

# Experiences with the Personalised Technology Support for Engineering Education

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***Abstract:** In this paper, the personalised “Technology enhanced learning” approach for engineering education support is presented based on the “batch knowledge processing” and automation of the teacher’s activities. The automation is performed via a multipurpose pre-programmed desktop environment which has been self-developed at the Faculty of Materials Science and Technology. It works on the teacher’s computer as a knowledge editor. This bottom up concept takes into account that knowledge is a key element when performing teachers’ activities. The various outputs were generated for the teaching support, e.g., learning materials for courses of study and a “Study WEB” with a supporting library, tailored internet forums, and other personalised applications respectively (internet batch retrieving, advanced search, multilingual support and digitalisation of the engineering content). The knowledge editor and the batch knowledge processing paradigm gives much reference to many other works and published literature in the area when regarding an applied personalised approach.*

**Key words:** technology enhanced learning, engineering education, batch knowledge processing, e-learning, standalone database application

## Introduction

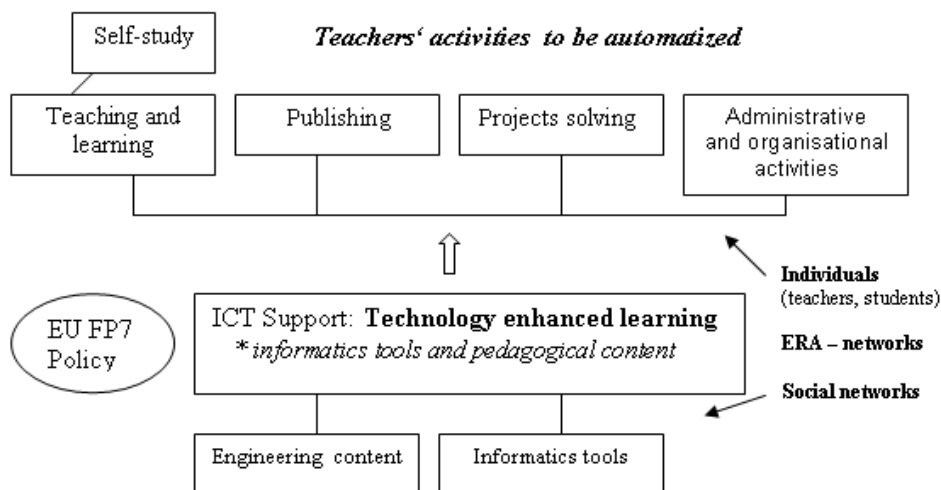
Within the European Union Seventh Framework Programme (FP7) for Research & Development the Technology enhanced learning (TEL) is one of the relatively newer priorities in the field of Information and Communication Technologies (ICT). According to European research, TEL investigates “how ICT can be used to support learning, teaching and competence development throughout life”. However, it must be emphasised that TEL policy automatically requires a shared approach by both teachers (engineering content) and ICT engineers (informatics tools). Thus, having only a technology-driven approach is not sufficient without applying the pedagogical - driven one in

parallel. On the other hand there are various approaches among researchers and institutes, especially in relation to informatics tools for TEL. From a programming point of view TEL is commonly understood as WEB2.0 technologies using programming languages for data processing (data should be readable via machines). The widely known TEL approaches are Virtual Learning Environments (VLE) and Learning and Course Management Systems (LCMS). For instance in one survey TEL was defined as “*any online facility or system that directly supports learning and teaching*. This may include a formal VLE, an institutional intranet that has learning and teaching components, a system that has been developed in-house or a particular site of specific individual tools”. Thus, the technology-driven approach is preferred (Browne *et al.*, 2008). the survey also included e-Learning tools. In another survey Moodle was evaluated as the mostly used TEL tool for higher education in European universities (Matusu, R., Vojtesek, J., Dulik, T.,2008). At the Slovak university of technology an Academic information system (AIS) is commonly used as the in-house university’s LCMS. The analogous approach can be found on NOE-Kaleidoscope, a network on TEL (see Case Studies on <http://www.noe-kaleidoscope.org/>), where the technology – driven approach is preferred (on-line informatics tools, not personalised). At the web-pages of the on-going FP7 TEL projects, there is also an unclearly mentioned focus on the creating and processing of personalised knowledge. ([http://cordis.europa.eu/fp7/ict/telearn-digicult/telearn-projects\\_en.html](http://cordis.europa.eu/fp7/ict/telearn-digicult/telearn-projects_en.html)).

