e-Application for ICT Enhanced Learning

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Abstract: - Since 2010 the three-year project “A flexible model of the ICT supported educational process reflecting individual learning styles“ has been running at the Faculty of Informatics and Management, University of Hradec Kralove, Czech Republic. The main objective of the project is to verify whether accommodating individual learning styles within the process of instruction supported by ICT results in increasing the level of knowledge. The core part of the project is the pedagogical experiment comparing study results in the process of instruction reflecting or ignoring individual learning styles. The paper results from the project and introduces a way of implementing the learning style theory in the field of eLearning. It deals with the Prensky´s approach to current learners, learning styles, their advantages and limits, the Churches´ concept of the Bloom´s digital taxonomy and the Johnston´s concept of detecting individual learner’s preferences. A software application was designed for the purpose of the pedagogical experiment. The e-application generates the appropriate type of study materials and related learning activities and tailors the process of instruction to the student’s preferences. Finally, the detailed description of the application and the list of learning activities appropriate for running the process of instruction efficiently are included.

Key-Words: - Didactics, university education, eLearning, application, LMS, project, experiment

1 Introduction
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.

2 Current process of education
The process of instruction, especially the ICT enhanced learning, is highly appreciated by most learners of all age-groups. For adult students, it is often the only way how to study and work, and reach new competences. The younger the learners are, the more easily they accept this approach.

2.1 Digital Natives and Digital Immigrants
Prensky emphasizes today´s students have changed radically [1]. They have not changed their behaviour (slang, clothes, body adornments etc.) only, as it has happened between generations before, but a really big discontinuity has taken place which could be even called singularity, caused by the arrival and rapid dissemination of digital technology in the last decades of the 20th century.

As a result of this ubiquitous environment and the sheer volume of their interaction with it, today´s learners think and process information fundamentally differently from their predecessors. These differences go far further and deeper than most educators suspect or realize. “Different kinds of experiences lead to different brain structures,” Perry says [2]. “Today’s students’ brains have physically changed as a results of the environment they grew up, their thinking patterns have changed“.

Prensky calls them Digital Natives. The others, who were not born into the digital world but have adopted most aspects of the new technology, are called Digital Immigrants. The crucial problem is the digital immigrant instructors teach the digital native learners. The Digital Natives expect and appreciate receiving information really fast; they like to parallel process and multi-task; they prefer the graphics to the text rather than the opposite; they function best when networked; they
prefer random access (like hypertext); they thrive on instant gratification and frequent rewards; they prefer games to “serious” work; they are used to the instantaneity of hypertext, downloaded music, phones in their pockets, a library on their laptops, beamed messages and instant messaging etc. They have little patience for lectures, step-by-step logic, and “tell-test” instruction. But Digital Immigrants have very little appreciation for these new skills that the Natives have acquired and perfected through years of interaction and practice. These skills are almost totally foreign to the Immigrants, who themselves learned, and so choose to teach, slowly, step-by-step, one thing at a time, individually, and above all, seriously. Digital Immigrants do not believe their students can learn successfully while watching TV or listening to music, because they (the Immigrants) are not able to [1].

2.2 Learning styles
People vary in the view upon the same situation, they do not do things and see the world in the same way as the others do. They differ in the way of perceiving a situation, evaluating it, judging its consequences, making decisions. In spite of these differences, each person is clever and may be right in his/her own manner. These different strategies, called the cognitive and/or learning styles, are commonly defined as an individual’s characteristic and consistent approach to perceiving, remembering, processing, organizing information and problem solving [3]. Despite some conflicts in the field of learning style stability, reliability and validity of measurements, researching this field is expected to be of great importance for the didactics.

Experience gained in the process of ICT enhanced instruction opened discussions on the theory of learning and teaching styles and their application in eLearning. It provides a wide range of tools which enable to accommodate needs of all learning style learners. Thus the process can be considered appropriate and beneficial for learners of all styles.

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. It favours certain students and discriminates others, especially if the mismatches are extreme [4]. 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 [5]. Mitchell concludes that making the educational process too specific to one user may restrict the others [6]. Only limited numbers of studies have demonstrated that students learn more effectively if their learning style is accommodated [7]. The question is whether tailoring the process of instruction running within the LMS to student’s individual learning style results in increasing the knowledge. To discover this is the main objective of the project described below.

2.3 The Churches’ concept of the Bloom’s digital taxonomy
These days, when the implementation of information and communication technologies in the field of education has become standard, the reflection of this process has appeared within the Bloom’s taxonomy. The concept of the Bloom’s Digital Taxonomy and Collaboration was introduced by A. Churches [8]. Special attention (and column) is devoted to the field of Communication which is understood a crucial competence penetrating all teaching/learning activities. Churches emphasizes and recommends the following activities to teachers’attention:

- 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 if they are used to collaborate with peers, organize and classify digitally etc.
- The Apply level includes using information and executing tasks, so examples of students’ active doing are offered, e.g. initiating a programme and/or operating and manipulating hardware and applications, gaming, uploading and appropriate 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, 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 gives educators an excellent framework to begin and/or assess their digital practices. We recognize that he differs from numerous teachers who tend to push the search concept, and provides strong support to networking, social bookmarking, blogging, and at the highest level to producing unique items to enhance the learning.

