Applying Web-Mining Methods for Analysis of Student Behaviour in VLE Courses

Lajos Izsó

Institute of Applied Pedagogy and Psychology, Budapest University of Technology and Economics, izsolajos@erg.bme.hu

Péter Tóth

Centre for Teacher Training and Engineering Education, Budapest Tech Polytechnical Institution, toth.peter@tmpk.bmf.hu

Abstract: In Hungary, a lot of electronic-based syllabuses have been developed during the last 8-10 years at a most considerable cost. However, not much has been heard of their success or efficiency, as would be supported by scientific testing. First, the present study is to provide a survey of our project, which aimed at creating an integrated electronic learning environment. The processing of an education technology syllabus integrated in the Moodle virtual learning environment system took place in the passing academic year. The analysis of student behaviour in the learning environment is based on log files created on the server during the course of interaction between learners and the electronic syllabus. We analysed the learning activity of the students in the learning environment in exact numeric terms by using methods of web-mining. The second part of the study presents some of our first empirical results in this field.

Keywords: virtual learning environment, collaborative learning, constructivist pedagogy, web-mining method

1   Preliminaries

At one of the legal predecessors of the Centre for Teacher Training and Engineering Education, at the Institute for Engineering Education, an electronic syllabus package of four modules was developed in 2004 as a result of a project supported by "Apertus" Public Foundation. The objective of the project realised under the leadership of one of the authors was the development of an electronic syllabus package with unlimited availability in space and time together with accompanying methodological aids in the topics of education technology and

multimedia. The main application areas of the syllabus package are teacher training and in-service teacher training. As a result of the project, the processing of the education technology and multimedia syllabuses was completed in distant teacher training, and took place in a blended form in full time teacher training. At the beginning of the term students received the electronic syllabus on CD first, and later it was made also downloadable from an FTP server.

The electronic syllabus package was comprised of the following parts:

−   Basic skills module: to introduce the elements of education technology and media development as well as the related requirements.

−   Module for editing media: to aid the acquisition of skills necessary for editing digital media. This module has two parts: one of them presents the editing tools of media independent of time (still image and figure), the other presents those of media dependent on time (audio and video).

−   Module for multimedia editing: to aid the acquisition of the frame program "Authorware" necessary for the development of electronic learning program.

Two methodological aids were also developed accompanying the syllabus modules. Students of technical teacher training taking part in the training may, after graduation, participate in adult retraining and in-service training, too, where electronic-based distance learning may play a decisive role. Therefore we deemed important to elaborate recommendations helping the teacher's (tutor's/instructor's) work, which process methodological questions in connection with the development and application of electronic syllabi. In addition, a methodological guide was developed to provide more information about the individual characteristics of independent learning, with a decisive role in adult education, as well as a questionnaire to assess and evaluate learning styles.

The other project relevant to our research focuses on the pedagogical and methodological examination of the adaptability to teacher training of virtual learning environments. The specific aims of this project are

−   to develop a methodology for assessing institutional requirements for networked learning and for selecting and implementing appropriate solutions, including the choice of VLE (Virtual Learning Environment);

−   to create staff development and training programs to support the management and use of virtual and networked learning;

−   to increase trans-national collaboration in vocational initial teacher training and develop capacity to deliver programs where this takes place;

−   to investigate the specific application of VLEs in vocational initial teacher training, and to revise curricula to maximise benefits to teaching and learning processes;

−   to compile and analyze data comparing various VLEs, and to disseminate this with a view to standardizing policy in vocational initial teacher training.

As a result of the "Leonardo da Vinci" project led by Dr. Pál Pentelényi and realized in an international co-operation (involving Hungary, Finland, England, the Netherlands, Portugal and Greece), the three electronic syllabus modules were developed: Basic Teaching Skills, Computer Mediated Skills and European Collaboration. These competency modules were integrated with BlackBoard and Moodle systems. Students of technical teacher training from England, Finland, Portugal and Hungary collaborated in processing the syllabus. Tutoring students' work created an excellent opportunity to become familiar with and analyse a virtual learning environment. More can be read about the results of the project "Virtual Electronic Learning Vocational Initial Teacher Training" (VELVITT) on the homepage velvitt.banki.hu and in the publication edited by Pál Pentelényi [1].

