

The Educational - Driven Approach for Technology Enhanced Learning

Stefan Svetsky, Oliver Moravcik, Jana Stefankova, Peter Schreiber

Abstract— A technology - driven approach within personalized technology-enhanced learning for the teaching of bachelors was presented in previous contributions to WCECS. The focus was on the building of a supportive infrastructure, the developing of the in-house application BIKE (2010) and on the creation of a set of informatics tools for active learning (2011). In this paper, further progress is presented, where the focus is more on the education - driven approach regarding automation of teaching. When programming technology by the teacher, participatory action research showed that, any excellent technology or knowledge base, would basically be "dead" if the teaching content was not transferable into the classroom. To revive the flow of knowledge the examination of teaching for sequences of steps is required together with content unification and the use of specific communication channels for each of the courses of study. If this all works together, then the teacher can select and mix the content of teaching, informatics tools, communication and didactic elements according to the actual requirements of the teaching process. In our case, this resulted inter alia, in the creation of two innovative teaching methods when teaching "how a writing semester works". This radically helped to eliminate a "plagiarism culture" which beginning bachelor students are not aware of. It seems that after some years, an effective didactic methodology was found for this purpose. Further, technological aspects from the practice of TEL are described with the intention to demonstrate examples of how the teaching outputs are made by the "all-in-one" BIKE (which can cover all main topics of the conference). It also explains the basic principle of how innovative teaching methods can be designed for bachelors from a teacher's point of view when understanding TEL as automation of teaching and learning.

Index Terms—information technology, batch knowledge processing, technology enhanced learning, eLearning

I. INTRODUCTION

Empiric research on computer support when teaching bachelors started approximately around the year 2007 at the Faculty of Materials Science and Technology, this resulted in a step by step approach into the systematic activity. In retrospect with the state-of-the-art, this research was

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Stefan Svetsky. Author is with the Slovak University of Technology - Faculty of Materials Science and Technology in Trnava, Paulínska 16, 917 24 Trnava, Slovakia (e-mail: stefan.svetsky@stuba.sk).

Oliver Moravcik. Author is with the Slovak University of Technology - Faculty of Materials Science and Technology in Trnava, Paulínska 16, 917 24 Trnava, Slovakia (corresponding author to provide phone: +421 33 5511033; fax: +421 33 5511758; e-mail: oliver.moravcik@stuba.sk).

Jana Stefankova. Author is with the Slovak University of Technology - Faculty of Materials Science and Technology in Trnava, Paulínska 16, 917 24 Trnava, Slovakia (e-mail: jana.stefankova@stuba.sk).

Peter Schreiber. Author is with the Slovak University of Technology - Faculty of Materials Science and Technology in Trnava, Paulínska 16, 917 24 Trnava, Slovakia (corresponding author to provide phone: +421 33 5511033; fax: +421 33 5511758; e-mail: peter.schreiber@stuba.sk).

assigned to "technology-enhanced learning" (TEL) and the so called "participatory action research". Moreover, in our case, the teacher is also the designer of technology, i.e. programming codes were operatively written by one according to an actual situation in the classroom.

In previous contributions on the subject of WCECS (2010-2011), methods of solving the personalized approach, in the years 2007-2010, were presented. This was based on a technology - driven approach because firstly it was needed to create a supportive infrastructure (personalized virtual learning space, libraries with engineering content, teaching texts and a set of informatics tools). The key to the solution was the development of a pre-programmed environment called BIKE and its part - the standalone application WritingPad which is installed on computers in the classroom. By this in-house software a specific batch knowledge processing paradigm is performed. This is important because knowledge is the basic element in teaching and learning, e.g. when transferring content knowledge from teacher to students.