### 2.4 The Johnston´s concept

The above mentioned project arises from the Ch. A. Johnston´s concept “Unlocking the will to learn” [9]. The traditional learning process is based on belief that all learning occurs as part of learner’s intelligence. The greater the intelligence, the more a child can learn. Johnston attracts attention to the verb *can*, as no one says *will* learn [9, p. 16]. For centuries, the *will* has been closely aligned with the concept of motivation, being described as the passion, the energy that moves individuals to actions. To work effectively, the will must be supported by the *why*-question. It can show the learner whether the learning content is relevant, meaningful and applicable to real life. In other words, learners want to discover the wholeness of learning, and it will spark their will to learn. 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 an individual’s understanding of his/her learning combination. The will lies in the centre of the model, and interaction is the key. She 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 individual weaver (learner) how s/he combines them and what the final pattern is [9].

Johnston designed the Learning Combination Inventory (LCI) consisting 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 responses are categorized into four groups as follows [9]:

- **Sequential Processors**, defined as the seekers of clear directions, practiced planners, thoroughly neat workers.
- **Precise Processors**, indentified 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. by Kolb, Honey and Mumford etc.) in emphasizing not the product of learning, but the *process* of learning. 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.

### 3 Problem formulation

The research problem results from the Johnston´s approach to the theory of learning styles applied in the ICT enhanced process of instruction. The question is whether the level of student’s knowledge is higher if the individual preferences (i.e. the individual learning style) are accommodated within the process of instruction in comparison to the process in which the learning styles are ignored.
4 Problem solution
The problem is solved within the 3-year project “A flexible model of the ICT supported educational process reflecting individual learning styles” which has been running at the Faculty of Informatics and Management, University of Hradec Kralove, Czech Republic, since 2010. The pedagogical experiment, based on the pre-test / instruction / post-test concept is held within the online course intentionally designed for this purpose.

4.1 Course and experiment description
The on-line e-course was designed in the LMS WebCT. The content focuses 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 is 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.

There are 530 university students participating in the project. Students in the experimental group are offered such study materials, exercises, assignments, communication and other activities which suit their individual learning styles. The selection is made electronically by an application which automatically generates the “offer”, i.e. it provides each student with types of materials appropriate to his/her learning style. Students in the control group have access to all types of materials, and the process of selection is the matter of individual decision, and it is tracked by the LMS.

4.2 Application generating the Course Content
The application (plug-in) supporting the flexible model of instruction within the LMS WebCT was designed by students within the specific research activities. 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 works is the student’s individual learning style. Single items of the Course Content, i.e. Study Materials, exercises, assignments, assessments, communication and other activities applied within the process of instruction, are presented in such order which accommodates student’s preferences, i.e. the plug-in arrange single items on the introductory page in such order which matches the student’s individual learning style.

To reach this objective, not only data on each student’s learning style are required but also single items of the Course Content and relating activities are classified according to the suitability to a certain style of learning, i.e. whether the material is appreciated (value 1), accepted (value 0) or rejected (value -1) by the student. Finally, single types of study materials and activities are matched to each student’s pattern and the course is tailored to the individual student’s needs.

The whole plug-in is implemented in the JavaScript language and inserted in the Heading of the introductory page of the e-course directly in the source form. The plug-in is activated in the student’s browser at each access to the Course Content page, and it accomplishes following sequence of activities:

- 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.
- It hides the original content of the Course Content page.
- Applying the AJAX inquiry it detects the student’s ID.
- Applying the AJAX 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 AJAX inquiry it uploads the tree of links to single types of study materials.
- Having evaluated each type of study materials, activities and tools 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.

If the process fails of any reason, the original Course Content page is displayed with caution an error appeared. In such a case the Error report is created in the browser, which is commonly hidden to the user.

The source code must be included in the Headings of the introductory page of the e-course (Designer view – Course Content – Edit Heading – HTML Creator: Plug-off, tick Use HTML, Insert the Plug-in code, Save). Single topics of the Course Content must be structured into folders - one folder for each topic containing links
to single learning objects (i.e. various types of study materials). Each learning object in the folder is classified by four figures of the value of -1, 0, 1 which correspond to four types of processors (Sequential, Precise, Technical and Confluent) as follows:

- minus one (-1) means this type of study material, activity, assignment, communication etc. is rejected, i.e. does not match the given learning style;
- zero (0) is the middle value, i.e. the student neither appreciates, nor rejects, but accepts this type;
- one (1) means this type is appreciated and matches the given learning style.

The figures are presented at the beginning of the link to the object in the field of “User name of the link”, e.g. in the form “(0,1,-1,-1) Basic terminology”.

