The Impact of Interactivity on Students´ Results When Passing Through an E-learning Course

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Abstract
Professionals in pedagogy and psychology have been dealing with the issue of employing interactive medial elements within the framework of educational process for the development of students´ cognitive and intellectual capacities for a rather long time. The importance of interactivity increased mainly after the implementation of an e-learning support of education, as its standard complement designed not only for the development of knowledge, but also students´ skills. In the contribution the impact of interactivity on students´ results obtained within academic years 2009/2010 - 2011/2012 while passing the subject Computer Architecture is described. In this period we executed a series of experiments focused on the evaluation of quality and method of instruction using a linear way of presenting study material (with and without a limiting condition) in an e-learning course, into which interactive animations were implemented. All experiments were verified in advance by means of a modelling tool – Petri nets. By means of this tool we expressly identified an ideal transition through the e-learning course. Results of these experiments as well as the comparison from the point of view of effectiveness of their employment are presented in the contribution. The impact of interactivity on the quality of study results obtained based on the method of presentation of study material by individual students has been proved.

Keywords

Introduction

The issues of employment of interactive media in educational process for the development of mental and cognitive abilities of students (Mayer, 2001) have been concerned by psychologists, pedagogues (Renk, Atkinson, 2007), but also experts on information and communication technologies (ICT) for almost three decades. The idea of their implementation into educational process was expressed for the first time by Hannafin and Peck in 1988 (Domagk, Schwartz & Plass, 2010), who mentioned the fact that „perhaps the greatest advantage of computerized instruction over. . . . linear media is the potential for interaction during a lesson“ (Hannafin, Peck, 1988). A certain parallel with this expressed idea can be observed also at the definition of concepts such as medial element and multimedia. In the mid 80s it was supposed that the concept “multimedia” could represent a combination of individual medial elements such as graphic, sound and text. However, with the gradual employment and improvement of ICT it was inevitable to modify this definition, or complement it with other medial elements such as animation and video. Some ten years later
Bransford started to deal with the employment of interactivity as a property of the given medial elements. According to him, interactivity makes it easy for students to revisit specific parts of the environments to explore them more fully, to test ideas, and to receive feedback. Noninteractive environments, like linear videotapes, are much less effective for creating contexts that students can explore and re-examine, both individually and collaboratively (Bransford, Brown & Cocking, 1999).

Possibilities of student´s passing through an e-learning course

The idea expressed by Bransford in 1999 we can, by analogy, employ also upon parallel employment of virtual learning environments. Their advantage when compared with the classical method of education is quoted mainly upon parallel massive education of students.

Due to staff, time and space capacities, it is not possible to cover the increased number of students of both distance and full-time study by an increase of the number of face-to-face lectures. Therefore, implementation of e-learning tools is one of the significant approaches of possible solutions to the problem (Kostolányová, Šarmanová & Takács, 2009).

Interactive learning environments are viewed as a promising option not merely for presenting information but for allowing the learner to engage actively in the learning process (Renkl, Atkinson, 2007).

Among the benefits of virtual environment belongs first of all an opportunity to:

- employ elements of interactivity based on implemented interactive medial elements (interactive animations, video, etc.), eventually interactive tests representing conceptual task designed for the development of psychomotor skills and abilities,
- manage his/her own course of study from the point of view of the student,
- increase motivation within the study and influence the results of learning using suitably selected methods and procedures,
- simulate conditions of the real world thus inducing situations allowing for deeper comprehension of the given problem,
- create an instant feedback,
- provide autonomy in decision making,
- verify, from the point of view of the student, various variants of solution to the given problem without a sense of threat.

In each of the given benefits, an e-learning system affecting the student with certain limitations (i.e. has not a linear character of providing study material) is a basic prerequisite. What differentiates a classical linear transition from a linear one with a limiting condition, is interactivity. According to Mareš, the concept “interactivity” means a reciprocal activity between the learning man and the e-learning system. Action/reaction of the learning man depends on the action/reaction of the system itself (Mareš, 2011).

Every e-learning course is characterized by (Pavlíček, 2004):

- content and structure,
- educational goal,
- didactic function.