When focusing on an education - driven approach in the next stage, a relatively rapid progress was achieved. In this context, some technological and educational aspects are discussed; this relates to computer support of teaching bachelors, this includes a demonstration of solutions from practice. Furthermore, the principle of the automation of teaching is explained in the example of the issue concerning computer support "writing semester works". When teaching content is unified, it significantly helps to automate (computerize) the writing of semester work. This resulted in different innovative teaching methods. In this case a significant role is played by the programming of the communication channels in the so called Forums (this title is better understandable by students). In these channels, teaching instructions and teaching content are incorporated. For example, this enabled one to link a teaching tutorial (written by a student in c++ language) or eLearning manuals (made by students within diploma works) between courses of study and for it to be implemented when teaching bachelors. All of this is demonstrated by the screenshots from the characteristic results of TEL in practice.

The examples presented in the following text were selected with the intention to cover all main categories of the conference topics in order to demonstrate the multipurpose character of the BIKE environment, thanks to the performance of the batch knowledge processing paradigm.

II. APPROACHES AND TERMINOLOGICAL ISSUES

To start at the beginning, the empirical research at the Faculty of Materials Science and Technology on - how to improve basic engineering knowledge, how to enhance writing and language skills of bachelor students by using

computers, all faced large problems regarding terminological and theoretical issues. The research was originally understood as eLearning, then as *technology-enhanced learning* (TEL) because of terminology used within the European Union Seventh Framework Programme (EU FP7) for Research & Development. In the EU FP7 - ICT calls (from 2007), TEL was defined as “how ICT can be used to support learning and teaching and competence development throughout life”. However, this definition is very large and confusing, therefore resulting in different approaches presented in literature.

The typical technology-driven approach is presented, e.g. in [1] – where TEL is understood as an “online facility or system that directly supports learning and teaching” (“Moodle remains the most commonly used VLE platform at a devolved level within schools and departments”) or in [2] – where “Moodle” was evaluated as the mostly used TEL tool in EU universities - this is a so called Learning Management System (LMS), not a teaching tool. The so called WEB 2.0 technologies are often presented as TEL tools; however they are more important from an institutional point of view. Simply said, if you were a teacher and taught in a real classroom, you would very quickly find that they are not suitable for teaching.

In comparison with the state-of-the-art, the BIKE environment also works as a personal system that directly supports learning and teaching. It is a combined desktop and online system, the system which is based on database technology of the nineties; however it has been adapted on actual technologies. It is a type of personalised TEL software tool (work environment), i.e. dedicated to single users – teachers, students and researchers. However, this tool enables a teacher or students to perform many additional activities, which are not possible to make with LMS, e.g. batch internet retrieving, off-line retrieving, generating html-files, launching PHP, creating tutorials, etc. (see the chapter III - IV).

It could help one if any theory of TEL existed. On one hand, there is information science and technology with its own theories and on the other hand, there are learning theories which are significant for teaching. There is not any universal theory, which would show how teachers deal with computer support in the educational sector. This situation also affects the existing terminology. For example in Slovakia, practically all issues are covered with the term eLearning. In other countries “technology-enhanced learning is preferred”. Table 1 illustrates this complication in practice. According to the search result, within academic and scientific literature, the frequency of using TEL is 3 -20 times less than that of eLearning.

Nowadays, the need for an education – driven approach in TEL is more required and emphasised – for instance see the UK’s teaching and learning research programme at <http://www.tel.ac.uk/> for TEL. The significance of educational aspects by using technology are also emphasised, e.g. in the University of Oxford, where in the Programme MSc in Education, the term *eLearning* was substituted by *Learning and Technology* because the title eLearning is “becoming both out-of-date and somewhat misleading” (<http://www.ox.ac.uk/>). The problems with terminological issues also confirm this, such as text from the university’s page: “More recently, terms such as Technology Enhanced Learning and Educational

Technologies have been popular, but the first is somewhat loaded in meaning, and the second too *technologically focussed*”.

