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FLEXIBLE HYBRID LEARNING: COMPARISON OF TWO APPROACHES AND LEARNING RESULTS

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Abstract

Hybrid learning has become a widely exploited approach within the ICT-enhanced instruction. Making it flexible to students´ individual needs and preferences was the problem solved in various ways at Czech higher education institutions. In the paper two approaches to adapting the learning process to learner´s individual preferences are described comparing two different models of flexible hybrid learning. These models were exploited in educational practice and pedagogical experiments comparing learners´ knowledge in flexible and non-flexible learning were conducted. The results did not proved clearly visible differences in the two approaches, as neither numerous world-recognized researches did. Despite this, authors are persuaded that research activities in this field should go on, paying deeper attention to learners´ personal characteristics and other activities within the learning process.

Keywords

hybrid learning, pedagogical experiment, adaptive environment, flexibility, learning preferences, learning styles

Introduction

The ICT implementation within the Czech higher education system started in 1999 after the new Higher Education Law No. 111/98 Coll., §21b had become effective. The starting phase was closed in 2007 when all (i.e. 26) Czech public universities mentioned the process of ICT implementation in their annual reports. Their approaches to solving this problem were different but the analysis made by the Centre for Higher Education Studies, Prague (2006) mentions that:

- All universities emphasize the use of ICT in the process of instruction and consider it as priority.
- Technical universities, closely dealing with results of technical development, express more keen interest in the field of ICT than non-technical institutions.
- Universities differ in approaching and solving the problem of implementation: technical universities often concentrate on material and technical point of view, i.e. they put emphasis on equipment and its technical characteristics, whereas faculties of education run the slow process, but they pay more attention to didactic aspects.

Within the process of ICT implementation three institutions became the leaders and following two centres were established: (1) at the University of Ostrava (UO) and Technical University of Ostrava (TUO), which formed a joint centre; (2) at the University of Hradec Kralove (UHK), particularly the Faculty of Informatics and Management (FIM), other faculties joined the process later.

At all institutions either fully distance education, or the hybrid (blended) courses to support the full-time and part-time study programs were provided. Moreover, rather wide exchange of experience was running with surrounding countries (mainly the Slovak Republic) and with those being more experienced in this field. This fact resulted in participation in European Union projects, e.g. with Poland, Great Britain, Island, Italy, Finland, Portugal, Netherlands, Germany etc. Since 2000 the eLearning conference and competition have been held at the UHK, hosting participants from the Czech Republic and Slovak Republic, whose papers were published in the conference proceedings and best ICT-supported courses for hybrid and distance education were awarded.

This paper focuses on the problem how the process of flexible hybrid learning implementation ran at the two Czech centres. Two different approaches were applied and two different learning management systems (LMS) were exploited – a university-made LMS tailored to special needs of the institution and designed by university staff was used in Ostrava (Kostolanyova, 2012; Poulova et al., 2013; Simonova and Poulova, 2012) and LMS WebCT, currently called Blackboard, was used at FIM UHK. This study aims at following objectives:

- to summarize main concepts of ICT-enhanced teaching/learning on the basis of literature review;
- to introduce in detail the current concepts of hybrid learning at both institutions;

to present the comparison of research results collected from two hybrid learning processes conducted at two institutions.

Theoretical Background

Various approaches and terms are widely used in this field – hybrid and/or blended learning and web-enhanced or online instruction – depending on the share of information and communication technologies (ICT) in the process of instruction.

A wide consensus has not been made on the definition of hybrid learning which is also called blended learning by some authors, e.g. (Bonk and Graham, 2005; Littlejohn and Pegler, 2007; Whitelock and Jelfs, 2003; Fong et al., 2013). The University of Washington, Bothell, defines blended courses as those where 25 % - 50 % of the traditional face-to-face class time is replaced with online or out-of-class work (Allen et al., 2007) (see figure 1), compared to the Sloan Consortium (2015), which defines the blended learning as a course where 30 % - 70 % of the instruction is delivered online.

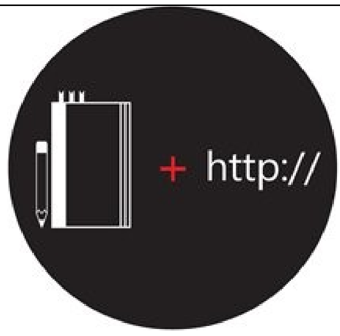
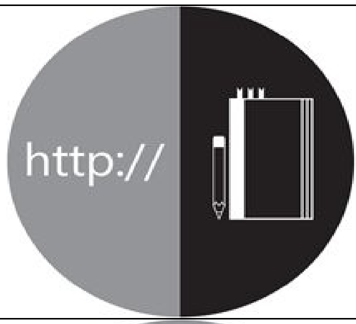
Type of course	Structure
Web-enhanced	
Hybrid	
Online	

Fig. 1: Types of courses

However, as Yamagata-Lynch (2014) claims that there is no agreed percentage of what constitutes a course as blended, and in many institutions there are idiosyncratic definitions of online, distance education, and blended instruction. Nevertheless, reflecting the share of in-class and out-of-class work we can define the blended and web-enhanced courses as those where learners have traditional class hours and use various online sources and tools to support face-to-face lessons (Allen et al., 2007).

As mentioned in several recent studies (e.g. Yamagata-Lynch, 2014; Porter et al., 2013), many more institutions of higher learning are currently showing interest in the official implementation of hybrid learning (e.g. Graham, 2006), as they consider it to be an advantage for their distance learning courses. In such a way universities can be more economical as far as the use of faculty space, time and staff are concerned (e.g. Dziuban et al., 2006). Furthermore, in other research studies (e.g. Garrison and Kanuka, 2004; Graham, 2013) ample advantages of the hybrid learning/teaching were proved, such as learning effectiveness and learners´ satisfaction.

