Reflection of Intelligent E-Learning/Tutoring - The Flexible Learning Model in LMS Blackboard

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Abstract. The article encompasses the theoretical background and practical concept of teaching/learning through online courses as an example of smart solution of e-learning system adjusting to individual learning preferences, including students' reflection on the individualized online instruction. First, the 'Unlocking the Will to Learn' concept by C.A. Johnston is introduced and implemented in the research design. Second, the pedagogical experiment reflecting individual learning style preferences is conducted. For this phase of research the e-application was designed which considers learners' individual characteristics and consequently generates the online course content adjusted to them. Finally, learners' feedback after studying in the course is presented.

Keywords: Cognitive modelling · eLearning · Intelligent e-learning/tutoring · Tracking · Ubiquitous environment

1 Introduction

The process of instruction, especially the technology enhanced learning, is highly appreciated by most learners of all age-groups. Fast technical development and new technologies, globalization of the world, the need of unlimited access to education for everybody – these are some of the reasons which enabled and caused information and communication technologies (ICT) were brought to all spheres of everyday life, including the field of education.

Adult students often accept this approach as the only way how to study and work, and reach new competences. The younger the learners are, the more easily they accept ICT in everyday life, including education. Being called 'digital natives' by Prensky [1], they differ substantially from previous generations of 'digital' immigrants. They have not changed their behaviour (slang, clothes, body adornments etc.) only, as it happened between generations before, but a really big discontinuity, singularity was detected with them, caused by the appearance and rapid dissemination of digital technology at the end of the 20th century. As a result of this ubiquitous environment and the sheer volume of their interaction with it, current learners think and process information fundamentally differently from their predecessors and differences go far further and deeper than most educators suspect or realize, Berry states (in [2]): "*Different kinds of*

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experiences lead to different brain structures. ... Today's students' brains have physically changed as a result of the environment they grew up, their thinking patterns have changed".

2 Research Design

This fact provides impact not only on a single learner but the whole education systems are affected, and curricula should reflect this state, particularly in the field of teaching methods where the above mentioned ICT can help substantially.

The question is whether tailoring the process of instruction running within the LMS to student's individual learning preferences can result in increasing the knowledge. To discover this was the main objective of the three-year research on 'A flexible model of the technology enhanced educational process reflecting individual learning styles' which was solved at the Faculty of Informatics and Management, University of Hradec Kralove, Czech Republic.

2.1 Theoretical Background

Within the last two decades the society changed substantially. The information and communication technologies have been implemented in all spheres. The development towards democracy and information and knowledge society transformed the existing structure of the Czech educational system, defined new competences reflected in the learning content, called for new teaching and learning strategies.

The effectiveness of the educational process, been given by such factors as learner's intelligence, prior knowledge, level of motivation, stress, self-confidence, and learner's cognitive and learning style, has been researched by numerous scientists from many countries. It is generally acknowledged that the instructor's teaching style should match the students' learning styles. Felder says that mismatching can cause a wide range of further educational problems [3]. It favours certain students and discriminates others, especially if the mismatches are extreme. On the other hand, if the same teaching style is used repeatedly, students become bored. Gregorc claims that only individuals with very strong preferences for one learning style do not study effectively, the others may be encouraged to develop new learning strategies [4]. Only limited number of studies have demonstrated that students learn more effectively if their learning style is accommodated. Mitchell concludes that making the educational process too specific to one user may restrict the others [5]. The possibility of individualization the educational process from the both students' and teachers' point of view is its greatest advantage [6].

Numerous scientists and researchers have been dealing with the role and impact of cognitive and/or learning styles within the process of instruction, but there are a fewer ones focusing on this field under the conditions of ICT-supported learning. More than a decade ago, Honey was one of those who were asked their opinion on learning styles in e-learning, specifically '*Are there e-learning styles*?' [7]. In 2000 he ran a research to investigate the existence or non-existence of e-learning styles. In the sample group of 242 respondents he indicated their individual learning style preferences and reacted to a long list of potential likes and dislikes about e-learning. Unfortunately, the correlation to the learning preferences did not reveal the significant differences as Honey expected - the likes and dislikes were remarkably similar regardless of learning style preferences [8]. 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 seems unlikely that learning ‘at my own pace’ and ‘when and for how long’ 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?*’ [7]. On the contrary, Honey criticized e-learning industry’s developers and vendors for tending to be didactic rather than involving, preferring to tell rather than ask [9].

2.2 Individual Learning Preferences

Numerous researches have been conducted on how individual learning preferences to be efficiently accommodated. The Learning Combination Inventory (LCI) designed by C.A. Johnston was applied in this research to detect the learning style pattern of each learner [10]. To describe the whole process of learning, Johnston uses the metaphor of a combination lock saying that cognition (processing), conation (performing) and affectation (developing) work as interlocking tumblers; when aligned they unlock individual’s understanding of his/her learning combination. The greater the intelligence, the more a child can learn. She attracts attention to the verb can, as no one says will learn. The LCI consists of 28 statements, responses to which are defined on the five-level Likert scale, and three open-answer questions:

- What makes learning frustrating for you?
- How would you like to show the teacher what you know?
- How would you teach students to learn?

The results are provided in the form of the four-figure score to quantitatively and qualitatively capture a student’s cognitive, conative, and affective interactive learning combination (pattern). In other words, the score represents the degree to which each learner ‘Uses first’, ‘Uses as needed’, or ‘Avoids’ certain type of learning material and learning strategy, i.e. what his/her learning preferences are. Learners’ responses create the schema (pattern) that drives the will to learn. The patterns are categorized into four groups and described as follows [10]:

– *sequential processors*, defined as the seekers of clear directions, practiced planners, thoroughly neat workers;
– *precise processors*, identified as the information specialists, info-details researches, answer specialists and report writers;
– *technical processors*, specified as the hands-on builders, independent private thinkers and reality seekers;

– *confluent processors*, described as those who march to a different drummer, creative imaginers and unique presenters.

The LCI differs from other widely used inventories (e.g. [11, 12]) as it focuses on how to unlock and what unlocks the learner's motivation and ability to learn, i.e. on the way how to achieve student's optimum intellectual development. This was the main reason why the LCI, not any traditional tool was applied for detecting respondents' individual learning styles within the above mentioned project.