According to Wikipedia, TEL refers to the support of any learning activity through technology, and it is often used synonymously with E-Learning even though there are significant differences. The main difference between the two expressions is that TEL focuses on the technological support of any pedagogical approach that utilizes technology. TEL should provide socio-technical innovations for learning practices, regarding individuals and organizations, independent of time, place and pace. In this context, IGIP – International society for Engineering Education has as autonomous working group dealing with knowledge management and computer-aided technologies, i.e. working with knowledge is emphasised ([www.igip.org](http://www.igip.org)). Also according to its partner SEFI, the application of ICT offers “a deeper and more interactive access to learning material than the traditional classroom environment” ([www.sefi.be](http://www.sefi.be)). As ICT tools for engineering education are mentioned, e.g. interactive tutorials, dedicated laboratory/computer software, digital libraries/ databases/ repositories, virtual and computer-based learning, and also network-based learning environments. According to Littlejohn, A. (2007) the VLE systems can be viewed as “collections of integrated e-tools that enable the management of e-learning” (as commonly used commercial VLE systems such as WebCT and Blackboard). She states that these systems “have the potential to support e-learning at the primary, secondary and tertiary levels of Mayes’ Conceptualisation Model” (in her paper the model is described consisting of three steps: conceptualisation, construction and dialog stages). Nowadays, there are some newer approaches emphasising that there is an absence of a pedagogically-driven approach for TEL, and that knowledge and multilingual support are very important issues (Vuorikari, R., Bettina Berendt,2009).

In this context, the TEL approach as an “all-in-one” approach was investigated at the Slovak University of Technology - Faculty of Materials Science and Technology (FMST SUT) in recent years (e.g., Svetsky *et al.* 2007, 2008, 2009). At the beginning the ICT support of Mayes' conceptualisation cycle was taken into account and inspired by Littlejohn, A. (2007). Each stage of the cycle (conceptualisation, construction, dialogue and feedback) was supported by a set of programming codes. Learning materials for some courses of study were also created using the in-house database application “Writing pad”. It was found that the Mayes' conceptualisation cycle would be a very simply background when supporting engineering education. For example, each course of study had its own cycle and feedback history and it required specific programming codes in connection with tens of learning and teaching activities “within the cycle”. Therefore, the following TEL approach was based on the “batch knowledge processing” paradigm. It must be noted that the TEL approach is based on the multipurpose pre-programmed desktop environment which enables the “batch knowledge processing”, not due to mention, “automation” of teachers activities. Thus, it is not an internet application neither is it a management tool as the VLE or LCMS (only the mentioned forums are programmed by php/mysql). The scheme of the TEL approach for engineering education in figure 1 illustrates the typical teachers’ activities which should be automatised, i.e. teaching and learning (including self-study), publishing, projects solving, administrative and organisational activities. All

these activities, comprising many individual steps, should be automatised via ICT support. From the EU FP7 policy point of view the ICT support of TEL needs to solve engineering content and the informatics tool in parallel. There is a possibility to solve it on two levels - in general via the creation of networks (e.g., European Research Area, social networks), and as a personalised approach (for individuals) which is presented in this paper. This approach is based on batch knowledge processing which is enabled by means of using the user applications programmed by one of the authors (Svetsky) and directly tested and applied with some pedagogues for the universities' course of study at the FMST SUT for approximately 600 students till now.