Moreover, the hybrid learning has also undergone a shift from exploiting non-portable (immobile) devices to using mobile ones. In the past the process of implementation in the Czech Republic was limited by the fact that mobile devices were not available to such extent as in the developed countries. However, currently the situation has changed substantially, mobile devices have become available to a large extent and for reasonable prices. Consequently, mobile learning can be exploited at all levels of education Poulova and Simonova, 2012; Roschelle, 2003). Learners using mobile devices all days long for private purposes have been basically literate to use them for education. Before the process of the wide-spread exploitation of mobile devices in education started, several questions had been researched in the Czech Republic focusing on whether students were sufficiently equipped with mobile devices, for what purposes do they use the mobile devices and what is the final feedback. Briefly summarized, the results proved both a wide ownership and exploitation of mobile devices for education and education-related communication (Simonova and Poulova, 2015a).

Above all, another phenomenon is intimately connected to flexible hybrid learning, i.e. tailoring this process to learners´ individual needs and learning preferences. In spite of numerous advantages, there exist several conflicting ideas. Therefore, as widely accepted, teachers should support higher motivation and stimulation with students (e.g. Poulova and Simonova, 2012; Lee et al., 2005). Moreover, hybrid learning might also be tailored to student's learning style preferences; it can offer more interactive ways of learning and almost immediate feedback on students' tasks, assignments or test results. However, the clear consensus on this issue has not been reached (Poulova and Simonova, 2012; Coffield, 2004; Gregorc, 1979; Wakefield et al., 2008). Mismatching in teaching/learning styles can cause a wide range of further educational problems (Felder, 2010). Gregorc (2004) discovered that only individuals with very strong preferences did not study efficiently, the others may be encouraged to develop new learning strategies under the conditions of mismatching. Mitchell (2004) emphasizes making the educational process too specific to one user may restrict the others. Up-to-now only limited number of studies (approximately 50 %) have demonstrated that students learn more effectively if their learning style is accommodated (Coffield, 2004).

The research results in learning styles by the above mentioned authors and many others been taken into consideration, the methodology on how to implement learners´ preferences into instruction was rather deeply worked out. However, Honey was the first one who was asked the question about learning styles in e-learning. After monitoring the likes and dislikes about e-learning in the group of 242 respondents he concluded that their opinions did not differ to such extent he had expected. When drilling down into deeper analysis, another question appeared, i.e. whether people with different learning style preferences had the same things in mind when they signed up for these likes and dislikes. It seemed unlikely to him that e.g. learning 'at my own pace' would be the same for learners with different learning preferences. Honey concluded that despite his initial survey had failed to reveal e-learning styles as such, it discovered some important differences about how people approach online learning. 'One size fits all' has never worked for clothes. Why should it for e-learning?' (Honey, 2010).

In the Czech education environment the Ross and Schulz´s approach (Mares, 1998) and Gregorc´s concept (2004) were applied by Mares for the hybrid learning reflecting learning styles preferences, i.e. four types of websites were designed:

- the concrete/sequencing,
- abstract/sequencing,
- concrete/random,
- abstract/random ones.

Mares (2004) also proposed to adjust the World Wide Web to various learning styles, i.e. to sensory, social and cognitive preferences, and to design:

– the visual Web providing static texts, images, graphs, animations, video-recordings etc.,

– the auditory Web with recordings of lectures, music, discussions,

– the kinesthetic Web providing hands-on activities and practical examples,

– the Web adapted to social preferences reflected in independent, pair or team work.

He also emphasized that for each learner it is important to be aware of his/her learning style, to know the strengths and weaknesses and be provided a variety of instructional methods to choose the most suitable ones (Simonova and Poulova, 2014.

Two approaches to flexible hybrid learning

The history of ICT implementation at the above mentioned Czech institutions (University of Ostrava and Technical University of Ostrava; University of Hradec Kralove, Faculty of Informatics and Management), started at the beginning of 1990s, when shared directories started to be exploited to make study materials available to students, followed by using the e-mail service for communication between students, and students and teachers. Step-by-step other services appeared, e.g. electronic administration of credits and examinations, displaying syllabi, timetables, entrance exams results, university websites were designed etc. In 1997 the first professional virtual learning environment Learning Space was bought by FIM, in 2001 it was replaced by WebCT. At University of Ostrava, the development of LMS Barborka started, been designed by the academic staff.

At the same time first distance on-line courses were designed at FIM within European Frameworks, e.g. Tempus Project MUDILT (Multimedia and Distance Learning for Teachers) or PATTER (Public Administrators´ Training Towards EU), ECDL (European Computer Driving License). Moreover, first projects for university students were conducted, e.g. within the OLIVA Project (On-LIne VýukA, on-line learning); their main objective was to prepare both the teachers and students for e-learning in higher education. First courses were designed for subjects in the field of Informatics, Economy and Management, then in foreign languages, Psychology, Ethics etc. In November 2015 more than 310 courses were available to 5,000 UO and TUO students and more than 250 courses to 2,300 students of FIM. University of Ostrava and Faculty of Informatics and Management also solved several international projects, e.g. on the borderless education, in co-operation with other Czech and international universities (RIUS Project: Run-up of Inter-University Study; IUS Project: Inter-University Study within selected universities in the Czech Republic).

Thus it can be stated that up-to-now both students and teachers have collected rather wide experience in this field. There is no doubt, the information and communication technologies provide a wide range of tools and strategies so that each student with individual preferences can choose from and learn efficiently. The result is that the student satisfied with the process of instruction is positively motivated and able to develop the possibly highest level of knowledge in the shortest time period spending least efforts (Simonova and Poulova, 2014). To reach such a level in the real process of instruction, requirements for optimizing the teaching/learning arose, particularly the call for improving the flexibility of the process, mainly by applying the individualized approach (Poulova and Simonova, 2012).