TABLE 1
SEARCH RESULTS FOR TWO KEYWORDS (TEL, E-LEARNING)

WEB SEARCH SERVICES AND DATABASES (12.5.2012)	TEL	E-LEARNING
IEEE	195	4 446
SCOPUS	848	16 528
GOOGLE SCHOLAR	30 300	243000
SPRINGER	1 590	12 150
SCIENCE-DIRECT	52 858	529388
WEB OF KNOWLEDGE		
ALL DATABASES	607	12 068
WITH CONFERENCE	592	8 954
PROCEEDINGS	221	2 233
CURRENT CONTENTS		
CONNECT		
WILLEY	913	6 106
SCIENTIA.CVTTISR.SK	16 540	194 282
SCIRUS	1 166 237	3 021 717

In the field of information technology there are many tools at ones disposal. When it come to learning theories, there is also a large system problem due to teaching and learning activities and processes that are not described or standardised (thus, they are unstructured). Paradoxically, in relation to targets to be achieved by technology in teaching, a very good inspiration can be found in previous centuries by Johan Amonius Commenius (1592-1670). This Czech educational reformer, known as the "Father of Modern Education" and religious leader, was remembered mainly for his innovations in methods of teaching, especially languages (see e.g. www.newworldencyclopedia.org/entry/Comenius).

Despite the fact that there are many sources for literature, projects and portals, only some of them are in compliance with TEL when applied to teaching bachelors in real conditions. Especially, Paul S. Goodman’s book *Technology Enhanced Learning: Opportunities for Change* can be mentioned [3]. This excellent book helped us to categorise our research as a form of “participatory action research”, to be used for when a teacher investigates technology in one’s own teaching. In this book, the education – driven approach of TEL is emphasised, as well, basic obstacles are explained when solving technology support because learning and teaching are not described as “if - then” processes. Now, the research on TEL within bachelors study is more systematic and for instance, its strategy is in compliance with opinions of Derry [4] (“demand a turning of attention away from the technology to the knowledge domain, from here to questions of pedagogy and from there one step further, back to epistemology”), Saljö [5] (technology should be understood as a teacher’s partner) or Laurillard’s model of instruction (dialogue between tutor and student is seen as central to learning) [6].

III. TECHNOLOGICAL ASPECTS OF TEL ON EXAMPLES

For the successful use of TEL in practice, it must be at the disposal a suitable technology, e.g. educational software, a set of informatics tools, virtual learning space, etc., including content of teaching in an appropriate form. However, teaching and learning are very sophisticated

activities; thus, one should use many software products to cover all potential activities. In this case, the developed BIKE system is presented as a multifunctional tool, like an “all-in-one” solution [7, 8]. Knowledge is defined in an appropriated way and stored in off-line or online “knowledge tables”. The multipurpose effect is enabled due to the combination of off-line and online database applications by using the as mentioned batch knowledge paradigm which enables the processing of huge amounts of knowledge. It must be emphasized that the database technology of the nineties was adapted to actual internet technologies, browsers and all type of freeware, shareware or open source. This means that the pre-programmed environment does not solve “what can be handled” by other software. Thus, the various compatible browsable outcomes can be simply produced off-line or / and in online mode, according the actual needs within teaching in classrooms. This is illustrated by the following examples from the practice of teaching bachelors by using the personalized TEL approach. To demonstrate the flexibility of the mentioned approach, screenshots were selected according to main topics of this conference.

A. Technology for Instructions – Educational software

The applications within technology enhanced – learning using BIKE were published abroad in the USA, Australia, Asia and the EU ” [9-10]. The presented approach is so atypical that some evaluators evaluated this as knowledge management or a soft computing issue. When using BIKE only for education the pre-programmed environment BIKE works as universal personalised educational software. This means, it enables knowledge acquisition (from WEB or any information e-sources), as well their creation, construction, management, presentation and advanced searching. It is also used as a programming language editor (c++, html, php, prg). For instance, some diploma works were solved by a pre-service teacher who showed that a teacher can use the WritingPad (a part of BIKE installed on classroom computers) as a “teaching tool which generates teaching media tools”, which is due to the possibility to integrate various formats in an interactive way. In this case, some learning materials for WEB based learning were prepared by them, e.g. a manual for Windows7, an information system for cutting tools, descriptions of a set of specific useful informatics skills (how to use Windows safe mode or how to reinstall an operation system, what is ping or how to install a 16-bit application on a 64 bit operating system, etc.).