**Figure 1: The scheme of the TEL approach for engineering education**

If we summarized the above mentioned state-of-the art of TEL, any personalised informatics tools working on the teacher's computer performing knowledge creation and its complex processing is not described in the field, yet. Knowledge processing in batches ("bulk processing") is not mentioned anywhere as a way of the work.

## Batch knowledge processing paradigm

The "batch knowledge processing" is a bottom up concept. It takes into account that knowledge is a key element in education, and educators work with knowledge when performing daily educational and other activities. In addition, today's teacher must work on his computer with a huge amount of knowledge in conditions which are characterised by attributes such as multipurpose, multilingual, multifomat and multiwindow. This state-of-the-art automatically requires working with "knowledge packages" which are to be batch processed. This is not possible with common software. For this purpose, "knowledge" was defined as information with a specified content stored in one row of the database table with a default structure. Such a definition is acceptable from both an informatics and pedagogical point of view. Knowledge is then concentrated by storing it in the "knowledge tables" which can be used for building larger knowledge clusters and for the sophisticated systems rich on information respectively. The multipurpose pre-programmed desktop environment has been developed at the FMST SUT regarding the possibility of an actual ICT tools level being too low, this includes software for personal computers. This desktop environment exploits knowledge tables for batch knowledge processing and enables browsable outputs, batch retrieving, generating study material offline or WEB pages, text processing, image processing within digitalisation (made by the teacher when preparing lectures), writing and launching programming codes (prg, php, html), and many other pre-programmed actions. Hence, the actual "work name" of the personalised environment is "BIKE"-Batch Information and Knowledge Editor. In this case, the TEL approach should be understood as "the automation of all activities performed by teachers" related to any type of education, both in general

and in a personalised way. With the BIKE and the use of existing software, the automation is being solved in the following order: knowledge – knowledge tables – templates for automation – knowledge processing – outputs (products) and target activities. It should also be explained that the core of the TEL approach is the database application BIKE (conventional RDMS for Windows – Foxpro) which enables the production of standalone tailor made applications, e.g. Writing pad (a simple installation via USB), interactive tutorials, personalised virtual libraries with thousands of files, php/html editing and launching, internet batch retrieving, and modelling of language support, etc. Because working with knowledge has a huge amount of possibilities, the further development is a “never ending story”. The knowledge editor on the teacher’s computer has hundreds of options in the menu, e.g. one option is searching in Wikipedia – default is that the outputs are three output windows from English, German and the Slovak version of Wikipedia. This informatics tool generates html-files or php files (if the teacher has advanced informatics skills) and works together with internet browsers (default IE, Opera), Windows (from 3.1 to 7), common search engines. Because of its compatibility with MS Office it enables the teacher to use all programmes that they use daily. Thus, the BIKE (only on the computer of its author) or Writing Pad (on the computers of pedagogues and in class-rooms) enables the teacher to select everything one wants regarding actual pedagogical needs. For instance one can create one’s own learning and teaching materials, or personalised virtual environment, domain oriented portal (in this case the generated off-line files are simply to transfer to the internet server via FTP with any common file manager).

## The automation of teachers’ activities via technology support

When understanding the TEL approach in connection with the automation of teachers’ activities using knowledge, the experiences showed that the basic teachers’ activities to be supported can be divided into teaching and learning, publishing, research projects solving, self-study including administrative and organisational activities. In relation to the automation of these activities, various types of templates were designed i.e., the pedagogical (with engineering content), informatics, combined (pedagogical plus informatics), administrative and organisational ones.

For performing TEL in engineering education, there are many possible combinations when interlinking together: “activities – templates – individual stages of the conceptualisation cycle”. Various types of TEL output were prepared and worked out on this account. For example, the learning and study materials for courses of study (environmental protection, semestral projects, occupational health and safety, engineering of the workplace environment), the internet Forum I, II (due to better communication and feedback), the virtual libraries at the faculty’s server (for each course of study), and the other BIKE applications (internet batch retrieving, advanced search, multilingual support, digitalisation of printed engineering content, and data interlinking with the AIS).