The “studenti.csv” file contains the classification of each student’s learning style. It is placed in the root directory of the e-course using the File managers. The appropriate form of classification (Sequential (S), Precise (P), Technical (T) and Confluent (C) Processor) is presented in table 1:

```
Table 1 Sample classification of a student’s learning style

<table>
<thead>
<tr>
<th>User name</th>
<th>S</th>
<th>P</th>
<th>T</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>webct_demo_69259477001</td>
<td>25</td>
<td>18</td>
<td>14</td>
<td>20</td>
</tr>
</tbody>
</table>
```

The data should be taken from a spreadsheet, e.g. 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. It is available within “My Grades” in Student view, presented in brackets on the first line, e.g. Demo Student 69259477001 (webct_demo_69259477001).

For running the plug-in appropriately each student is required to have the Internet access for the purpose of uploading the jQuery from the ajax.googleapis.com server.

The plug-in has been designed for the WebCT, version CE 6.0.3 (12.0.11.15), and considering the strong dependence on the concrete HTML page structure, it is highly presumable the potential adaptation to another version will require additional modifications. Because of impossibility to adapt the WebCT source codes and absence of suitable API, it is necessary to implement the plug-in on the client side using JavaScript which modifies the content of the displayed page and uploads other necessary sources from the WebCT server using AJAX requirements. The data are received by parsing of the uploaded HTML pages. The implementation uses the jQuery of 1.4.2 version mainly for the manipulation with the page content (of the DOM model) and defining the AJAX requirements to receive additional data from the server.

Several limitations have been discovered, e.g. the WebCT shortens file names in the Course Content tree, which the plug-in uses to receive links to learning objects, up to approx. 11 characters plus the length of the classification chain including brackets. That is why the file names in the newly generated Course Content page are shortened and filled with three dots. The problem can be solved by re-naming the links using the appropriate length (i.e. number of characters) or making a relatively complicated change in the plug-in code, which will result in the increase in higher frequency of inquiries on the server (total number will correspond to the number of topics in the e-course).

### 4.3 Didactic recommendations

In table 2 below the list of recommended approaches, both from the teacher’s and learner’s side, is provided. The approaches, being matched to activities provided by Churches, form the base of recommended activities and didactic approaches. The items are structured according to four characteristics by the Johnston’s concept and other aspects which are crucial for determining the appropriate learning style [10].

### 5 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 ICT 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 process. Material and technical requirements having been
satisfied, strong attention must be paid to didactic aspects of instruction. To contribute to this process is the main objective of the paper.

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 support the development of the whole system of education, which is often put into effect in a distance way being supported by ICT. Teachers’ and students’ awareness of styles may help substantially in this process.

Acknowledgment
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References:
<table>
<thead>
<tr>
<th>Aspect/Style</th>
<th>SEQUENCING</th>
<th>PRECISE</th>
<th>TECHNICAL</th>
<th>CONFLUENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In processing information</strong></td>
<td>-collects, summarizes, classifies information</td>
<td>-collects and analyzes information,</td>
<td>-thinks about practical use of information, eliminates those of no</td>
<td>-considers information from the unique point of view</td>
</tr>
<tr>
<td>student</td>
<td></td>
<td>asks questions</td>
<td>value</td>
<td></td>
</tr>
<tr>
<td><strong>In the field of autonomy</strong></td>
<td>-creates own system of storing and recalling information</td>
<td>-concentrates on searching own sources, verifies them</td>
<td>-has own way of processing information, analyzes the predefined information, applies trial-and-error approach</td>
<td>-longs for doing things another way, applies own approaches and ideas, never pilots them</td>
</tr>
<tr>
<td>student</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>What student does:</strong></td>
<td>-He completes lists, manages (organizes) things and activities, plans first, then makes.&quot;</td>
<td>-If I explain something, it takes me long, because I present many details.</td>
<td>-My hands need to be in motion, so I touch things.</td>
<td>-I start work first, and only then I ask what the procedure is.</td>
</tr>
<tr>
<td><strong>What student thinks:</strong></td>
<td>-What does the teacher want me to do?</td>
<td>-I think about what I have learned.</td>
<td>-Why is it important to know this? -When (where) can I use this? -What tools will I need to fulfil the task?</td>
<td>-I think about things another way than other students do. -I am always full of new ideas.</td>
</tr>
<tr>
<td></td>
<td>-I think about how to work according to the instructions.</td>
<td>-I keep asking.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>What student feels:</strong></td>
<td>-I need to have everything clean and tidy. -I am frustrated if instructions are changed. -I hate being in a hurry.</td>
<td>-I am satisfied if I am true. -I like someone telling me I am true. -I am satisfied to know more than others.</td>
<td>-I like to know how things work. -I feel good if I can work on the project independently. -I do not like writing about things, I prefer oral explanations to an individual.</td>
<td>-I like trying something new. -I like to differ from others. -I do not like doing things in one way only.</td>
</tr>
<tr>
<td><strong>What student says:</strong></td>
<td>-Could you give me an example? -Would you repeat the instructions? -I need more time!</td>
<td>-Do you know that ....? -Why ....? -Anyway, .....</td>
<td>-I can do this myself. -How can I fix this? -Is it necessary to work in team?</td>
<td>-I have an idea. -I have another idea.....</td>
</tr>
</tbody>
</table>