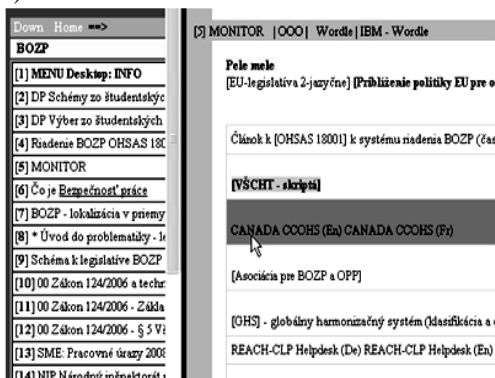


Fig.1. An example of a screenshot from the teaching texts of a course of study

Figure 1 illustrates a screenshot of teaching text for the course of study of Occupational health and safety. On the left scroll menu there are various learning items. On the right (the item Nr. 5), there a student can click on several useful links, e.g. with the arrow to indicate a link to high-quality study material from the Canadian Centre for Occupational Health and Safety (both in English and in French).

Figure 2 illustrates a test of how a hand could be used for the creation of learning material for deaf people in a very simply and quick way. The photos of a sign language interpreter, made by a mobile phone’s camera, show a person communicating “I had a headache”. There is also a sign language template with a static image (top) and a movable image (below) (WEB-page <http://www.svti.sk/DEAF/MILANLP.HTM>).

Boli ma hlava - Ich habe Kopfschmerzen [Bild]

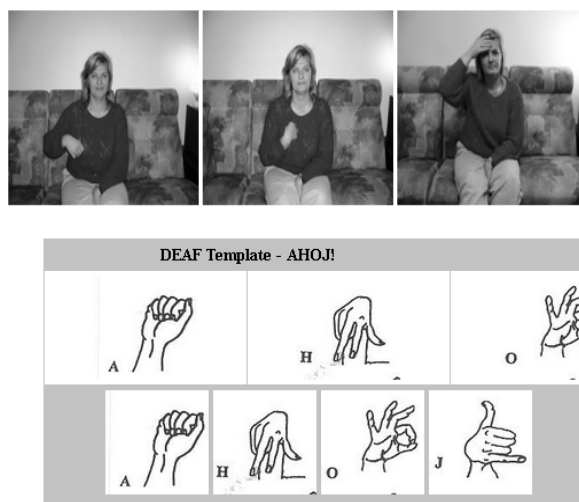


Fig. 2. An example from the designs of learning material for deaf people

B. Digital Libraries, Searching and Information Retrieval, Tools

Fig. 3 illustrates a teacher’s pop-up menu in BIKE with nine items for a personalized advanced search in the stage of design and testing. The items are indicated with ADV (from the arrow pointing in the direction below). For instance, the teacher can search on pages of Cplusplus, Google Scholar, Youtube, W3Schools, About.com directly from the BIKE pre-programmed environment.

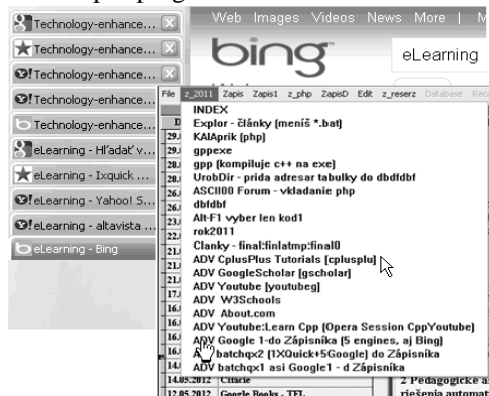


Fig.3. Illustration of batch internet retrieving using five search engines into ten opened windows within the OPERA browser

The last three options are dedicated for batch internet retrieving, e.g. if a teacher or students click on the item “Google 1-do Zápiskníka (5 engines aj BING)” and types one keyword, the result of this search is five opened windows in the OPERA browser by the search engines of GOOGLE, IXQUICK, YAHOO, ALTAVISTA and BING. If a user typed 2 keywords in the WritingPad’s environment then $2 \times 5 = 10$ windows with search results would be opened in OPERA. Other browsers are not suitable for the “multi-window” search. There is a limitation in that if 50 windows are opened they cover the whole computer screen, also if the computer has a low operational memory it would freeze and a reboot would be needed.