2 The structure of the Integrated Electronic Learning Environment

As an integration of the results of the above mentioned two projects in the autumn of 2006 we made an endeavour to create a virtual learning environment of our own (Moodle). We launched our first electronic courses, based on content developments supported by "Apertus" Public Foundation. The first virtual course processes media independent of time. Besides electronic syllabus development we considered it important to reflect on the design aspects of the VLE system. Therefore we formed a team responsible for the creation and operation of the system to test the quality of the completed electronic course [6].

This quality testing must cover the content and structure of the syllabus as well as some elements of the user interface, such as the ergonomic, psychological and pedagogical examination of the graphical layout of the screen or the evaluation of interactive and navigational possibilities offered by the system.

Figure 1 shows the structure of the course under scrutiny. Having entered Moodle, the learner selects first the course to be studied then the most appropriate one to his needs of the particular units of the syllabus, of the learning aids and of the communicative forms on the home page. Six such objects have been incorporated in the virtual course under scrutiny, namely an electronic syllabus, a glossary, a self-check test, a forum, a check test and an uploading assignment.

The structural principles of virtual learning environments are regulated by the SCORM standard [7]. This standard distinguishes between sequence and navigation. They are to be provided only if the syllabus developer wishes to realise a navigational route more complex than the content hierarchy. An example for this may be a conditional branching from one knowledge base to another one depending on whether the student has obtained a given test score or not.
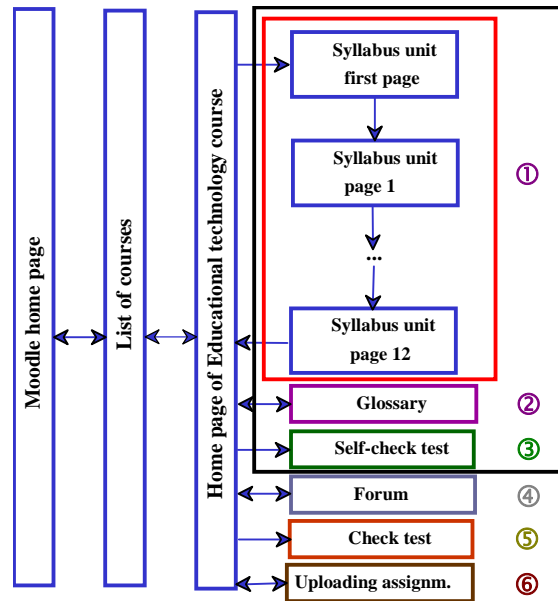
Figure 1
The structure of the syllabus content

The SCORM standard recognises two kinds of navigation: one within and the other among content objects. Navigation within the content object is realised by the object itself, while navigation among content objects is realised by the system shell, which is Moodle in the present case.

Navigation within the content object always has to be created by the syllabus developer and it may be a simple hyperlink, pointing at one syllabus element after another, Java script and frame based, Java applet based and plug-in based.

Navigation among content objects may be of the following type (Fig. 2):

- *linear (a)*

  It is a step-by-step survey of the syllabus content. Having studied a page the learner will either move on to the next page or return to the previous one.

- *hierarchical (b)*

  It is an upgraded version of linear navigation. According to its simplest version, the learner may select from a hierarchical table of contents the subsequent syllabus unit, which Moodle is to represent.

- *grid-like (c)*

  It is the two-dimensional arrangement of syllabus elements. With this type, students may make their selection from the possible hierarchies. It may prove practical in the case of arranging syllabus elements in space and/or time.
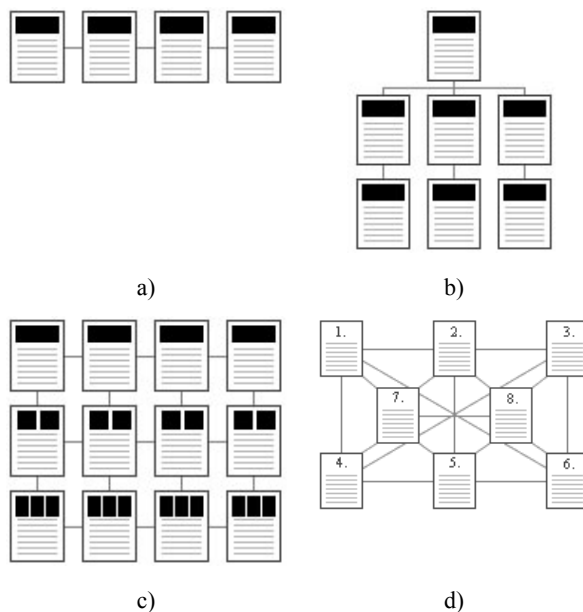
Figure 2
The basic type of navigation