Model of flexible hybrid learning at University of Ostrava and Technical University of Ostrava

The flexible and personalized education is a current research topic at the University of Ostrava and Technical University of Ostrava where automatic adaptive e-learning model has being exploited. The optimal adaptive process should respect students' differences in learning styles (particularly in sensory preferences in this case) and level of their knowledge and skills (Kostolanyova, 2012). On the basis of identification their personal characteristics and qualities, students are provided such study materials which reflect their learning preferences. For the adaptive e-learning model following students characteristics are monitored:

- sensory perception preferences, covering verbal, visual, auditory, kinesthetic preferences (the VARK questionnaire by Fleming and Mills was used);
- social aspects, monitoring learner´s preferences in individual, pair, or team work (the Learning Style Inventory by Dunn and Dunn was applied);
- affective aspects, particularly including inner and outer motivation (this feature was monitored by the Dunns´ Learning Style Inventory);
- learning strategies, i.e. whether learners prefer
  - system or free work (the Inventory of Learning Style by Vermunt was exploited),
  - theoretical deductions or experimenting (the Inventory of Learning Style by Vermunt was exploited),
  - analytic or holistic processes (the Thinking Style Inventory by Sternberg and Wagner were applied),
  - deep, strategic or shallow learning (the Approaches and Study Skills Inventory for Students by Entwistle was used).

Out of all above listed questionnaires the Dunns´ Learning Style Inventory was the only one which had been translated to the Czech language and gone through the process of standardization; the others were translated and piloted by 200 students of University of Ostrava and Technical University of Ostrava. Then, further activities were applied within the process of adaptive learning:

- students were provided the introductory information and practical training on how to study in online courses so that their preferences were accommodated (in this phase adequate learning strategies were also provided to students);
- the pre-test was applied to detect learners´ starting knowledge before studying the adaptive e-learning course;
- the VAKR questionnaire was applied to detect learners´ preferences;
- the adaptive online course for learners with visual, auditory and kinesthetic preferences was designed;
- the process of teaching/learning was conducted (adaptive materials were used in the phase of independent out-of-school learning, i.e. homework);
- the post-test was applied detecting students´ knowledge after the process of instruction and home preparation exploiting the adaptive online course;
- learners´ final feedback was collected.

The adaptive personalized instruction is directed by the expert system (Kostolanyova, 2012), the schema is displayed in figure 2.

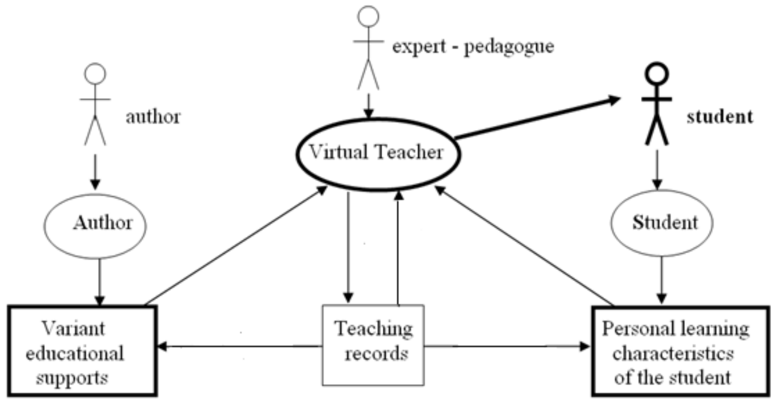


Fig. 2: Model of adaptive personalized instruction (designed by authors)

The system consists of three parts: Student, Author and Virtual Teacher. The process is student-centred.

Various types of information are required about the ´Student´ relating to the starting knowledge and learning preferences – both fields are tested before the process of adaptive learning starts, as described above (Kostolanyova, 2012).

Students with verbal preferences

- are disturbed by useless information, non-relating to the topic, within teacher´s lecturing;
- prefer independent study from books to all other teaching methods, only ´computer´ is accepted as a source of information;
- understand more from the text materials;
- always lack something important from teacher´s speech;
- like attending libraries and reading rooms;
- are not disturbed by anything when reading;
- are able to easily distinguish meanings of similar words;
- like puzzles and word games;
- can read for hours without being tired.

Students with visual (graphic) preferences

- understand more, if working with images, schemas, animations, maps, diagrams, figures, but also with tables, they use graphic tools as arrows, circles, hierarchies;
- like writing notes and highlight important parts of the text in different colours which help them remember the content. It can be summarized that they
- remember more from written notes and texts;
- keep attention for a longer period when watching, observing the speaker, situation;
- need a quiet place for work, music or noise disturb them;

- recall whole pages of texts, including colours emphasizing important parts;
- need to write notes when learning;
- sometimes do not understand and miss the point of speech;
- draw something on the paper during listening;
- have problem to keep attention in lectures;
- are influenced by surrounding colours during their learning.

Students with auditive preferences

- often speak aloud when learning;
- prefer listening to lectures, group discussions, tutorials, recordings, using mobile devices for communication;
- remember more when listening the learning content;
- do not solve problems not by thinking but speaking about them;
- do not have their written notes well-arranged;
- do not like to follow written instructions, they prefer oral ones;
- like to listen to music when learning;
- feel their eyes are quickly tired, despite they do not have any eye problems;
- sometimes confuse letters when reading;
- sometimes do not understand the body language.

Students with kinaesthetic preferences

- prefer manipulating with things, walking when learning;
- prefer practical experience, or at least examples, training, simulations, demonstrations, case studies;
- start solving the task before reading instruction;
- are not able to sit at the desk;
- watch the sample and then do it themselves;
- apply the trial – error method;
- like reading when e.g. cycling on the stationery bicycle;
- often make breaks when studying;
- often use body language and gestures;
- remember more when rewriting their notes;
- like sport activities and are good at sports in general.

Student´s characteristics also include

- social aspects, i.e. preferences to working and learning alone, in pairs, groups;

- affective aspects, i.e. incentives to inner and outer motivation, so that to detect whether they are motivated, neutral non-motivated because of lack of interest, responsibility, not understanding the learning content, or from other reasons;
- learning tactics which reflects learner´s preferences in
  - been directed, or free in learning,
  - ways of processing information (theoretical, or experimental),
  - processes of information processing (wholistic, or detailistic),
  - approaches to information processing (deep, strategic, shallow, pathologically shalow);
- regulation of learning (undirected, directed, shared direction, free direction, self-regulation).

The *´Author´* works as a modifier of student´s learning; data in this part of model are exploited for designing such study material which reflect learners´preferences. Two main aspects were taken into account: didactic principles defined by Gagné (1975) and Comenius (1948).