Although the process-oriented nature of collaborative learning is quite evident, current e-learning systems mainly concentrate on individual learning tasks rather than on learning processes.
To describe the management of communication between human being and the computer it is appropriate to employ graphic tools in order to describe and formulate the basic rules underlying this interaction. Interaction between student and LMS in the process of teaching and learning is a composite process and it is highly recommended to employ Petri nets for this purpose. Petri nets are used in several courses, both required and electives, as a fundamental tool in conceptual modelling of concurrent computing systems, in model-driven software development, in performance evaluation of concurrent computing systems, and in design and analysis of workflow management systems. There are a lot of modelling and analysis tools available for workflow, but Petri net is more preferable because of its solid mathematical foundation and graphical nature, for evaluation structural and behavioural properties of students (Balogh, Klimeš, 2010; Frosh et al., 2008; Nikolajczak, 2008; Wang, Ding, 2009).

E-learning course in LCMS Moodle system on a regular basis consists of the total number of N lectures, while each of them can be divided into a theoretical and practical part. Such division is suitable mainly from pedagogical and psychological point of view, when the student based on the description of each of these mentioned parts knows the requirements for its successful acquisition. Theoretical part is the one, which is divided into chapters and subchapters, in which exposition of the contents of lecture is situated in the textual, video or audio form. Practical part is the one, which is designed for the verification of acquired skills and knowledge. Testing is executed based on self-tests, which consist of questions defined in advance.

Linear transition through an e-learning course without any limiting condition (Figure 1) is characterized by the fact that it accentuates only minimally the needs of students, development of their skills and abilities. The submitted study material within the theoretical part of the course can be processed for example in PDF format, while these materials consist of mostly static medial elements. From this point of view, it is obvious that upon linear transition there does not exist any limiting condition, which would force, in a certain sense, the student to enter the process of study in order to actively cooperate not only with the submitted study material, but at the same time participate in the knowledge verification.

Figure 1: Transition through an e-learning course “Computer Architecture” without any limiting condition – linear transition

Student crossing through the course is created using linear Petri net (Figure 1). According to the current position of the token in the Petri net model we can determine in which part of the course is student currently located as well as which lesson he goes about (Kuna, 2011).
The state, when students employ within theoretical and practical part of the course individual implemented interactive medial elements, can be considered a linear transition with a limiting condition. Results of the student’s work, or manipulations with them are registered in the system database (Balogh et al, 2011). Upon linear transition with a limiting condition it is necessary that the student based on the submitted study material not only worked with it in order to acquire the necessary knowledge, but also to duly apply it within control points, such as self-tests. An example of such system can serve LCMS Moodle 2.X+.

At our university we use LMS Moodle as the central environment for five faculties and all the departments. In the last few years were created many courses for supporting teaching and also for testing process (Tomanová, Cápay, 2010).

This way the defined transition of the student is in this system carried out using self-tests with continual evaluation of results within the feedback. Student in this mode (Figure 2) is obliged based on the defined condition (e.g. successful passing of the test – minimum result is 80%) to pass through the whole course. This means to simultaneously pass both theoretical and practical parts of the e-learning course.

![Figure 2: Linear transition through an e-learning course “Computer Architecture” with a limiting condition (Balogh et al, 2011)](image)

**Comparing the effectiveness of students’ transition through an e-learning course – study personalization**

Method of presenting the study material, as well as the personalization of the needs of students in an e-learning course itself has been the subject of investigation for almost two decades (Hsiao, Sosnovský & Brusilovsky, 2010, De Bra, Post, 1994).

The impact of interactivity on the increase in the quality and didactic effectiveness within educational process has been proved by several empirical studies (Mayer, 2001, Mayer & Chandler, 2001). However, at the same time several authors point to the potential limitations (Moreno, Valdez, 2005). In fact, a high degree of interactivity of the system does not necessarily ensure a high degree of comprehension - cognitive load (Mareš, 2011).

For the comparison of effectiveness of transition of students through the created e-learning course based on the evaluation of study results reached by the students in the academic year...
2009/2010 (linear transition/LT), 2010/2011 (linear transition with interactive animations/LTIA) and 2011/2012 (linear transition with interactive animations and condition/LTIAC) the following experiments were executed. The aim was to find out, at which method and form of presenting the contents of the study material students reach better study results, and thus also which of the methods and forms suits their study requirements most.