There are some screen output examples from the technology support of the FMST shown in figure 2 and figure 3. Figure 2 illustrates a BIKE environment (left: an example from self – study) and generated study materials for the course of study “Environmental protection” (right: a browsable html – output).

Figure 3 illustrates input and output screen examples of the internet Forum created by BIKE and php/mysql on a teacher’s computer and copied to the university’s server via FTP. Basic information about semestral works with abstracts that are written by students. In this way the teacher has obtained English abstracts as feedback from hundreds of students. Now, the level of the abstract will be evaluated by language teachers and used in the next teaching of technical English (there is a big handicap because English is not the native language of the students).

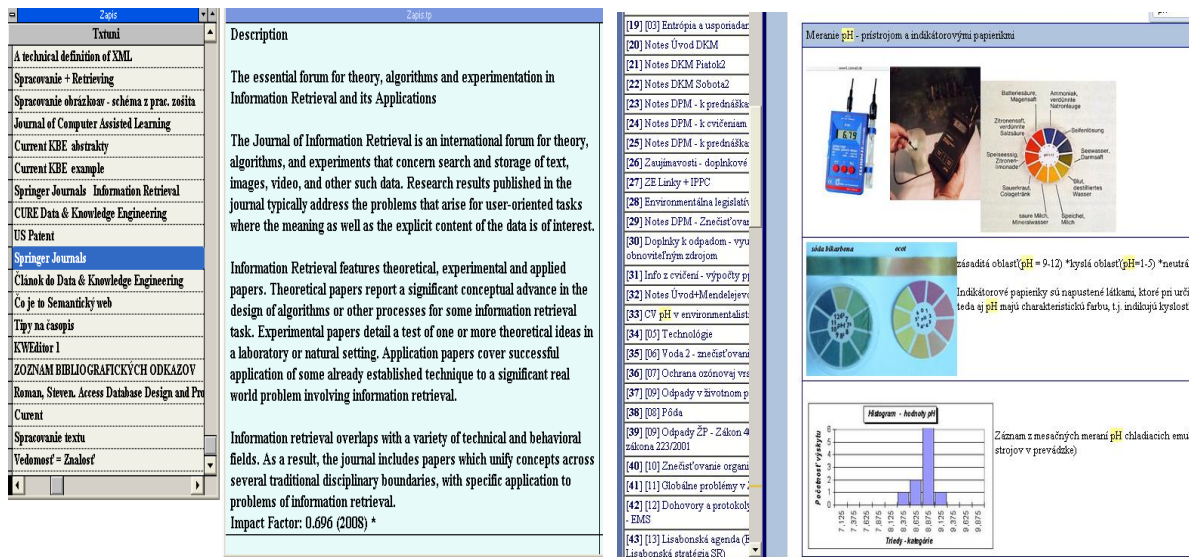


Figure 2: Screen output examples: self – study notes and generated study materials