2.3 Methodology of Research

The course of research was structured into following phases:

1. Pre-research activities, i.e.
   – Analyzing the "Learning Combination Inventory", translate and adapt it for the Czech educational system. Run a pilot research; consider the results.
   – Designing the online course and pilot it.
   – Preparing and piloting the questionnaire monitoring students' preferences in study materials (Q1), piloting the questionnaire, considering comments
   – Designing an e-application.
   – Designing and piloting the evaluation questionnaire (Q2).
2. Pedagogical experiment.
   – Setting the research sample, experimental and control groups.
   – Applying the LCI and determining students' learning styles.
   – Applying the questionnaire monitoring students' preferences in study materials (Q1), collecting and processing the data; interpreting the results.
   – Specifying the methodology, planning the process of instruction.
   – Designing and piloting didactic tests (pre-test, post-test).
   – Testing the entrance level of students' knowledge by a didactic test (pre-test).
   – Running the multistyle process of instruction.
   – Testing the students' level of knowledge after the instruction (post-test).
   – Comparing the results reached via different learning strategies.
   – Processing the collected data; interpreting the results.
3. Students' feedback after instruction
   – Applying the evaluation questionnaire (Q2), collecting and processing the data; interpreting the results.

Several research methods were applied within the project:

– pedagogical experiment running on the "pre-test – instruction – post-test" structure,
– method of testing knowledge,
– method of questionnaire,
– statistic methods (t-test, Kolgomorov-Smirnov (K-S) test, Mann-Whitney test (Z-value).

To reach the research objectives following research tools were used:

- didactic tests to evaluate students' entrance level of knowledge before the process of instruction starts (pre-test) and students' final level of knowledge after the instruction (post-test);
- Learning Combination Inventory (LCI) to detect students' individual learning styles;
- questionnaire monitoring students' preferences in study materials (Q1);
- questionnaire monitoring students' feedback after the process of instruction (Q2);
- statistic software NCSS 2007 and MS Office Excel to process the collected data.

2.4 Process of Instruction

The process of instruction was held within the online course intentionally designed for this purpose in three versions:

- Version LCI reflecting the learner's style (experimental group 1) where students were offered such study materials, exercises, assignments, ways of communication and other activities which suit their individual learning styles; the selection was made electronically by an e-application which automatically generates the "offer"; this smart solution provides each student with types of materials appropriate to his/her learning style,
- Version CG providing all types of study materials to the learner, the process of selection is the matter of individual decision, the choices are monitored and compared to expected preferences defined by the LCI (experimental group 2).
- Version K reflecting the teacher's style (control group) where participants study under traditional conditions, when their course is designed according to the teacher's style of instruction which they are expected to accept.

The on-line course was designed in the LMS Blackboard. The content focused on library services, which is a topic students have to master before they start studying but they often have hardly any system of knowledge and skills in this field. The e-course was structured into eight parts covering the crucial content, i.e. Basic terminology, Library services, Bibliographic quotations, Electronic sources, Bibliographic search services, Writing professional texts, Writing bachelor and diploma theses and Publishing ethics.

2.5 Sample Group for Pedagogical Experiment

The sample group consisted of students of Faculty of Informatics and Management, University of Hradec Kralove, who enrolled in the online course running in the LMS Blackboard. It was designed as the learning environment so it provides all tools necessary for simulating the process of instruction efficiently.

All students were randomly (by lots) divided in three groups described below.

Nearly 400 respondents started the pedagogical experiment but only 324 finished it, from various reasons. Starting and final amount of respondents are presented in Table 1.

Table 1. Amounts of respondents

Group	Respondents before pedagogical experiment (n)	Respondents after pedagogical experiment (n)
K	130	113
CG	131	103
LCI	131	108
Total	392	**324**

3 E-Application Generating the Course Content

The application (plug-in) supporting the flexible model of instruction within the LMS was designed. Its main objective is to re-organize the introductory page of the e-course where the course content is presented to students. The criterion under which the application worked was the student's individual learning style. Categorization of learner's preferences (i.e. his/her individual learning style pattern) to certain types of learning style, which are mentioned above (sequential, precise, technical confluent processors), are not presented in the binary way (yes/no) but described by the fuzzy value expressing the relevance rate of each learner to a given group. Various types of learning materials are presented in such order which accommodates student's preferences, i.e. the plug-in arranges single items of the course content on the introductory page in such order which reflects the student's individual learning style pattern.

To design the online course reflecting learner's preferences as described above (LCI version), not only data on each student's learning style were required but also single items of the course content were classified according to the suitability (appropriateness) for a certain learning style, i.e. whether the material is preferred, accepted or refused by the student. Then, single types of study materials and activities were matched to each student's learning style pattern and the course was tailored to the individual student's needs. This final phase was carried out by the e-application (plug-in).

3.1 Process of Implementation

The plug-in is implemented as the extension of Building Block type for the BlackBoard Learn system. The administration rights are required for installing the extension in the system. The plug-in is distributed in the form of WAR file and script in JavaScript language. The WAR file having been installed by the administrator, the plug-in is available to course designers to be inserted the Course Content page by Add Interactive Tools. The plug-in creates a course item with static HTML code which contains:

- link to jQuery library hosted at http://ajax.googleapis.com;
- JavaScript code `jQuery.noConflict()` preventing from collision between the Prototype library, internally used by BlackBoard, and the `jQuery` library, used by the plug-in;
- link to `data/script.jsp` file which is part of the `Building Block` (plug-in);
- `HTML DIV` element where the new learning content reflecting learner's preferences is dynamically generated.

A new item `Table of Contents` is added to the main course menu. This item opens the entry page of the course where the plug-in is inserted, i.e. where study materials and learning activities are structured reflecting learner's preferences. Then, the original course content (folders with study materials and activities) is available under another item (Course Content) in the main course.

3.2 How the Plug-in Works

The plug-in is activated in learner's browser after accessing the `Table of Contents` page (where the plug-in is inserted). Then, the plug-in runs following activities:

- it downloads the jQuery library from the Internet (the `jQuery` library supports further activities);
- it downloads the JavaScript code generated by the `data/script.jsp` file;
  - this file generates `JSON` data providing information on the classification of files with learning objects, learner's preferences detected by LCI, evaluation of in/adequacy of learning objects to learner's preferences and adds the JavaScript code read from the `/uhk-flexible-learning/script.js` file within the given course;
- it activates the JavaScript code which calculates the in/adequacy rate of each learning object for each learner reflecting the LCI results;
- generates the `Table of Contents` and displays it in the place of DIV element, i.e. single learning objects (study materials and related activities) are presented in such order which reflects learner's LCI results, i.e. individual preferences.

If in case of error the `Content page` is not generated, the error notice appears.

3.3 Requirements for Plug-in Work

Under the `Control Panel – Content Collection`, resp. Files in the latest version, the `uhk-flexible-learning` folder should be created and the script.js and students.csv files uploaded.