Despite the fact that WritingPad enables these batch internet retrievals for bachelor students, this was not natural because they are used to searching directly in Google whilst giving only one keyword. On the other hand, they do not have study courses in English. This is very suitable for PhD. students or for a teacher when writing research paper.

Fig. 4 illustrates a virtual tool – the “chemistry calculatrice” from a personalized digital library. If a student clicks on 33 which is indicated with the arrow (bottom), the top window for calculating the Nernst equation is opened. Students can change values and when clicking on “Chemia” (see the hand) they obtain a result. This is written in the BIKE environment on a teacher’s desktop and php-files are generated and copied on the faculty’s server with the virtual learning space.

$$E = E^{\circ} + (RT/nF) \times \ln c_{Me^{n+}}$$

$$E = E^{\circ} + (RT/nF) \times 2.303 \times \text{LOG } c_{Me^{n+}}$$

pri 25 °C $\Rightarrow E = E^{\circ} + 0.059/n \times \text{LOG } c_{Ag^+}$

Nernstova rovnica pre potenciál elektródy E:

Vstupné údaje výpočtu - zadávajte

Zadaj: E° (napr. Ag=0.773, Cu=0.337)	Zadaj: n (1,2,...)	Zadaj: 0.059 (len pri 25°C!)
0.773	1	0.059

Chemia: Vykonaaj

30	PHP LOG	Kontrola výpočtu E s logaritmom	17.01.2011
31	TERMODYNAMIKA	Termodynamika/Elektrochemia dG° = - nFE°	17.01.2011
33	ELEKTROCHEMIA	elektrolýza - Nernstova rovnica výpočet E	16.01.2011

Fig. 4. Example of the chemical calculatrice

C. Internet-based Education: E-learning

The basic feature of BIKE or the WritingPad is to generate outputs which are browsable with Internet Explorer and OPERA (default). Thus, eLearning materials can be very simply generated by teachers or students (only standard specific skills are required). This is demonstrated in fig. 5, i.e. the eLearning manual for Windows 7 that was made within a diploma work for vocational learning. In this case, the feature “Windows AERO SNAP” is explained. Fig. 6 demonstrates how it looks in WritingPad – this case is from the design of eLearning material for multilanguage support, this was also written in another diploma work.

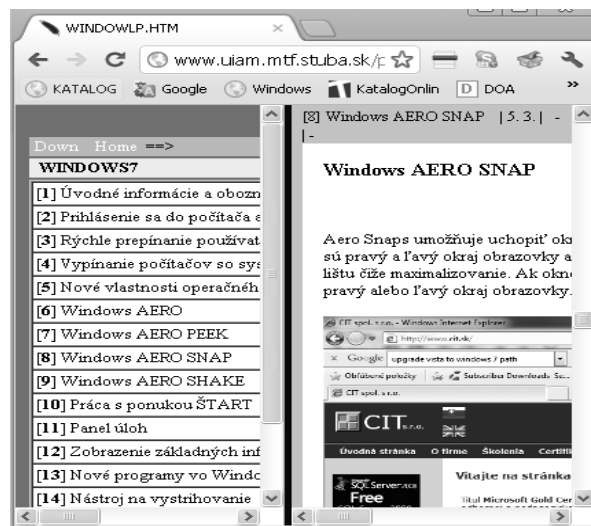


Fig. 5 Screenshot from the eLearning manual for Windows 7

CV_GRAM	Textni	Zapísip
CV_SLOV	[GRAM] Languages Onlin	http://www.weblinguas.com.br/Alphabet.html
CV_VYSL	[GRAM] Cartoon Story Ma	=> Weblinguas :: a project conceived inside CLL - Centro Latino de Liguas
GRAM	[GRAM] Weblinguas	Languages: English - French - Spain - Portuguese
PREK	[GRAM] LANGMaster	WEB - gramar, interactive excersise,
SLOV		
VYSL		