- *net-like (d)*

    Net-like navigation makes it possible for students to navigate from any page to another one within the syllabus content. This yields a freedom of browsing and exploring the syllabus. The net-like structure faces the student with a decision to select the suitable direction of progress. Besides its flexibility, it may often result in losing one's way, in "lapses". This method may prove most effective in the case of students with a good learning ability.

3   Collaborative Learning in VLE

Self-directed studying must not be confused with independent studying that the student does on his or her own without supervision or contact with fellow students. Moreover, a clear distinction needs to be made between using the Internet as a channel for distributing material and teaching an online course. One of the clear strengths of an online course is the opportunity for adding the element of social networking to distance learning. The teacher has got an essential role in this, but also ways of interacting with other learners should be provided. Gilly Salmon points out that the groups of learners always tend to exchange views and

ideas, and that people enjoy learning from the experience of others. She emphasises that to offer these benefits to learners, a considerable amount of group work is needed to be included within any learning program. [8]

According to Salmon, the key to active and interactive online learning lies in bringing students into greater interaction and group participation. She thinks that from these modest beginnings a new body of practice will build up around "e-tivities" that will transfer to new technologies, as they become available. Salmon also mentions that the need for skilful e-moderations will not disappear, regardless of how sophisticated and fast-moving the technological environments become. E-moderator adds the real value to learning techniques by designing and running "e-tivities". In her opinions the students learn to use the system through five stages. Each stage requires participants to master certain technical skills. Each stage calls for different e-moderating skills. At first at stage 1 (*Access and motivation*), the participants interact only with one or two others. After stage 2 (*Online socialisation*), the number of others with whom they interact, and also the interaction frequency, gradually increases, although stage 5 often results in a return to more individual pursuits. At stage 3 (*Information exchange*), the participants engage in mutual exchange of information. The form of co-operation occurs, whereby each person supports the other participants' goals. At 4th stage (*Knowledge construction*) the course-related group discussions develop and the interaction becomes more collaborative. Collaboration requires an active sharing of information and intellectual resources amongst the participants. Finally, at stage 5 (*Development*) the participants look for more benefits from the system to help themselves in achieving personal goals and reflect on the learning processes. [8]

According to constructivist pedagogical approach, learning environments should keep the activity, intentionality and collaboration for students. Activeness means that the student is in a key role in his or her own learning. The student is actively engaged in the learning process, processing information. Activeness leads to students taking responsibility in their learning. Intentionality refers to the learners' active attempts to achieve a particular cognitive goal. Striving to reach the goal makes the learner think – and thus also learn – more. Collaboration comes from the students' natural tendency to form communities in which the members can benefit from each others' skills and social support.

The most VLE system has some communicative and non-communicative elements for collaboration.

1 Chat

The Chat module allows participants to have a real-time synchronous discussion via the web. This is a useful way to get a different understanding from each other and also get the topic being discussed – the mode of using a chat room is quite different from the asynchronous forums. The Chat module contains a number of features for managing and reviewing chat discussions.

2 Forum

This activity can be the most important – it is here that most discussion takes place. A forum can be structured in different ways, and can include peer rating of each posting. The postings can be viewed in a variety for formats, and can include attachments. By subscribing to a forum, participants will receive a copy of each new posting by email. A teacher can impose subscription on everyone if they want to.

3 Assignment

Assignment allows the teacher to specify a task that requires students to prepare digital content (any format) and submit it by uploading it to the server. Typical assignment includes essays, projects, reports, and so on. This module includes grading facilities.

4 Workshop

A Workshop is a peer assessment activity with a huge variety of options. It allows participants to assess each other's project achievements, as well as exemplar projects, in a number of ways. It also co-ordinates the collection and the distribution of these assessments in various ways.