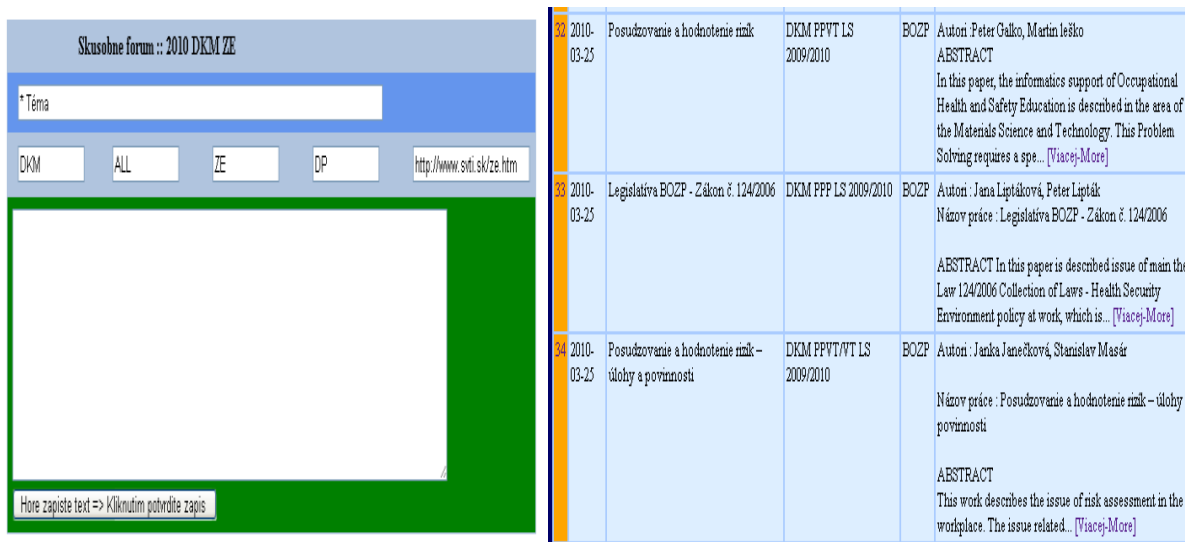


Figure 3: Screen output examples - the internet Forum I

## Conclusion

The purpose of this work was to present experiences with the personalised technology enhanced learning approach which was applied for solving the technology support for engineering education at the Faculty of Materials Science and Technology in Trnava. Technology enhanced learning in the European Union represents one of the relatively newer research priorities in the field of ICT which requires the shared approach by both teachers (engineering / domain content) and ICT engineers (informatics tools). Although only the technology-driven approach is not sufficient without applying in parallel the pedagogical - driven one, as the supporting informatics tools are mostly understood as the so called, Web 2.0 technologies, e.g. Virtual Learning Environments, Learning and Course Management Systems. However, these are internet applications, i.e. they do not work on the teacher's computer but on the internet servers. They do not work by also creating the domain context. In this case, a teacher cannot process or create the teaching and learning materials on his personal computer in a way that is needed, but one must comply with the philosophy of the software and is also forced to work with dozens of various types of software for the support of one's daily activities.

Thus, the result is that there is no known personalised informatics tool for technology enhanced learning in the European Union or at the world market (any freeware, shareware, Open source or commercial software). In this paper the experiences are described, on the other hand, with long-term development of such the personalised informatics tool, i.e. which is tailor made for technology enhanced learning and works as the knowledge editor on a teacher's personal computer (above mentioned BIKE or Writingpad).

The experience with the formulating and solving of the concept for batch knowledge processing is described (e.g. via defining knowledge – knowledge tables – modelling informatics, pedagogical and combined templates /TEL-templates). Furthermore, the principles for the automation of teachers' activities via the knowledge editor are briefly mentioned (developed by one of the authors of this paper). Some experiences from the technology support for engineering education were presented as well as- (courses of study, internet forums, virtual libraries and BIKE applications). The examples of the generated screen outputs (figure 2-3) illustrate a personal knowledge table of the BIKE/Writing pad (the teacher writes there with plain ASCII texts or copies from any e-sources), the other knowledge table converted to html and an internet application due to better feedback with students (passworded teacher forum – bachelor students of a course of study).

In this context, the integrated informatics and educational approach is required - an approach based on batch knowledge processing using the pre-programmed environment which works as the Batch Information and Knowledge editor (BIKE). The implemented TEL approach is explained as the automation of all activities performed by teachers, where knowledge is understood as a key element within the automation. In this context, the principle of batch knowledge processing and the automation of the teacher's activities were briefly mentioned. Some experiences from the technology support for engineering education were presented, and also: courses of study, internet forums, virtual libraries and BIKE applications. In the case of engineering education, the pre-programmed environment serves as a user-friendly personalised informatics tools convenient for technology and supporting all types of teacher activities. The previous results of the FMST SUT showed that the developed TEL approach can be a good starting point for building other personalised applications or for sophisticated systems which are generally rich on information.

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## **Acknowledgement**

This work was supported by the Slovak Research and Development Agency under the contract no. APVV-P01905.

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