Single topics in the `Table of Contents` are structured into folders, one topic per folder, and the link to each learning object (study material, activity) is included.

Each learning object in the folder is described by four figures of the value of −1, 0, 1 which correspond to four types of processors by Johnston's concept (sequential, precise, technical and confluent) as follows:

– minus one (−1) means this type of study material, activity, assignment, communication etc. is refused, i.e. does not match the given learning style;
– zero (0) is the middle value, i.e. the student neither prefers, nor refuses, but accepts this type;
– one (1) means this type is preferred, it matches the given learning style.

This three-state model could be extended to a wider scale of fuzzy values reflecting the Johnston's model in deeper detail. The above mentioned file students.csv contains the classification of students' individual learning patterns (i.e. fuzzy values reflecting the relevance rate of each learner pattern to a given group of processors – sequential, precise, technical confluent) as displayed in Table 2.

Table 2. Classification of students' individual learning patterns.

User name	Classification 1	Classification 2	Classification 3	Classification 4
krizpa1	25	18	14	20
webct_demo_69259477001	20	12	18	27

Data are taken from the spreadsheet (e.g. MS Office Excel) in the CSV format, separated by semicolon, e.g. `krizpa1;25;18;14;20`.

For designer view the designer user name is included in the `students.csv` file. If missing, the error notice is displayed saying the `Table of Contents` does not reflect student's preferences.

The plug-in requires student access to the Internet so that the `jQuery` library could be downloaded from the ajax.googleapis.com server.

The plug-in was designed for and tested in the Blackboard Learn system, version 9.1 and uses the Application Programming Interface (API) for detecting the Course Content, metadata for learning object classification, student's user name and for reading the `script.js` and `students.csv` files. Some functions of the API are not documented (e.g. reading metadata) and changes in Blackboard version are expected to require modification of Java code using the API.

3.4 Implementation Details

The process of plug-in implementation in the course is structured in several steps represented by activities of single files.

Step 1 is created by `create.jsp`, `create_proc.jsp` and `modify.jsp` files. This step is applied only once, in the moment of plug-in implementation in the course. The `create.jsp` and `create_proc.jsp` files contain codes in Java language which work for creating the above described item `Table of Contents`. Following classes of BlackBoard API are used:

- `Content` – the learning object in the BlackBoard system; the object is always assigned to a given course and it may belong to the folder;
- `FormattedText` – serves for creating the Table of Contents formatted by HTML code;

- `ContentDbPersister` – serves for saving the learning objects.

The `modify.jsp` file displays information the plug-in generated content (`Table of Contents`) cannot be adjusted but deleted if needed.

Step 2 is introduced by `script.jsp` file containing the code in Java language generating the necessary code in JavaScript which is subsequently interpreted by user browser. The `script.jsp` file processes the original `Course Content` and information on the user and generates data in the `JSON` format. The `script.js` file is then appended to the generated `JSON` data to be submitted together to the user's browser.

Compared to the previous version, which was designed for previous generations of the LMS WebCT/Blackboard, the current version is better implemented regarding to API, which was missing in WebCT. Thus the main problem of version 1 was eliminated, i.e. the plug-in dependence on concrete structure of HTML pages, as the Learning Content was detected by parsing HTML pages.

Step 3 works with `script.js` file which contains the main JavaScript code. The `script.js` is a common file saved in the course which can be easily adjusted by course designer so that higher flexibility was reached – if small changes in plug-in functionality are required, adjustments in script.js file are made and the plug-in re-installation is not necessary. The plug-in can be also tailored to the course requirements as each course has its own the `script.js` file.

The key part of the `script.js` file is the algorithm calculating the appropriateness of a learning object for the given student which is based on both the learning object and student classification (LCI pattern). The core of algorithm in JavaScript language is described below:

```
var totalEval = 0;
for (var i = 0; i < topicData.classification.length; i++)
{
    // rejected
    if (userData[i + 1] < refuseValue)
        totalEval += topicData.classification[i] *
                     (userData[i + 1] - refuseValue);
    // appreciated
    if (userData[i + 1] > acceptValue)
        totalEval += topicData.classification[i] *
                     (userData[i + 1] - acceptValue);
}
```

The algorithm in the cycle goes through single values of the given learning object classification in array `topicData.classification` (indexed from 0) and reflecting the `userData` (indexed from 1) it detects for each value whether the student refuses, accepts or prefers material of this type. The threshold values for decision-making process of accepting/refusing the type are saved in constants `refuseValue` and `acceptValue`. The appropriateness value of the type for the learner's LCI pattern is added to `totalEval` value (being 0 at the beginning). The final appropriateness rate is expressed by the `totalEval` variable. Then, the script.js file ranks learning objects in each folder according to the calculated rate and displays them to the student – the preferred types of learning materials and activities are on the top of the list, underlined, written in bold font of large size and black colour. A sample of individually re-organized table of contents is displayed in Fig. 1.

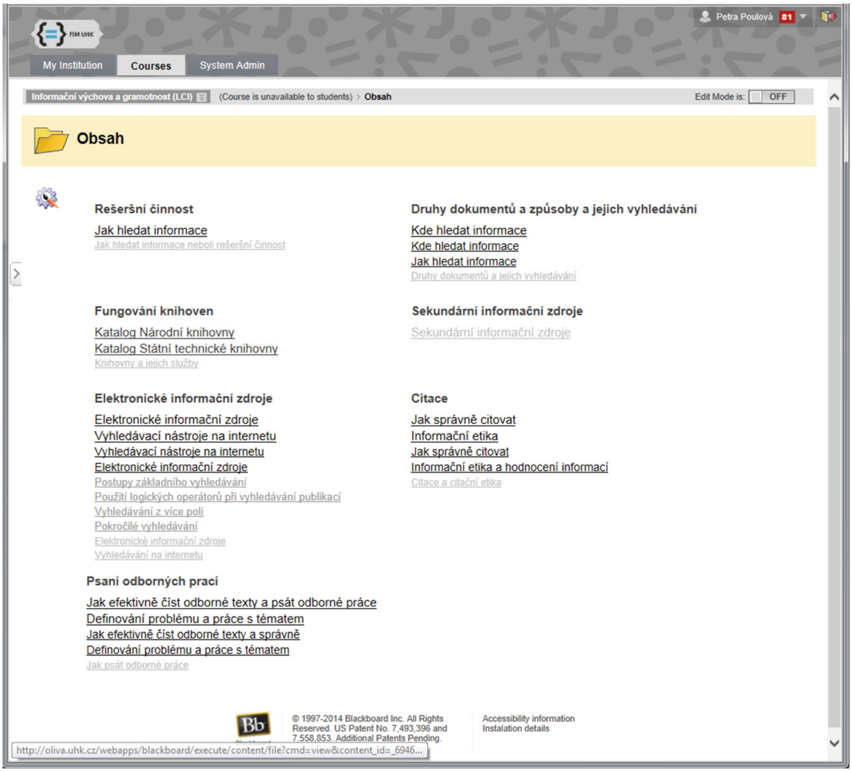

Fig. 1. The individually re-organized table of contents

The `script.js` file uses the `jQuery` library version 1.4.2 mainly for manipulating with the page content. In `jQuery` library the "`$`" function cannot be used as it colligates with the same one in the Prototype library used by Blackboard. That is why the `jQuery` function instead of `$` function is used in the `script.js` code.