4   Web-Mining Method

Data mining involves the use of sophisticated data analysis tools to discover previously unknown, valid patterns and relationships in large data sets. These tools can include statistical models, mathematical algorithms, and machine learning methods (algorithms that improve their performance automatically through experience, such as neural networks or decision trees). Consequently, data mining consists of more than collecting and managing data, it also includes analysis and prediction.

Web-mining is a very effective data mining approach developed in the internet-based segments of the business world. In fact, it is applying data mining for sophisticated traffic analysis of websites based on the so-called "logfiles" continuously being created on the server machine of the content provider [2] [3]. Its aim is to increase the efficiency of the given web-sites.

These "logfiles" of different formats are in principle very rich sources of information about the activities of visitors. The problem here is just the contrary of the usual: we have not too little, but too much information. The size of the logfiles in the business sphere – depending, of course, on the number of actual visitors and the studying time – is quite often in the range of several hundreds of MBs or even GBs. This huge body of mainly technical information has to be

filtered, transformed, and processed so that valuable piece of information characterising the visitors' behaviour and motivation could be extracted. [4]

For practical web-mining purposes, based on our earlier experiences, we propose the Clementine WebMining tools [5]. The "user-centred" philosophy of these tools is in perfect harmony with the concepts of modern marketing, ergonomics, and pedagogy.

This new approach, as opposed to the traditional "page-centred" philosophy, puts the users' goals and intentions to the centre, and designs the services of the system accordingly. As a matter of fact, as we experienced, quite successfully.

Several examples of analytic approaches that proved to be successful and which are supported by very sophisticated software modules – called here "streams" – often containing intelligent learning algorithms:

- Visit and User Segmentation (E-ChannelUser RFM Classifications, User Mode Determination, Visit Branding).

- Web Site Activity and User Behavior (Visit Activity Variances, Identifying Undesirable Behavior, Lifetime Conversion Tracking, Points of Abandonment, User Activity Focus, Visit Activity Funnels, Navigational Usage).

- Activity Sequence Analysis (Most Common Activity Sequences, Eventstream Visualisation).

- Propensity Analysis.

- Advanced User Segmentation.

- Targeting Online Promotional Activity, and Campaign Performance Measurement.

Some part of these streams can immediately be adapted to important problems in the world of Internet-based teaching materials.

5   Analysis of Student Behaviour by Web-Mining Method

At the Institute of Applied Pedagogy and Psychology of the Budapest University of Technology and Economics – with the active participation of the Centre for Teacher Training and Engineering Education of the Budapest Tech Polytechnical Institution – a research group has been composed aiming at revealing advantageous practical application possibilities of web-mining for the usage of educational materials based on Clementine tools. This group has about 14-16 active members, mainly from the staff members and PhD students of the two institutions.

The professional study of the learners' interaction with Internet-based educational materials makes possible identifying the real actual usage modes, from which well-established conclusions can be made concerning both the efficiency of these materials and the concrete obstacles of efficiency. By the way of careful targeted redesign these identified obstacles can be removed.

In the process of developing electronic educational materials appropriate web-mining methods therefore can provide the possibility of exact intermediary "sampling measurements": the development process after each "sampling measurement" can adopt a course determined by how the learners received the actual version of the material provided. To the identified professional, scientific, didactic, usability, software ergonomic (mainly concerning navigation and information presentation) etc. problems quick redesign answers can be given, which in turn can be tested in the next cycle.

This approach is radically different from the traditional ones, as it is not based on some "representative sampling" concerning the interaction of the learners and the material, but of the contrary, all interactions of all learners can be analysed at the fine resolution of single keystrokes and mouse clicks. This analysis, therefore, is not based on samples more or less representative of the target population (the set of possible learners), it is rather all inclusive in this respect.

An important requirement of successful web-mining is that the analyst be able to interpret the results gained from different models in terms of learner/user experiences. This also means: only those could be really successful who knows the web-mining methods and tools, the actual educational material, and also the actual learners equally deeply enough.

6   Case Studies

Now we present our first results in this field.

Approx. 50 learners of technical teacher training took part simultaneously in processing the Educational technology course, all their activities performed in Moodle learning environment were registered in a log file ("combine log file") by the server. The processing of this log file was performed by the SPSS Clementine web-mining programme. Here we are going to present the first results exposed by quality testing in connection with the students' learning activity, the structure of the syllabus as well as the navigational opportunities.