If the Gagné´s approach is applied into the adaptive learning process, following structure is formed (table 1):

Principle	**Reflection into the adaptive study material**
Attract learner´s attention.	motivation part
Inform learners about learning objectives.	definition of learning objectives
Recall previous knowledge.	testing the starting knowledge before the adaptive e-learning
Present the learning content.	theoretical part of study material
Guide the learner through the learning content.	explanatory part of study material
Initiate and encourage learner´s performance.	practical examples
Provide feedback.	self-testing, questions, answers, practical examples
Evaluate the performance.	results of tests, key to problem solving
Improve the saving knowledge in memory, make conditions for transferring the knowledge	fixation of knowledge, revision, practising

Tab. 1: Application of Gagné´s didactic principles into adaptive learning materials

From the didactic principles defined by Comenius five ones were applied in the process of adaptive learning, as presented in table 2.

Tab. 2: Application of Comenius´ principles into adaptive learning materials

Principle	**Reflection into the adaptive study material**
Clearness	multimedia components included in learning materials
Awareness	motivation to studying, emphasizing the exploitation of knowledge in practice
Systematicness	continuity of previous and new knowledge
Adequacy	reflecting the learner´s age and previous level of knowledge, small steps, feedback
Retention of knowledge	setting the learning objectives, meeting learner´s professional needs, practising the new knowledge and application in practice

Moreover, the Bloom´s taxonomy of educational objectives was applied within the design of the process of learning, as well as recommendations by Tollingerova within the taxonomy of tasks (Kostolanyova, 2012).

Finally, the third part of the model, the *´Virtual Teacher´,* reads information about the student´s learning preferences, level of knowledge, and has also available various types of learning materials. Considering all these data, the ´Virtual Teacher´ recommends provides the ´Student´ the optimal way of learning. Within this step pedagogic rules and didactic principles are also taken into account; the final process of learning is really individualized, i.e. tailored to student´s needs and preferences.

Model of flexible hybrid learning at University of Hradec Kralove

The approach to flexible hybrid learning conducted at FIM, UHK reflects the theory of learning styles by C.A. Johnston. She partly agrees with works by Piaget, Jung, Skinner, cognitive psychologists etc., i.e. with the tripartite theory of the mind – feelings, thoughts and behaviour. They are expressed in the processing self (i.e. cognition), performing self (i.e. conation) and developing self (i.e. affectation). Johnston describes the whole process of learning as a combination lock, where the cognition (processing), conation (performing) and affectation (developing) work as interlocking tumblers; when aligned they unlock individual´s understanding of student´s learning combination. The will lies in the center of the model, and interaction is the key. She also compares human learning behaviour to a patterned fabric, where the cognition, conation and affectation are the threads of various colours and quality. It depends on the individual weaver (learner) how s/he combines the threads and what the final pattern is (Simonova and Poulova, 2012).

Johnston designed the Learning Combination Inventory (LCI). It focuses not on the product of learning, but on the process of learning, i.e. on how to unlock and what unlocks the learner's motivation and ability to learn. Respondents´ answers to the questionnaire form the schema (pattern) consisting from four categories (Johnston, 1996):

1. Sequential processors, who are defined as the seekers of clear directions, practiced planners, thoroughly neat workers. They expect teachers to make sure all instructions are clear and were explained step-by-step, provide a model, or an example, repeat the instruction appears more times, provide students enough time, do not change instructions,

display the content structure of expected outcomes, use numbering within the structure, procedure etc.

2. Precise processors, who are identified as the information specialists, into-details researches, answer specialists and report writers. They appreciate if teachers provide references to other, more detailed sources, more detailed information on instructions, work etc., provide students with detailed notes on everything what you say, pay attention to both the providing information and finishing student's work.
3. Technical processors, who are the hands-on builders, independent private thinkers and reality seekers. They work well if teachers make sure the student understands the consequences if he does not follow the instructions, perform the hands-on activities relating to the field, let students learn in the hands-on way, apply problem-solving and immediate evaluation of the activities, accept the trial-and-error approach, students will not take notes, and then they will need your advice and support to fulfil the expectation (i.e. assignment) in the paper form.
4. Confluent processors, i.e. those who march to a different drummer – creative imaginers and unique presenters. They feel free if teachers accept students will not read instructions and follow them, help them understand when their independent work is desired or acceptable, and in what situations following the instructions is strictly required, make sure students know that taking a risk in applying new approaches is appreciated, understand that some students learn more by making mistakes, discuss possible ways of doing activities and reaching targets, detect some students will have the same problems for several times, accept some students will have more ideas and consider more approaches, which may look like they are not able to finish the work and keep the deadline.

To summarize the most frequent responses, students of all types of processors do not like to be disturbed from work, and being short of time, they would like to have entertaining environment at schools, select such ways of evaluating their knowledge which do not stress but motivate them to further study.

Data collected from the LCI were exploited by the e-application which matched appropriate types of study materials to individual student´s learning style pattern. Then, the e-application reorganized the Course Content page of the online course, i.e. where the most appropriate types of study materials were listed. Learners had each topic of the learning content available in six forms:

─ full texts presenting detailed information;

─ short texts structured for the distance form of education,

─ PowerPoint presentations;

─ animations;

─ video-recorded lectures;

─ links to additional sources.

The LCI data were sent to the e-application in the form of four figures describing each learner´s preferences, i.e. the combination of the sequential, precise, technical, confluent learning preferences which formed the individual pattern of each learner. Each of six types of study materials was classified by four figures (-1, 0, and 1) which corresponded to four types of processors preferences (Sequential, Precise, Technical and Confluent) as follows:

- minus one (-1) means this type of study materials was rejected by the student, as it did not match the given learning style;
- zero (0) meant the student neither appreciated, nor rejected, but accepted this type of study material;
- one (1) meant this type was appreciated and matches the student´s learning style.

After the appropriateness of each type of study materials was evaluated for a single type of learning styles (Sequential, Precise, Technical and Confluent) and the individual student´s learning style was detected by LCI, all data were processed by the e-application and the Course Content page was restructured for each student reflecting his/her individual learning preferences. On this individualized page of Course Content the e-application placed various types of study materials – those which were most appropriate to student´s learning preferences were located on the top left position, those which were rejected were situated below them. Above all, the preferred types were highlighted in colour and size of the pictograms, as displayed on figure 3.