3.5 Currently Known Limits and Future Work

While designing the plug-in, several limits have been discovered for the time being. We have not succeed in hiding the item with original course content (which does not reflect individual learning preferences) in the main menu therefore we have renamed it

`Course Content` (as mentioned in chapter Process of implementation) and shifted it on the bottom position so that students did not primarily use it.

Currently the plug-in supports two-level hierarchy of learning objects, i.e. single learning materials and activities are presented in the form of files which are clustered into folders, one folder per topic. The more-level hierarchy requires changes in data structure in `JSON` format (in the `Table of Contents`) generated by the `data/script.jsp` file and in algorithms creating the new learning content reflecting learner's preferences (`Table of Contents`).

4 Research Results

All data were collected within three phases the research were processed by the NCSS2007 statistic software.

4.1 Results in Detection of Individual Learning Preferences

Before the pedagogical experiment started, individual learning style of each respondent had been detected by the Learning Combination Inventory. The structure of research groups from the point of learning style pattern is displayed in Table 2. The groups did not differ significantly, they were considered equal.

Following the research design, individual learning style of each respondent had been detected by the Learning Combination Inventory before the pedagogical experiment started. The LCI results structure of each group is displayed in Table 3 and Fig. 2.

Within the online course various types of learning materials were available to learners. The correlations between single learning style patterns and types of learning materials used in the online course were detected. Results are presented in Table 4.

The results (the recommended value of the correlation is 0.15 min.) show, *sequential* processors mostly use electronic study texts, books and professional literature, video-recorded lectures and presentations; they reject self-tests and other supportive materials, e.g. dictionaries. *Precise* processors work with books and professional literature, animations, examples, electronic study texts and other supportive materials, e.g. dictionary; they do not like video-recorded lectures. *Technical* processors often use animations and video-recorded lectures; they do not work with electronic study texts, other supportive materials, e.g. dictionaries and presentations. *Confluent* processors work with books and professional literature and self-test; they do not use electronic study texts, video-recorded lectures, presentations and other supportive materials, e.g. dictionaries.

4.2 Results of Pedagogical Experiment

The individual learning patterns in three research groups having been detected, the pedagogical experiment started following the "pre-test – instruction – post-test structure". The data collected from didactic tests were applied in the process of verifying hypotheses.

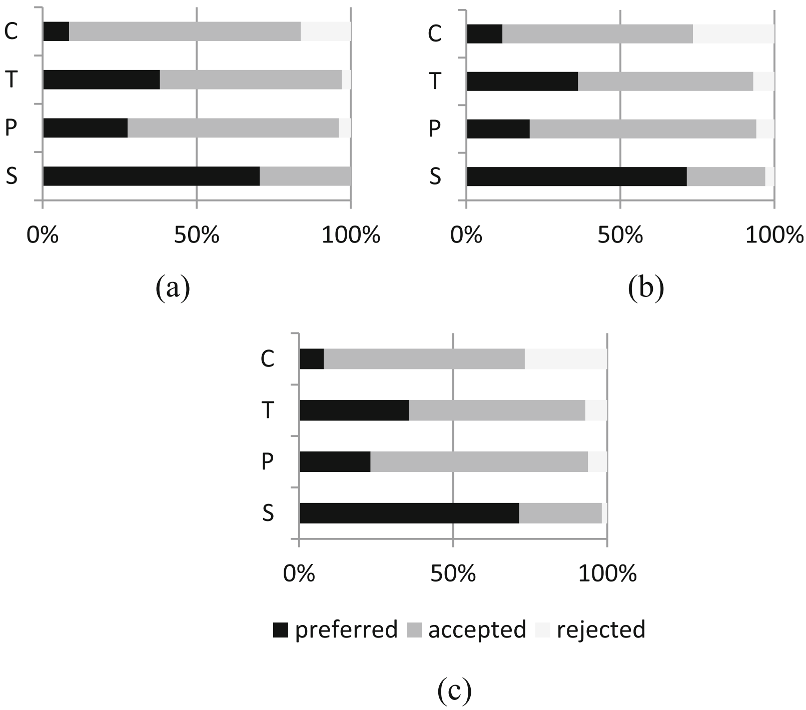

Fig. 2. Learning styles structure in the LCI (a), CG (b) and K (c) Groups

Table 3. Learning styles structure in LCI, CG and K groups

Group/n		Sequential	Precise	Technical	Confluent
LCI 108	Preferred	75	29	40	9
	Accepted	33	75	63	82
	Rejected	0	4	3	17
CG 103	Preferred	76	23	39	14
	Accepted	26	76	59	64
	Rejected	3	6	7	27
K 113	Preferred	80	26	41	9
	Accepted	31	80	64	74
	Rejected	2	7	8	30

Two hypotheses to be verified were defined as follows:

H_1: Students reach higher increase in knowledge if the process of instruction is adjusted to their learning style (LCI group) in comparison to the process reflecting teacher's style of instruction (group K)

H_2: Students reach higher increase in knowledge if they can study independently using all types of provided study materials (CG group) in comparison to the process reflecting teacher's style of instruction (K group)

Table 4. Correlations between types of study materials and patterns

	Sequential	Precise	Technical	Confluent
Books	0.11	0.27	0.05	0.11
Electronic study text	0.12	0.11	−0.18	−0.17
Presentation	0.01	0.01	0.11	−0.10
Video-recording	0.09	−0.03	0.20	−0.16
Animation	0.01	0.24	0.23	−0.02
Self-test	−0.04	0.11	0.12	−0.14
Examples	−0.11	0.00	−0.12	0.09
Dictionary	0.05	0.12	0.02	−0.04

Three statistic tests were applied to process the data collected in didactic tests:

- the parametric equal variance t-test for the normal distribution of data;
- the non-parametric Kolgomorov-Smirnov (K-S) test for different distribution (despite the total distribution of datawas normal, this test was conducted to support those situated close to the margin);
- the Mann-Whitney test for difference in medians (Z-value) was applied. Then, the transformation of means was done, the transformed mean values were compared and proved no statistically significant differences in pre-test performances of the experimental group 1 (LCI group) and the control group (K) and the experimental group 2 (CG group) and the control group (K), so the groups were considered equal. This entitled us to running the pedagogical experiment. Results are displayed in Table 5.