Fig. 6. Example of browsing in WritingPad when preparing eLearning material

D. Educational Issues: Testing and Evaluation

When regarding educational issues, there are a set of tests for the course of study in *Background of environmental protection* written in JavaScript. They are at disposal both online and off-line and are used as a part of the final semester exam. Another way of support is communication channels. This PHP/MySQL application was used by students that wrote the exam directly from the FORUM at the faculty’s server. Fig. 7 is a screenshot from the FORUM, it shows a hand made schema by a teacher. The student’s task was to explain energy aspects of the Ti^{3+} ion spectrum. To use hand written made schemas is very suitable in practice, because this is not time consuming. To simply write schemas, scan them and work them out in WritingPad, this is a very powerful method.

Fig.7. Example of hand written schema in the communication channel during a final exam from a Chemistry course of study

There are many such applications that are beyond the use of this paper. However, it is worth mentioning that there are always some technical limitations in practice, e.g. in relation to power failure, changes of operation systems, servers, etc. (no technology is perfect).

It could also be noted, that from an informatics point of view, all screen outputs are browsable or directed into the BIKE environment. Any data-projector is not used, only computer screens, virtual learning environment with communication channels and a classical blackboard with chalk and paper (students use notebooks and paper sheets).

IV. EDUCATIONAL ASPECTS AND INNOVATIONS OF TEACHING METHODS

If a teacher has at one's disposal the above mentioned support system – virtual learning space, libraries with files and teaching texts, educational software and the set of informatics tools, it becomes very important in how to select a personal didactic approach in practice. For instance, a teacher must prepare various types of teaching, administrative or other appropriated materials. In this context, BIKE or WritingPad enables not only the construction and the creation of teaching and learning content but also allows for an interactive management of various formats.

In real teaching it is fastest and easiest to work with texts, files or partially with images. There are problems with audio and video formats that require long preparation and more specific skills, mainly because they are not in a compatible format and the Internet uses several independent platforms (wav, mp3, wma, mov, mpeg, avi,). Most of these can not be handled as quickly as text, i.e., their use in the classroom is inflexible, and the teaching of bachelors is not usually possible in the one hour time period. A situation in conditions of teaching bachelors from a teacher's point of view is presented in table II.

TABLE II
 SUITABILITY FOR THE CREATION OF TEACHING
 AND LEARNING MATERIAL

	TEXTS	IMAGES	AUDIO
Simplicity of processing	+	+ / -	-
Sending in e-mail	+	+	-
Time for creation	+	+ / -	-
Compatibility of formats	+	+	+ / -
Adaptability for users	+	+ / -	-
Internet browsers	+	+ / -	-

+ suitable +/- suitable with limitation - not optimal

To better explain the complexity of creating teaching material, an example of how to transfer engineering content, with regards to teaching and learning is illustrated in fig. 8. The content from the older book – “French for autodidacts”

by the author Taislova was wrote before the Internet was launched. This book was scanned, text from the image was converted to normal text by OCR software and worked out

by BIKE into browsable html - it was outputted for off-line or online use on the internet.

