - otherwise such an all-in-one program would not be solved even in many years)
- The program can also be used by users who are deaf or blind and visually impaired, for whom an adapted version is being developed
- The teacher using the educational software and IT infrastructure is independent of the global software and can manage everything even in distance learning.

Over the years of use, the concept of two versions has been adopted: (1) basic level ("for dummies") for teaching bachelors, diploma works, production of e-learning and (2) advanced level (used in FP7, Horizon 2020 and the international project V4+ACARDC). The basic version addresses the IT barriers and from an educational point of view it is up to the willingness of teachers and students to use it. It provides a user-friendly solution - for example, it has been used by hundreds of students for around ten years without any problems. Conversely, it fails to motivate teachers to at least try WPad (two language teachers were the exception, and one teacher even tested it years ago in a high school classroom). The advanced version requires basic IT skills and collaboration with the first author of the article.

5 Conclusions

The paper presented the interdisciplinary educational-informatics approach for solving the IT integration in teaching. The approach is based on using WPad tables in which only reduced, selected educational content is inserted, whilst state-of-the-is characterized by using standard computer file with unselected content. So, a higher pedagogical quality is added value. Using the educational software, individuals can create, transfer and use the content faster. Moreover, it is a cheap and user-friendly solution because for the basic version of WPad only Window and internet connection is needed. The presented system should be seen not as a competition to existing software but as the missing additional tool for personal IT support of teachers. In the context of overcoming the aforementioned barriers, further research will concentrate on WPad development with a focus on human-centered computing and multilingual applications.

6 Acknowledgements

This research work is co-financed by the governments of Czechia, Hungary, Poland, and Slovakia through Visegrad Grants from the International Visegrad Fund.

The mission of the fund is to advance ideas for sustainable regional cooperation in Central Europe.

7 References

[1] Goodman, S.P., et al.: Technology-Enhanced Learning: Opportunities for Change, p. 2002. Laurence Erlbaum Associates, Mahwah, NJ, USA (2002)

[2] Balacheff, N., Ludvigsen, S., Jong, T, Lazonder, A., Barnes, S. (eds.): Technology-Enhanced Learning. Principles and Products. Springer, XXVI, 326 p (2009)

[3] M. D. Roblyer, A. H. Doering, Integrating Educational Technology into Teaching. 6th Edition. Pearson, 2013.

[4] Bower, M. (2017). Design of Technology-Enhanced Learning: Integrating Research and Practice. Emerald Group Publishing – Education

[5] Kirkwood, A., Price, L. (2021). Technology-enhanced learning and teaching in higher education: what is 'enhanced' and how do we know? A critical literature review. Learning, Media and Technology, 39 (1).

[6] P. Mishra and M.J. Koehler, "Technological pedagogical content knowledge: A framework for integrating technology in teachers' knowledge," Teachers College Record, 108(6), 1017-1054, 2006.

[7] W. Zhang, J. Tang, "Teachers' TPACK development: A review of literature," Open Journal of Social Sciences, 9, 367-380, 2021.

[8] Martens, A.: Software engineering and modelling in TEL. In: Huang, R., Kinshuk, N.-S.C. (eds.), Book: The New Development of Technology Enhanced Learning: Concept, Research and Best Practices, pp. 27–40. Springer (2014)

[9] Lundie, D.: Authority, autonomy and automation: The irreducibility of pedagogy to information transactions. Stud. Philos. Educ. 35(3), 279–291 (2016)

[10] Svetsky, S., Moravcik, O.: The utility model UV 8787. The linked system for conversion unstructured data for semi-structured. Industrial Property Office of the Slovak Republic (2020).

[11] Svetsky S., Moravcik O.: Some barriers regarding the sustainability of digital technology for long-term teaching. In: Arai, K., Bhatia, R., Kapoor, S. (eds), Proceedings of the Future Technologies Conference. FTC, 2018. Advances in Intelligent Systems and Computing, vol. 880. Springer, Cham (2019)

[12] Svetsky, S., Moravcik, O., Tanuska, P., Markechova, I.: The practical experiences with educational software for modelling interactive collaborative teaching. In ICL Conference on Interactive Collaborative Learning, Budapest, Hungary. Springer (2017)

[13] S. Svetsky, D. Mikulowski and O. Moravcik, "Universal IT Support Design for Engineering Education," 2022 IEEE Global Engineering Education Conference (EDUCON), 2022, pp. 498-507, doi: 10.1109/EDUCON52537.2022.9766538

[14] Svetsky, S., Moravcik, O., Tanuska, P., Cervenanska, Z.: The Didactic-Technology Challenges for Design of the Computer Supported Collaborative Teaching. In: ICL 2018, Kos Island, Greece. Springer (2018)

[15] Herwiana, S., Laili, E.N.: Exploring benefits and obstacles of online learning during the covid pandemic in EFL students' experiences. Qalamuna - Jurnal Pendidikan, Sosial, dan Agama| Vol. 14 No. 1 (2022) 61-72