Table 5. Results of pre-tests

	CG	K	LCI
Mean	22.61	22.48	22.46
Min	6	13	6
Max	28	28	28
Range	22	15	22
SD	3.62	3.73	3.98
Modus	24	23	–
Median	24	23	23
t-test	−0.2506 (crit. 1.9706) = NR		–
	–	0.0366 (crit. 1.9704) = NR	
K-S test	0.16648 (crit. 0.086) = NR	0.1662979 (crit. 0.08) = NR	0.1451381 (crit. 0.084) = NR
Z-value	0.3717 = NR		–
	–	0.1826 = NR	

Note: NR: H_0 not rejected

After pre-testing the instruction started in three versions (groups) of the online course Library services – Information competence and education with the face-to-face entrance tutorial and closed with another one where learners' knowledge was tested. The period of study was three weeks of independent study. Students were randomly divided into three groups (LCI, CG, K) which differed in the extent of individualization of the process of instruction. After that, students' final knowledge was tested by post-test. The results are displayed in Table 6.

Table 6. Results of post-tests

	CG	K	LCI
Mean	26.34	25.42	26.10
Min	14	12	14
Max	30	30	30
Range	16	18	16
SD	2.98	4.13	2.42
Modus	28	28	28
Median	27	27	27
t-test	−1.8953 (crit. 1.9706) = NR		–
	–	−1.4987 (crit. 1.9704) = NR	
K-S test	0.1875374 (crit.0.086) = NR	0.1783263 (crit. 0.08) = NR	0.1622858 (crit. 0.084) = NR
Z-value	1.5995 = NR		–
	–	0.1863 = NR	

Note: NR: H_0 not rejected

The collected data underwent the same procedure as the pre-tests did, i.e. the t-test, Kolgomorov-Smirnov and Mann-Whitney tests were used, so that test scores were compared: the LCI group (experimental group 1) to the control group (K) and the CG group (experimental group 2) to the control group (K). Results are displayed in Fig. 3 (K – LCI pre-test upper left; K – LCI post-test upper right; K – CG pre-test bottom left; K – CG post-test bottom right).

The results proved differences neither in pre-tests results, nor in post-tests performance. Thus it can be concluded *no statistically significant differences were discovered in students' knowledge either their learning preferences are reflected within the process of instruction (LCI version), whether they work independently being provided all types of study materials and activities (CG version) or the process follows teacher's style of instruction (K version).*

4.3 Results in Respondents' Evaluation of Online Study

The pedagogical experiment having been closed, the final evaluation questionnaire (Q2) was applied to collect data on students' opinions and experience from online learning in the course they attended. The questionnaire consisted of 22 items which monitored both the learners' didactic experience and technological problems the

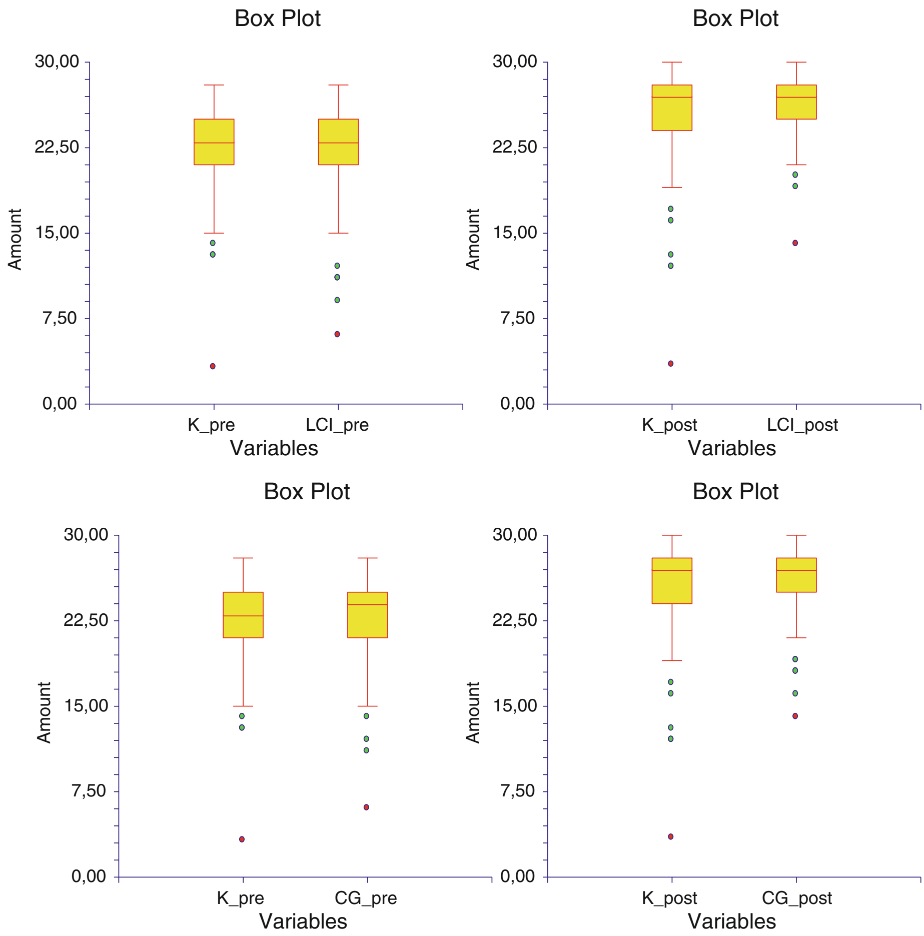

Fig. 3. Results of K – LCI and K – CG Pre-tests (left side) and Post-tests (right side)

learners might have had within the process of autonomous online learning. The detailed information about the sample group was collected in five items and 17 questions covered respondents' experience in studying the online course; seven statements were evaluated on the four-level Likert scale, six ones were the open-answer questions and four items were of multiple-choice type.

In the first part, the research group of 324 respondents was described in detail:

– 60–63 % of male respondents in each group (LCI, CG, K);
– respondents were from 20–50 years old, 80 % in the 20–24 year-old group;
– 62–67 % of respondents graduated from secondary professional schools, the others were grammar school graduates (29–45 %);
– 60–65 % of respondents did not have any experience in studying online courses, approximately 20 % of them had studied one course and 5 % were experienced online learners having passed four or more courses.