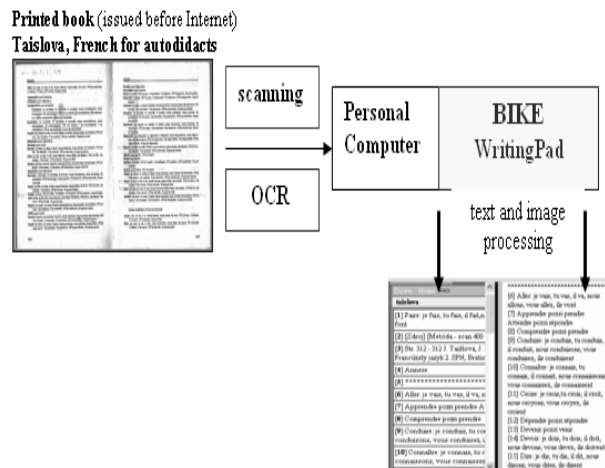


Fig. 8. The example of transferring content from a printed book in French for autodidacts into browsable html - output

In addition, the French texts could be spoken by a computer using TTS technology. Despite the fact, that the TTS French software is disposable, all bachelor courses are only taught in the Slovak language. Thus, this was dedicated for a teacher's self-study.

Here, it must be noted that a teacher usually only has 5 - 15 min. for teaching engineering topics often within the whole semester. Despite this fact, the computer support must be perfectly prepared, due to the time limit, even excellent audio or video material is mostly usable only as additional study material or for self-study. However, it is questionable if it will be used willingly by students. Fig. 9 documents this, as well a typical situation in the classroom.

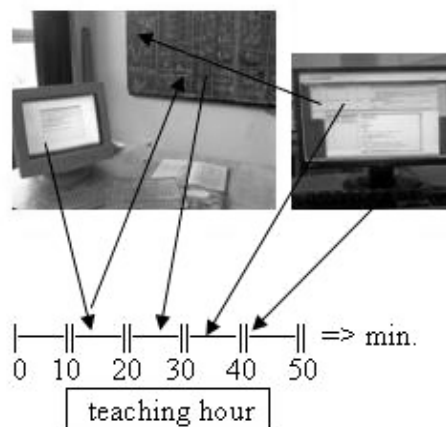


Fig. 9. Illustration of how teaching activities occur during a teaching hour

This illustrates a sequence of steps during a teaching hour, i.e. the teacher had to switch between chemical calculating (off-line – PC left), to writing down results of students on the school blackboard and then comparing this with internet data for the energy of photons (teaching of material in the faculty's virtual learning space).

In this example is very clearly demonstrated that TEL is not any *alternative to classic learning*, but it works as a very useful additional supportive teaching tool. Thus, TEL gives added value to teaching. Fig. 9, however, also clearly

demonstrates that “dead” teaching material stored on the internet or computers must be “revived” by a teacher in the classroom. Hence, by the solving of the education – driven approach for TEL, it was needed to be enlarged by programming the function of the communications channels, known as the so called Forums. This means that the integration of both teaching instructions and teaching materials into these channels was a necessity for each course of study.

One must be aware, that technology was not invented for the support of teaching and learning. Moreover, educational processes are basically not suitable to be supported by computers due to their complexity, variability and non-structured educational activities and appropriated processes. Any technology is not perfect (there is an absence of personalised software, technical problems with huge amounts of formats, hardware, operation systems, as well the PC screen being “too small”). Thus, the teaching and learning processes are not described enough to be automated. This is dialectically in opposition to programming accounting or Internet banking, where elements, structures and processes are strictly stated and unified.

The practice of the participatory action research in TEL, within bachelors’ teaching, found that there are limitations based on institutional or human factors, as well. It was found that bachelor students have not routined skills or enough motivation for progress in their learning. It seems to be mainly evident that:

- they do not have the sense to work with instructions,
- they are not aware of how to work with details,
- they do not know how to communicate with the teacher or between themselves.

This affected all of the research, because despite the extensive progress in the first stage of TEL in bachelors’ study with a focus on the technology – driven approach (2007-2010), the practice revealed that any learning content or any excellent technology is “dead” if the knowledge flow is not working between the teacher and students in the classroom.

It was also found that a significant dependence on the type of courses of study, i.e. computer support of teaching *Chemistry* and *Programming languages* requires the solving of other informatics tasks than that of teaching *Semestral projects* such as the *Background of Environmental Protection* or *Occupational Health and Safety*, therefore, various types of programming codes were written in BIKE’s menu for active learning.