The e-application (plug-in) was implemented in the JavaScript language and inserted in the e-course directly in the source form to the Heading of the introductory page. The plug-in was activated in the student´s browser at each access to the Course Content page, and it accomplished following sequence of activities (Simonova and Poulova, 2012):

- It hides the Expand button of the Course Content in Student view of the e-course so that the student is not able to access the Course Content tree; the entire tree is not adjusted to the student´s individual learning style and contains the numeric classification of various types of study materials and other activities and tools.
- Applying the inquiry it detects the student´s ID.
- Applying the inquiry it uploads data containing classification of single study materials according to their suitability to each learning style and the evaluation (i.e. pattern) of the logged-in student according to his/her user name.
- Applying the inquiry it uploads the tree of links to single types of study materials.
- Having evaluated each type of study materials to a single learning style, and detected the individual student´s learning style, it considers and counts the adequacy (appropriateness) of the item to the learning style within the topic.
- Finally, it re-organizes the Course Content page according to the provided data and displays a newly arranged page instead of the original one.

The data should be taken from a spreadsheet, e.g. in MS Office Excel, in the CSV format, separated by semicolon. For the purpose of the Student view of the e-course the user name of each student is required to be included in the "studenti.csv" file.

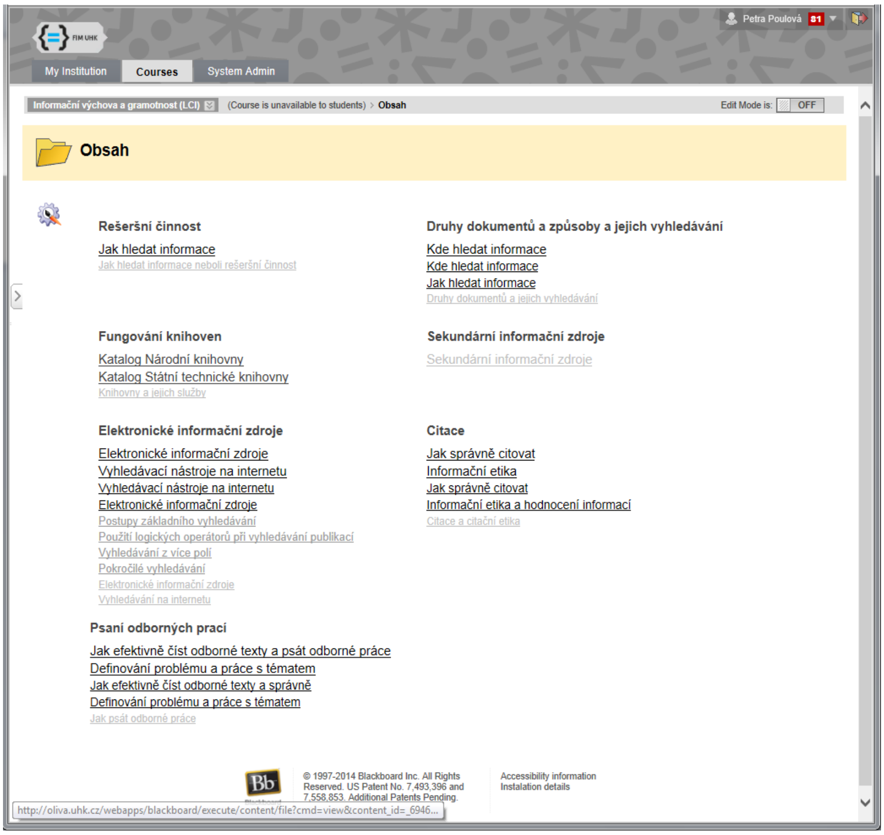


Fig. 3: Individually reorganized Course Content

Flexible hybrid learning in practice

The research on verification of both models of flexible hybrid learning by the method of pedagogical experiment was conducted in 2013/14 academic year. It followed the ´pre-test – instruction – post-test structure´. The main research objective was to answer the above mentioned question, i.e. whether students learn more if the hybrid process of instruction is tailored to their learning preferences.

Research design and results at the OU and TOU

The online hybrid course of English for Specific Purposes (ESP) was exploited for the research. Students attended two lessons per week (90 minutes), having adapted materials available in the online course for out-of-school autonomous learning.

Totally 40 students participated in this research. Students were randomly divided in two groups:

– experimental group (FEI-VAK), where the adaptive hybrid learning was applied;

– control group (FEI-CON), where no learning preferences were reflected.

The process of instruction followed the schema displayed in 3.1. Collected results are displayed in table 3 and figure 3.

	Pre-test		Post-test	
	FEI-CON	FEI-VAK	FEI-CON	FEI-VAK
Mean	5.004	5.964	7.569	8.730
Min (out of 10)	2.5	2.5	3.5	7
Max	6.5	8	9.5	10
Range	4	5.5	6	3
SD	1.37692	1.45281	1.72763	0.83142
Median	5.465	6.035	8.010	9.100
MC Sig. (1-tailed)	0.021 (Sig.<0.05) = R		0.009 (Sig.<0.05) = R	
Z-value	-2.002		-2.449	

Tab. 3: Statistic results: University of Ostrava and Technical University of Ostrava (F=0.05; FEI-CON: control group; FEI-VAK: experimental group; MC Sig: Monte Carlo Significance Test; R: H0 rejected; H0: There is no statistically significant difference between the experimental (FEI-VAK) and control (FEI-CON) groups.)