In the second part of the questionnaire the items focused mainly on evaluating the process of instruction considering e.g. the difficulty level of single topics, learners' feelings within the course of study etc. The difficulty was evaluated by on the seven-level scale from value 1 – least difficult topic (the structured pattern), value 2 – light grey colour) to value 7 – most difficult topic (black colour).

Creating quotations and Professional writing were considered the most difficult ones (Fig. 4).

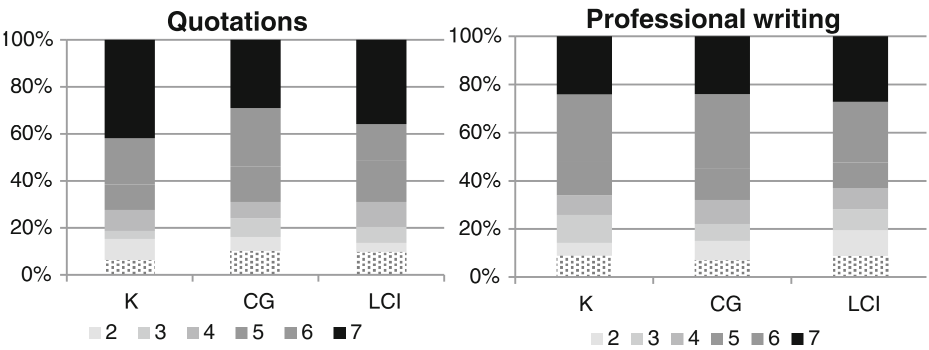

Fig. 4. Difficulty of topics (1 – least difficult, 7 – most difficult)

Creating quotations was considered the most difficult topic (level 7) by 40 % of respondents in the control group (K) reflecting the teacher's style of instruction and 25 % on level 6), followed by the LCI group (experimental group 1) in which individual learning styles were reflected in the process of instruction (35 %, 25 %) and by the CG group (experimental group 2; 29 %, 16 %).

Professional writing was also recognized a difficult topic; 26 % and 28 % of respondents in the control group evaluate it very difficult (levels 7 and 6), and similar results appeared in other groups: respondents in the LCI group showed 27 % and 25 %, in the CG group the results were 24 % and 31 %. The complete data are presented in Fig. 4.

The course of study was also evaluated from the point of learners' problems, difficulties and limits. Five criteria were set as follows:

- to start studying (i.e. find motivation, time etc.),
- to keep studying (i.e. keep motivated, have time etc.),
- lack of time (within the process of study),
- tiredness (within the process of study),
- problems with technology (tools not working properly etc.).

Data were evaluated on the six-level scale from no problems (level 1) to crucial problems (level 6). Results are presented in Fig. 5.

The results show that half of respondents (48 %) had no or little problems (levels 1–3) to make efforts and start studying in the LCI group while slightly fewer ones were detected in CG (46 %) and K (44 %) groups; higher rate was even expressed under the

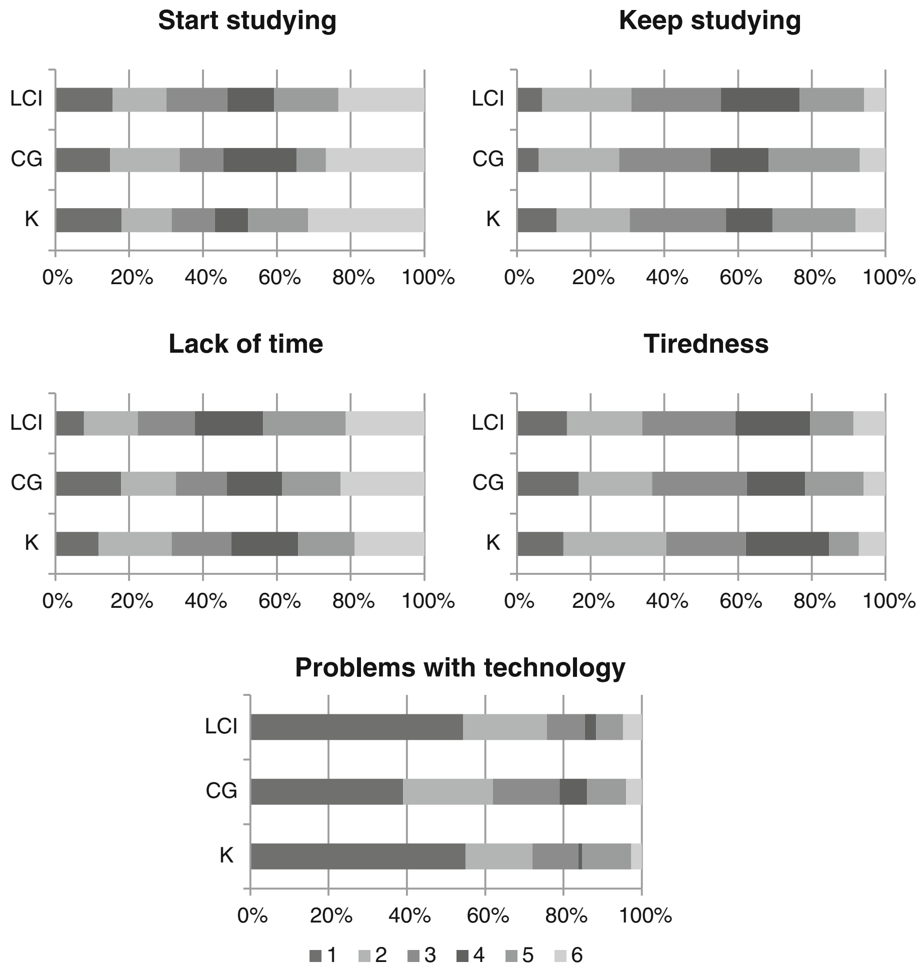

Fig. 5. Learners' problems in the course of study

second criterion, i.e. keep studying, when respondents in the K group reached the highest score of 61 %, followed by the LCI group (55 %) and CG group (53 %).

Approximately 20 % in each group suffered from lack of time for studying (61 % in the LCI group, 54 % in the CG group and 52 % in the K group.

What is rather surprising students did not feel so much tired as could be expected when studying in the combined, i.e. part-time form, after a full-time job. Fifty-nine per cent of respondents in the LCI group had no or slight problems with tiredness before or within learning, and even the higher scores were reached in other groups (63 % both in the CG and K group).