The further solving of the education – driven approach within technology-enhanced learning showed that it is needed to revive the knowledge flow in classrooms and to automate teaching activities. The following three categories of activities (conditions) are needed to be solved:

- a) to analyse teaching activities and sub-activities in classrooms for sequences of steps (this enables the “if – then” solving approach),
- b) to unify the teaching content in order to be more successfully computerised,
- c) to involve the teaching content and instructions into the communication channels of each course of study.

In other words, the *programming of a teacher’s preparation, content processing and communication* must be solved. By fulfilling all these conditions together, the teacher can then select and mix the informatics, learning and communication items. The existing infrastructure enables one to design one’s own didactic approach for the transfer of the knowledge flow in the classroom according to the actual needs of the teaching process. All of this occurs in a operative way and in accordance to the limited range of content (it is limited by the syllabus of a course of study), also, each learning item can be taught only for a limited time, usually tens of minutes during a teaching hour.

Figure 10 illustrates how two innovative teaching methods were created in teaching students when “writing semestral works”. By the modelling of “*Photosynthesis*”, five sub-themes were stated, including the content of chapters. In addition, students were required to prepare a 30 to 60 sec. audio - sequence to be spoken in English by a computer or by a student (using a microphone). Thus, after joining the five stated themes a simple audio - material on *Photosynthesis* was obtained. The results of this “experiment” were very good. In this case, it took five years until the students’ works achieved the appropriate level, especially because a “plagiarism culture” was radically eliminated. Now, this methodology for writing semestral works is at disposal for the next semesters and an additional one for the support of English. Fig. 10 illustrates how to create innovative teaching methods in the future.

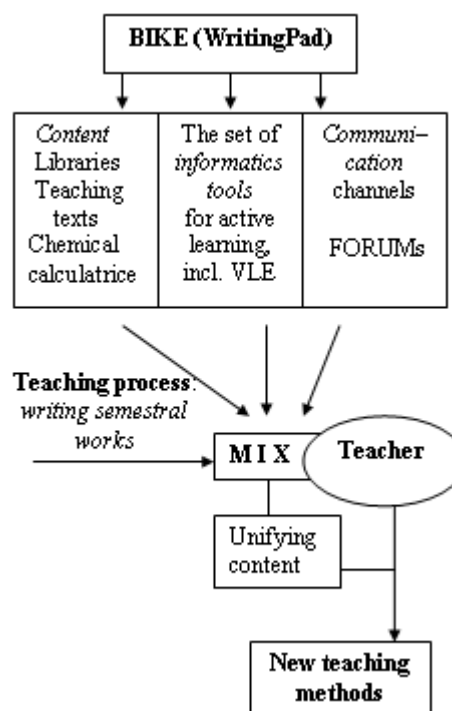


Fig.10. Scheme for the design of teaching innovative methods within TEL

V. CONCLUSION

In this contribution, some technological and educational aspects were discussed, including terminological issues, which were based on the experiences obtained with programming and applying the educational software of BIKE for solving TEL in the teaching of bachelors at the Faculty of Materials Science and Technology. The

technological aspects were demonstrated on the examples related to main conference topics, i.e. Technology for Instructions - Digital Libraries and Learning Objects - Internet-based Education - Educational Issues.

A specific focus was given on explaining the education – driven automation approach for TEL and a need to support the preparation of single teachers. Some limitations for the creation of teaching and learning material were discussed. Furthermore, a focus was given on explaining how to design innovative teaching methods when understanding TEL as any automation of teaching and learning.

In this context, it should also be mentioned that technology-enhanced learning is not an alternative to classic learning. Technology works only as an additional support tool, or a teacher's partner giving added value for face-to face teaching. Now, the challenge for the future is to design and test other didactic methods and procedures, especially when integrating teaching instruction and material into communication channels of courses of study (by involving students to design the teaching material).

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