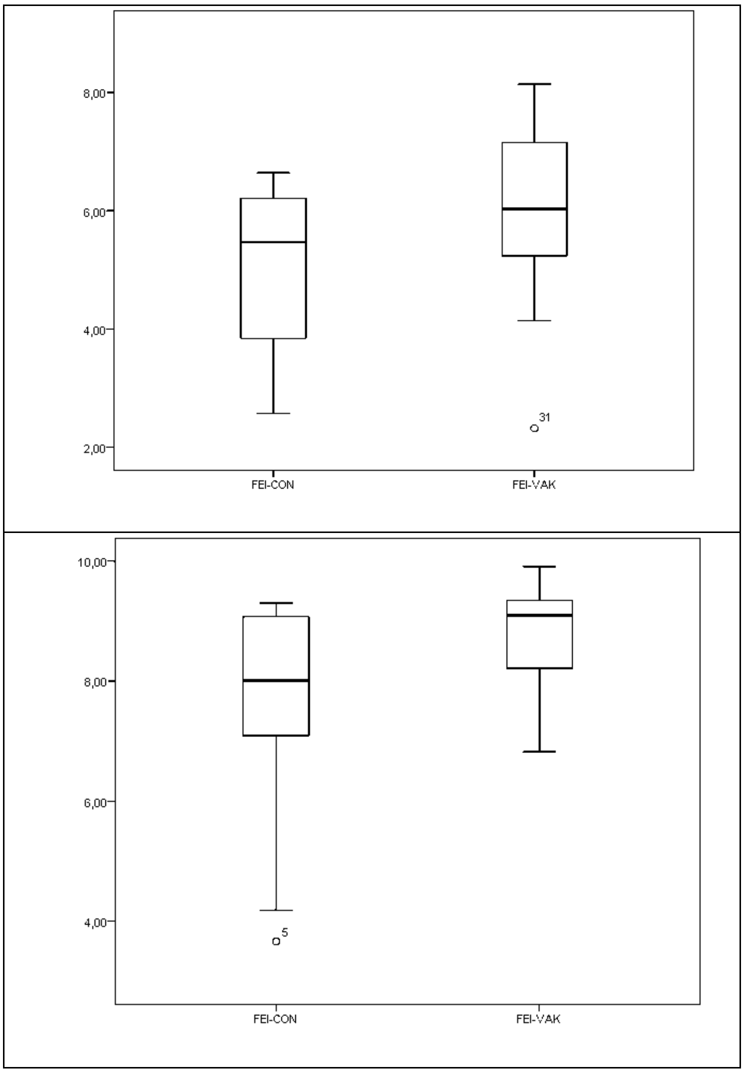


Fig. 3: Statistic results: University of Ostrava and Technical University of Ostrava

Results did not show statistically significant differences but following findings were discovered:

- both groups reached statistically significant improvement on 0.05 level (i.e. in-crease in knowledge (2.766 points in FEI-VAK group and 2.565 points in FEI-CON group; maximum score was 10 points);
- in the experimental (FEI-VAK) group the range of test scores in post-test was lower compared to pre-test;
- both groups reached rather high test score in post-tests (8.7 in FEI-VAK and 7.6 in FEI-CON);
- above all, the FEI-VAK post-test box illustrates that the adaptive hybrid approach had positive impact on learning in FEI-VAK, as the range of test score decreased compared to pre-test (bottom figure in fig. 3) and the group was more homogenous compared to the pre-test level of knowledge (upper figure in fig. 3); and, the increase in test score was higher with students who reached weak results in pre-test.

Moreover, following three aspects were important for further data processing:

- statistically significant differences were discovered between the pre-test and post-test scores in the experimental and control groups,
- normal data distribution was not detected,
- amount of participants in both groups was low (20 in each group).

These were the reasons why data were further tested by Kendall correlation coefficient. The results are displayed in table 4.

		Pre-test results	Post-test results	Increase
FEI-CON	Pre-test	1.000	0.497**	-0.106
	Post-test	**0.497****	1.000	0.400*
	Increase	-0.106	**0.400***	1.000
FEI-VAK	Pre-test	1.000	0.645**	-0.730
	Post-test	**0.645****	1.000	-0.366*
	Increase	-0.730	**-0.366***	1.000

Tab. 4: Comparison of increase in test scores (* correlation is significant at the 0.05 level (2-tailed) ** correlation is significant at the 0.01 level (2-tailed). The ´Increase´ was calculated as post-test minus pre-test result)

In the control group (FEI-CON) the statistically significant *positive* correlation was detected between the pre-test and post-test results (0.497) and the post-test and Increase results (0.400). In other words, students having higher per-test score also reach higher post-test score. *The difference between weak and excellent students was growing in the control group where no adaptation to learner´s sensory preferences was applied in the process of instruction.*

In the experimental (FEI-VAK) group the statistically significant *positive* correlation was detected between the pre-test and post-test results (0.645). The state is identical to the control group - students having higher per-test score also reached higher post-test score. But, strong *negative* correlations were detected between the post-test and Increase results (-0.366), as well as between the pre-test and Increase results (-0.730). In other words, the weak students with lower scores in pre-test reached higher increase in final knowledge compared to those with higher pre-test scores. The difference between weak and excellent students is slightly decreasing in the experimental group *where the adaptation to learner´s sensory preferences was applied in the process of instruction.*

At first sight, this result might lead us to conclusion that students with advanced knowledge (i.e. with higher pre-test scores) do not reach much development within the process adjusted to their learning preferences. This conclusion is not correct because the maximum score in the test was 10 points; students with high pre-test scores do not have enough ´space´ to show their complex knowledge (this is not the objective of testing) – the test limits are restricted to the level of knowledge required by the syllabus. Reflecting this fact we can conclude that students in the experimental group (FEI-VAK, exploiting the adaptive online course) reached better knowledge compared to those in the control group FEI-CON) who studied in the ´standard´, non-optimized one. Moreover, not only the increase in knowledge but also *acceleration* in learning with originally weak students was detected in the experimental group (table 4).

Research design and results at UHK

For the purpose of this research the online course Library services – Information competence and education was designed. Identically to the previous research, the method of pedagogical experiment was applied, and the ´pre-test – instruction – post-test´ structure was also exploited. The hybrid process of instruction included the face-to-face lessons (identically with the previous research 90 minutes per week) supported by independent study in the online course to fix and practice the learning content, develop new knowledge and be able to apply it in practice.

The sample group consisted of 324 students of University of Hradec Kralove. All students were randomly divided in three groups, each of them studying one of three versions of the same online course. The online course was provided in three versions:

1. reflecting the learner´s style (experimental group 1, online course LCI, n = 108) where the e-application was used to tailor the course;
2. providing all types of study materials to the learner; the process of selection is the matter of individual decision, the choices were tracked and compared to the LCI group (experimental group 2, online course CG, n = 103);
3. reflecting the teacher´s style (control group, online course K, n = 113) where the course was designed according to the teacher´s style of instruction.