Most respondents did not have substantial problems with technology (85 % in the LCI group, 79 % in the CG group and 84 % in the K group). To sum up these findings (Fig. 6), learners expressed their positive approach to studying online and satisfaction with the course of study. Minimal differences were detected between the groups; the lowest number of dissatisfied students was in the CG group (5 %), were all types of study materials were provided without individual preference recommendation. Hardly any crucial problems appeared which could indicate that neither the online learning (i.e. ICT-supported instruction), nor the entire learning environment built any limits and restrictions to students in the process of learning, and most of them expressed their preference of e-learning to the traditional face-to-face way of teaching/learning. As the satisfaction rate was high, further statistical processing of these data was not applied.

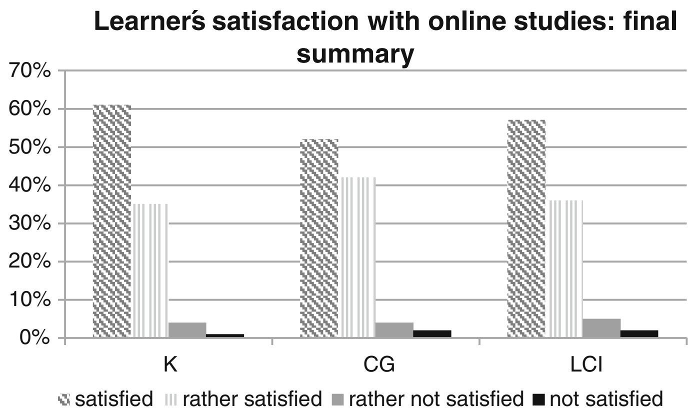

Fig. 6. Learners' satisfaction with online studying

Despite all the possible and real problems the course participants had during the course of study, approximately 80 % would take another course (other courses) within their university study and prefer online learning to traditional face-to-face approach (Fig. 7).

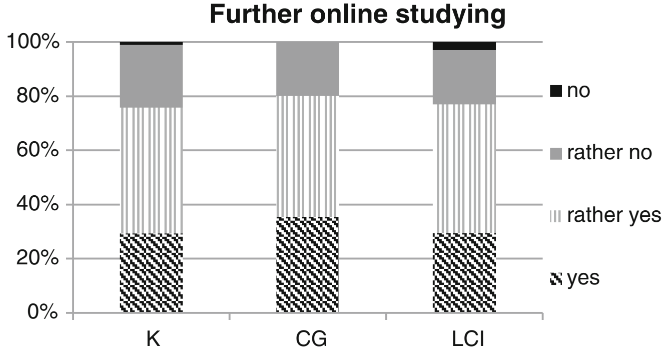

Fig. 7. Further online studying

5 Tracking Learners Activities Within Individualized Learning

So that the above presented findings were supported by real data, learners' activities in all three versions of the online course were tracked by the LMS. Two criteria were considered: (1) the visit rate to the course and (2) the usage of single tools.

5.1 Visit Rate to the Online Course

Totally 12,576 hits were detected in the course (4,271 in CG version of the course; 5,543 in LCI version; 2,762 in K version), which represents 32.6 hits per student in CG course; 42.32 hits per student in LCI course and 20.93 hits per student in K course. Results are displayed in Fig. 8.

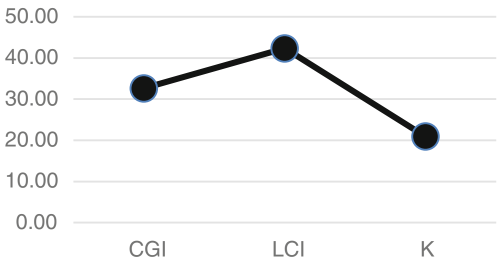

Fig. 8. Visit rate to the three versions of the online course (hits per student)

The data show the visit rate differs substantially in the three versions of the course. Whereas the lowest frequency (21 × per the whole study period) was detected in the K version of the course where the process of instruction reflected teacher's style, in the individualized LCI version the frequency was twice higher (42x); in the CG version where all types of study materials were provided to the learners and the process of selection was the matter of their individual decision, the frequency was in-between, i.e. students entered the course 32x. These results entitle us to conclude that students in the LCI version probably preferred to study online, whereas those in the K version downloaded study materials to their local computer and studied offline; students in the CG version combined both approaches.

5.2 Usage Rate of Single Tools

Totally five main tools provided by the LMS Blackboard were monitored within three versions of the online course:

- Announcements where messages from the tutor to the learners were presented;
- Calendar displaying important events within the course of study;

– Learning content where all study materials were listed in individualized or non-individualized order;
– Discussions running between tutor-learner or learner-learner/s and
– My grades displaying test scores each student reached during the study etc.

The usage of single tools by learners is displayed in Table 7 and Fig. 9.

Table 7. Usage of single tool (in per cent)

	CG	LCI	K
Announcements	1.90	0.76	3.59
Calendar	0.16	0.05	0.22
Content	88.78	96.36	89.48
Discussion	8.71	5.39	2.38
My grades	0.44	0.44	0.44

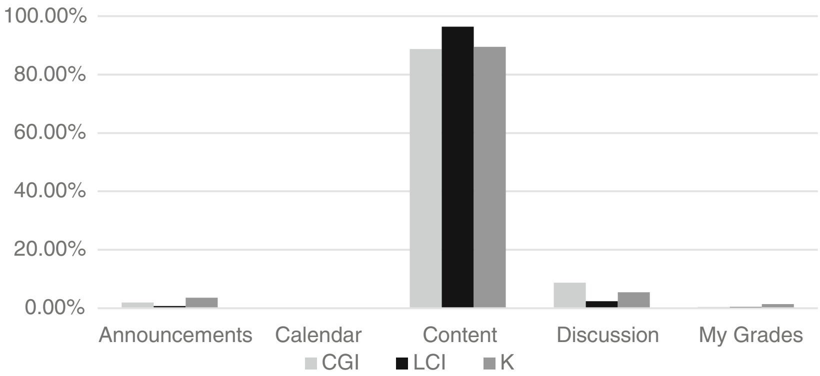

Fig. 9. Usage of single tools (in per cent)

All monitored tools were used to similar extend in all three versions of the online course.

As expected, it is clearly seen the *Learning content* was the most frequently accessed tool within all versions of the online course (96.36 % of learners used this tool in the LCI version, followed by 89.48 % in the K version, and whereas the learning content was the least frequently accessed by learners in the CG version). This result proved previous interpretation that students preferred the work online. Despite the frequency is high, the question appears how the learners could study without accessing the study materials. The interpretation could be that the missing part of learners up to 100 % are those who did not finish the online course.