Table 1: Comparison of results of the transition of students through an e-learning course in the monitored period

<table>
<thead>
<tr>
<th>Academic year/WS</th>
<th>Type of transition</th>
<th>Count of students</th>
<th>Final evaluation of the subject</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>2009/2010</td>
<td>LT</td>
<td>89</td>
<td>10</td>
</tr>
<tr>
<td>2010/2011</td>
<td>LTIA</td>
<td>119</td>
<td>23</td>
</tr>
<tr>
<td>2011/2012</td>
<td>LTIAC</td>
<td>155</td>
<td>45</td>
</tr>
</tbody>
</table>

We watched the study results of students from the evaluation of the subject Computer Architecture at three different type of transition (LT, LTIA and LTIAC). We set the following hypothesis H0.

H0: There are significant differences in study results between different type of transition.

At the significance level $\alpha = 0.05$, we assessed whether existing statistically significant differences in study results between different type of transition.

Table 2: Statistical method ANOVA - Assessment of statistically significant differences

| SUMMARY | | | | |
|---------|-------------------|-----------------|-----------------------------|
| Groups  | Count | Sum | Average | Variance |
| Row 1   | 6     | 89  | 14,83333 | 122,96666 |
| Row 2   | 6     | 119 | 19,83333 | 62,566666 |
| Row 3   | 6     | 155 | 25,83333 | 104,5666 |

ANOVA

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>P-value</th>
<th>F crit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>364</td>
<td>2</td>
<td>182</td>
<td>1,80108857</td>
<td>0,186512</td>
<td>3,68232</td>
</tr>
<tr>
<td>Within Groups</td>
<td>1515,75</td>
<td>15</td>
<td>101,05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1151,75</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

We do not reject H0, there are significant differences in study results between different type of transition ($P > \alpha$, the null hypothesis cannot rejected. It means that the difference measured in a sample can only be random).

When comparing the students’ results in individual academic years 2009/2010 – 2011/2012 we shall find out that with each academic year the number of students passing the subject “Computer Architecture” has been gradually increasing. Their results depended not only on the method of presenting the study material, but also character of the knowledge verification control during transition through the e-learning course.

Upon linear transition through the e-learning course in the academic year 2009/2010, 10 students obtained mark A, and only one student failed at the exam (mark FX). In this academic year we distributed questionnaires among students, in which they could express their opinion on the quality and way of teaching. Based on the obtained results we can state that the students missed
visual character of certain topics of the e-learning course and also interactivity and support of multimedial elements were required.

We tried to apply this finding also within the course evaluation and that is why the course was complemented by interactive animations in this academic year (Balogh et al, 2011). Regarding the growth in the number of students from 89 up to 119, they passed the study successfully, when 23 students reached mark A, while only 4 failed (FX). A positive increase in the number of students passing with B mark (22 students) was also observed. In the academic year 2011/2012 we distributed among students the questionnaire again, in which they had to express their opinion on the quality and way of teaching. Based on the results of the questionnaire we can state that students evaluated the method of instruction highly positively and that is why we decided to create also interactive self‐tests within the course. During the next academic year 2011/2012 students passed linear transition through the e-learning course with a limiting condition.

The subject “Computer Architecture” was passed by 155 students in the academic year 2011/2012. Positive growth in the evaluation comparing to the previous academic year, was observed. The number of students with A mark increased. The growth was twofold when compared with the academic year 2010/2011, 4,5‐fold when compared with the academic year 2009/2010. This fact gives us pleasure, however, it was shown that also the number of failing students (reaching FX mark) increased. Totally 26 students reached this evaluation, which represents a dramatic growth when compared with the previous academic years. The number of remaining evaluations (B –E), however, does not markedly differ from the number of evaluations obtained in the academic years 2009/2010 and 2010/2011. However, high rate of failure was not connected with the problems of accessing the study material, but the reason was the inaccurate direction of the study and field of study.

Discussion and conclusion

Interactivity as the tool of developing abilities and skills of the student is certainly a suitable complement within an e-learning support of education. As stated by several authors of professional publications dealing with its employment and implementation in educational process, inadequate amount of interactivity can cause the system a cognitive load. This statement was proved also by the series of experiments carried out. The number of students were compared in the academic years were influenced by the number of students admitted to bachelor study. We assume that despite the small sample count of students results can be regarded as relevant. The way we determine interactivity students of the course has been described in detail in Article: Interactivity elements implementation analysis in e‐courses of professional informatics subjects (Balogh et al., 2011). It is accruing from the results that the most suitable method of presenting the study material upon e‐learning support of education can be considered the linear transition through an e-learning course, into which were implemented interactive animations, but the course transition itself was not influenced by any limiting condition. At this method of presenting the study materials students reached on average better evaluation than in case of the remaining two experiments.

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References