Unfortunately, no statistically significant differences were discovered in learners´ performance in any group and test. The mean values and test scores in LCI, CG and K groups in pre-tests and post-tests are displayed in table 5 and figure 4.

	Pre-test			Post-test		
	CG	K	LCI	CG	K	LCI
Mean	22.61	22.48	22.46	26.34	25.42	26.10
Min	6	13	6	14	12	14
Max	28	28	28	30	30	30
Range	22	15	22	16	18	16
SD	3.62	3.73	3.98	2.98	4.13	2.42
Modus	24	23	-	28	28	28
Median	24	23	23	27	27	27
t-test	-0.2506 (crit. 1.9706)		-	-1.8953 (crit. 1.9706)		-
	-	0.0366 (crit. 1.9704)		-	-1.4987 (crit. 1.9704)	
K-S test	0.16648 (crit.0.086)	0.16629 (crit. 0.08)	0.14513 (crit. 0.084)	0.18753 (crit. 0.086)	0.17832 (crit. 0.08)	0.16228 (crit. 0.084)
Z-value	0.3717=NR		-	1.5995 = NR		-
		0.1826=NR		-	0.1863 = NR	

Tab. 5: Statistic results: University of Hradec Kralove (NR: H0 not rejected)

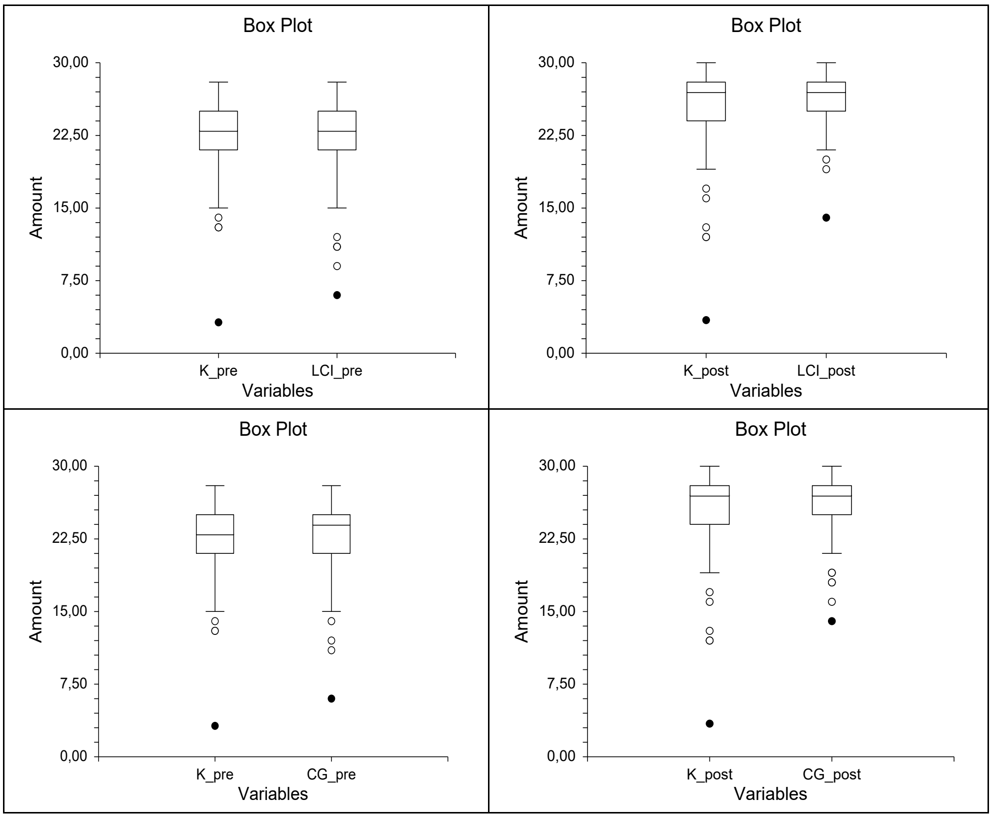


Fig. 4: Comparison of pretest and posttest test scores in LCI/K (left) and CG/K groups (right)

This result was surprising and rather disappointing for the research team. Reflecting the research results of authors mentioned above, e.g. Honey (2010), Simonova and Poulova (2012) and others) we expected, if not significant, some larger differences would be detected in the LCI group where the face-to-face learning was supported by the online course reflecting students´ learning preferences. Above all, in other researches dealing with hybrid learning which had been conducted at FIM the statistically significant differences were discovered in favour of hybrid learning, e.g. Frydrychova Klimova and Poulova (2014).
Reflecting this result, the follow-up research was conducted – closer insight in the course was applied and students´ performance was observed under several criteria Simonova and Poulova (2015b). The students´ visit rate to single tools in the course was the main criterion. It is expressed in the frequency of hits in each version of the online course. The data are displayed in table 6 and show that the Course Content was the most frequently exploited tool, i.e. more than 96 % of hits (visits) in this course were to the Course Content), which was not surprising, as study materials were available there. All materials in the Content were also available in the university library but to use those from the course might have been more convenient than borrowing them. Discussion was the second frequently used tool, but number of hits was much lower – about 5 % of students participated in discussions. The reason might have been that current discussions were held on social networks. Other tools were exploited exceptionally only. The highest number of hits made by one student was 235 times per the whole course.

Tool/Group	LCI (%)	K (%)	CG (%)
Announcements	0.76	3.59	1.90
Calendar	0.05	0.22	0.16
Course Content	96.36	89.48	88.78
Discussion	2.38	5.39	8.71
My grades	0.44	1.33	0.44
Total (n)	***5,501***	***2,784***	***4,271***

Tab. 6: Visit rate to single tools

Moreover, differences in access frequency were detected within the 20-day period, when the course was available to students. The total mean frequency was 739.8 hits per day, reaching from 254 to 1,774 hits per day. As expected, the increased number of hits was detected in the last third of the study period, when students intensified their study activities. When considering three periods within the 20-day time (starting period: days 1 – 7, middle period: days 8 – 13, final period: days 14 – 20), hardly any differences in courses were detected in the middle period, whereas increased number of hits was detected in starting and final ones. The data in all three courses show

- 19 – 29 % of hits in the starting period,
- slight decrease in the LCI and K courses and increase in the CG course in the middle period,
- sharp increase in all three courses in the final period; in the CG course the number of hits reached no fewer than 60 % of all hits detected in this course during 20 days. Details are displayed in figure 5.