From other tools *Discussion* was the most frequently used by learners studying in the CG version of the course (8.71 %). A reason might be that having all types of study materials available and their choice was the matter of individual decision, they longed for discussions, experience and feedback from other learners. This group was followed by K group, whose studies reflected teachers preferences and 5.39 % of learners were involved in discussions; and, only 2.38 % of students in the LCI version of the course participated in discussions. This rate was even lower than with *Announcements* in the K group, which reached 3.59 %. It is higher compared to 1.9 % in the CG group; and, only 0.76 % of students in the LCI version of the course read tutor's announcements. Remaining two tools (My grades, Calendar) did not exceeded the 1 % value (*My grades*: 0.44 % in CG and LCI versions of the course, 1.33 % in K group; *Calendar*: 0.16 % in CG, 0.05 in LCI, 0.22 % in K group). These results indicate minimum usage of these tools which can be interpreted students probably did not consider them important for their learning.

6 Discussion and Conclusion

Current orientation of university education, which is changing under the influence of latest technology development and new key competences, can be researched from various, different points of view. The technology enhanced learning has been spreading because of growing popularity of digital technologies in general. Another reason is it enables easier and more complex realization of the process of instruction, offers the choice of place, time and pace for studying, allows an individual approach to students preferring a certain learning style. These are the key values important for the efficiency of the educational process. Material and technical requirements having been satisfied, strong attention must be paid to the ICT implementation reflected in didactic aspects of instruction. To contribute to the optimization of this process was the main objective of the above described research.

The project having been finished, the-application is still tested in subjects Data-base Systems I and II. From the pedagogical experiment focusing on the increase in learners' knowledge in online courses reflecting learner's preferences it can be seen there is no definite solution and students' sensitivity to "facilitating" the process of learning widely differs [13]. Unlikely Prensky [1] and Berry (in [2]), whose results formed the background of our project, our results proved most students of IT study programs (Applied Informatics, Information Management) were flexible in learning to such extent they reached the same results either the process of instruction reflected their learning preferences, or not. Gulbahar and Alper developed the e-learning style scale, collecting feedback from 2,722 students of distance study programmes. Starting with 56 items categorized in eight groups, they finally defined 38 criteria structured in seven groups. [14] As our research did not prove statistically significant differences in learners' knowledge in the experimental and control groups, we are going to use the Gulbahar and Alper's scale to be applied in the future research of the technology enhanced instruction. Two decades ago Mehrlinger (in [15]) emphasized that a variety of learning styles influenced the teacher-designer's teaching methods and choice of media in a given course/lesson and predicted that technology of the future would be more integrated, interactive, and intelligent. Integration continued to escalate through the development of advanced multimedia systems and interactivity occurred with increased distance learning and Internet interaction, followed by individualized knowledge addressing the learning styles of each student. That has been imperative for teachers to keep abreast of technological changes to empower their students.

As stated by the EC-TEL 2013 conference (http://ectel2013.cs.ucy.ac.cy/), there is no doubt that technology enhanced learning has created enormous changes in educational institutions of all levels and at the workplaces. However, these innovations have tended to be unsustainable – they need a high degree of effort to be sustained, i.e. mainly funded. At the same time, the technology (mobile and social information and communication technologies) makes impact on everything and everybody around. And, above all, most of educational institutions have taken these technologies up in a systematic way to include them into their learning strategy, sustain them and develop by reflecting feedback provided by research activities.

The ICT contribution to the individualization of the process of instruction supported by e-application was researched by the method of pedagogical experiment. Unfortunately, neither the research results, nor learners' evaluation proved our expectations that the reflection of individual learning style might be the means which (if applied in the didactic and sensitive manner) could help substantially within the process of online learning. This result was surprising because the learning style reflection had been understood to be a powerful factor providing strong impact on the process of learning, and statistically significant increase in knowledge of the LCI course participants was expected.

There might be several reasons how to interpret the results.

First, neither strong, nor marginal preferences were discovered in patterns within the sample group which could produce statistically significant differences. We agree with e.g. Gregorc [16] or Mitchell [17] saying that not tailoring the process of instruction to learners' individual preferences results in increase the knowledge but they consider developing new learning strategies to be more contributive to the learner. Thus the current research question states as follows: *Is it really worth dealing with learning styles if the pedagogical experiment did not prove any increase in knowledge?* Despite the unexpected research result, our answer is 'yes', as all three groups of learners studying in three different versions of the online course declared their satisfaction with the process of instruction they went through, including those in groups where individual learning preferences were not reflected.

Second, as mentioned above, there exist some researches (and researchers) that reject the theory of learning styles resulting in the individually tailored process of instruction. The proposal might be to provide the individualized process of instruction (a) to learners showing very strong preferences in one learning style, and help them develop other strategies and approaches; (b) attract attention and show those who have very weak preferences and are able to study efficiently using any strategy that there exist approaches and methods which might suit them better, which finally can increase their motivation in learning, make the process more interesting for them, which is not of little importance.

Third, there could be several other reasons why the expectations and hypotheses were not verified, both on the researchers' and learners' side. In further research activities other approaches to running the process of instruction reflecting individual learning styles can be tested, i.e. tutor's role as a facilitator could be strengthened and emphasized so that learners feel and study in a more friendly environment, being provided wider technical and didactic support; learner's experience in online learning developed in this course could be extended and many other measures could be taken.

On the learners' side the skill of independent work and study must be supported and gradually developed, as online learning has become standard not only in the tertiary education but particularly in lifelong learning.

One of the project outcomes - the e-application generating the learning content in adequate order has been designed and can be used as freeware on request but no increase in learners' knowledge was discovered. What has been appreciated is the learners' positive approach to online learning which was expressed by their approach to further learning in online courses. Despite this factor did not belong to the primary or crucial ones, it can be considered a positive side contribution without hesitation.

Thus it can be concluded that despite the contribution of the learning style theory to the online learning process was not proved within this project, no decrease in learners knowledge was discovered in comparison to the traditionally led process of learning which follows teacher's style of instruction. As mentioned in the first chapter, the time came to deal with didactic aspects of ICT implementation into the process of instruction. And, the final question still exists: What else can be done to make the process of learning easier? Following the Felder's multistyle approach [18] we would recommend to use a wide range of methods, strategies and approaches which have been successfully applied in the face-to-face form of instruction for ages and use them under the conditions of e-learning. The Bloom's digital taxonomy [19] introduced by Churches might be one of the tools.

> "*Only providing technologies does not change the situation much, but it can start new activities and approaches. Bringing computers to schools is less important than provide teachers with new ideas. Technologies do not aim at removing traditional educational methods and forms. The new technologies do not automatically bring positive changes into the process of instruction. But they may contribute to increasing its effectiveness, under some conditions*" [20].

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