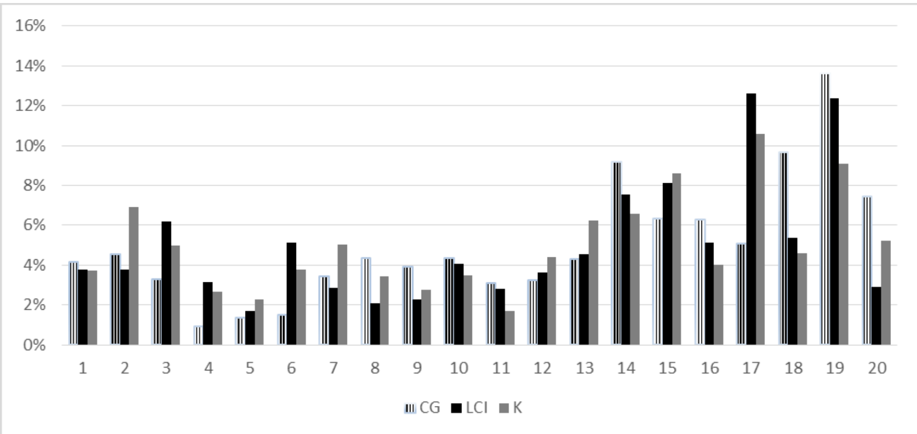


Fig. 5: Absolute frequency of hits per courseday rated to total hits in each course

Conclusions

The main objective of this research was to answer the above mentioned question, i.e. whether students learn more if the hybrid process of instruction is tailored to their learning preferences.

To sum up, within these researches the contribution of adaptive hybrid learning model was detected at the University of Ostrava, but no differences were detected in an increase in learners knowledge in the sample group of University of Hradec Kralove where the process of hybrid learning was detected in three groups reflecting/non-reflecting learners preferences. Being conscious of a small size of the research sample at UO/TOU (n = 40), the results cannot be generated. But, they prove to some limited extent that the model of adaptive hybrid learning can work. Contrary to this, the research sample at FIM UHK was rather numerous (n = 324).

Comparing these results to those reached by recognized teams, they can be considered of the same type – the contribution of flexible hybrid learning was not clearly proved.

Despite all the facts, the information about both approaches to solving this problem may be useful to those who are trying to answer the same questions; consequently, to those who are trying to find other ways to reach the target.

In both solutions ICT was used to design appropriate models of flexible hybrid learning; we consider this to be the right way for further research activities in this field.

The research results show that more detailed analysis of learner´s personal characteristics will be required, supported by their deeper reflection in tools of the hybrid learning process (assignments, tests, communication, schedule etc.).

From the results presented above it can be seen there is no definite solution. It is important for a student to be aware of his/her learning style, know what his/her strengths and weaknesses are and be provided a variety of instructional methods to choose the most suitable ones. In the days of fast technical and technological development, globalization, demand for further, lifelong education, the importance of education is increasing. These terms and conditions support the development of the whole system. Teachers´ and students´ awareness of learning styles and preferences may help substantially.

Last but not least, the development of adaptive learning systems which are able to tailor the process of teaching/learning to learner´s preferences has not been finished. The advantage of above presented approaches is they are currently being exploited in practice. The designers thus have immediate and continuous feedback from several aspects: how students are satisfied with the flexible learning, what their results are, and latest technological findings can be implemented in a short-time period. Despite students also will have different preferences and needs, future technologies are expected to help the field of education. To bring this idea into practice, the Bloom´s *Digital* Taxonomy and Communication was introduced by Churches (2015). This concept arises from the traditional Bloom´s taxonomy of educational objectives. Special attention and column is devoted to the field of Communication which is understood a crucial competence penetrating all teaching/learning activities. The concept provides a wide range of ICT-supported activities which can be used by learners of all styles.

Within the Lower Order Thinking Skills, on the Remember level students mainly focus on retrieval of information using e.g. bulleting to mark key words or phrases for recalling, bookmarking favourite web pages or sites for future use, social bookmarking and social networking, searching (googling) etc.

For the *Understand* level, i.e. interpreting, summarizing, inferring, paraphrasing, comparing, explaining etc. some procedures towards refining the newly developed knowledge can be applied, e.g. blog journaling, twittering. Both techniques can easily move beyond the understanding level to higher ones of the taxonomy if these tools are used to develop greater understanding, or to collaborate with peers, for digital organizing, classifying etc.

The *Apply* level includes implementing and using information, and executing tasks, so examples of students´ active "doing" are provided, e.g. initiating a programme and/or operating and manipulating hardware and software applications, gaming, uploading and legal sharing of materials on a site etc.

Within the Higher Order Thinking Skills, the *Analyze* level involves e.g. mashing ups, where several data sources are melded into a single set of usable information, making links within documents and web pages, but also validating the information, organizing, structuring and attributing online data etc.

The *Evaluate* level refers to verifying hypotheses, experimenting, judging, testing and monitoring, so it is place for providing informed judgments, for blog commenting and reflecting, examining materials in context, testing e-products etc.

On the highest, i.e. *Create* level students focus on designing, inventing, constructing, planning and producing, which includes e.g. finding a technology and applying it in the creative process. It could involve audio- and video-recordings, films, animations, podcasts, creating a programme application or developing a game, which results in creating completely new items.

In the extra column Churches provides the *communication* spectrum of activities from lower to higher levels: texting, instant messaging, e-mailing, chatting, networking, blogging, questioning, replying, reviewing, videoconferencing, skyping, net meeting, commenting, debating, moderating, collaborating etc.

To sum up, Churches´ work gave educators an excellent framework to begin and/or assess their digital practices. All learners, despite what their learning style is, can choose activities matching their preferences.

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