The course comprises three modules (basics, digital image editing, digital picture editing) and 2-3 syllabus units per module. As shown in Fig. 1, syllabus units are linear and normally of 15-18 screen pages in size.

Visit Page Funnel

Period: 11-febr.-07 - 25-?pr.-07

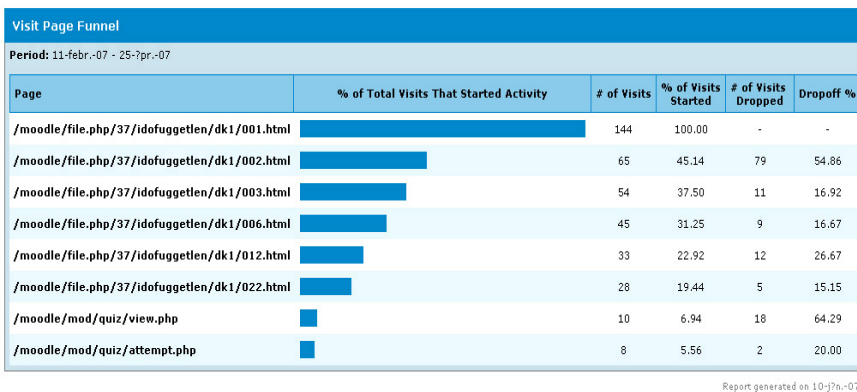| Page	% of Total Visits That Started Activity	# of Visits	% of Visits Started	# of Visits Dropped	Dropoff %
/moodle/file.php/37/idofuggetlen/dk1/001.html		144	100.00	-	-
/moodle/file.php/37/idofuggetlen/dk1/022.html		45	31.25	99	68.75
/moodle/file.php/37/idofuggetlen/dk2/001.html		23	15.97	22	48.89
/moodle/file.php/37/idofuggetlen/dk2/018.html		15	10.42	8	34.78
/moodle/file.php/37/idofuggetlen/dk3/001.html		12	8.33	3	20.00
/moodle/file.php/37/idofuggetlen/dk3/012.html		11	7.64	1	8.33
/moodle/mod/quiz/view.php		6	4.17	5	45.45
/moodle/mod/quiz/attempt.php		5	3.47	1	16.67
/moodle/mod/quiz/review.php		5	3.47	0	0.00

Report generated on 10-j?n.-07

self check test → view.php, attempt.php & review.php

Figure 3

The complete learning process in the module "Digital picture editing"

Visit Page Funnel

Period: 11-febr.-07 - 25-?pr.-07

Page	% of Total Visits That Started Activity	# of Visits	% of Visits Started	# of Visits Dropped	Dropoff %
/moodle/file.php/37/idofuggetlen/dk1/001.html		144	100.00	-	-
/moodle/file.php/37/idofuggetlen/dk1/002.html		65	45.14	79	54.86
/moodle/file.php/37/idofuggetlen/dk1/003.html		54	37.50	11	16.92
/moodle/file.php/37/idofuggetlen/dk1/006.html		45	31.25	9	16.67
/moodle/file.php/37/idofuggetlen/dk1/012.html		33	22.92	12	26.67
/moodle/file.php/37/idofuggetlen/dk1/022.html		28	19.44	5	15.15
/moodle/mod/quiz/view.php		10	6.94	18	64.29
/moodle/mod/quiz/attempt.php		8	5.56	2	20.00

Report generated on 10-j?n.-07

self check test → view.php & attempt.php

Figure 4

Details of the learning process in the first syllabus unit

By the application of the stream called "Visit Page Funnel" in the SPSS Clementine programme the realisation of the parts of learning processes became demonstrable. It can be seen on Fig. 3 that the three subsequent syllabus units and the self-check test of digital picture editing were processed by a very small percent of students during a visit. "Dropping off" was most significant (68,75%) during the first syllabus unit within the complete learning cycle. A modified adjustment of stream could also prove that giving up the processing of the syllabus is typical throughout the syllabus unit, although to a decreasing extent. "Dropping off" is most significant after pages 1-2 (Fig. 4). In fact, this screen page can be regarded as the table of contents for the particular syllabus unit. Traditional lecture notes

are also typically processed in the way that students, before settling down to actual studying, open the table of contents at random, leaf through the syllabus to see whatever there is to be learnt. This is what happened here as well.
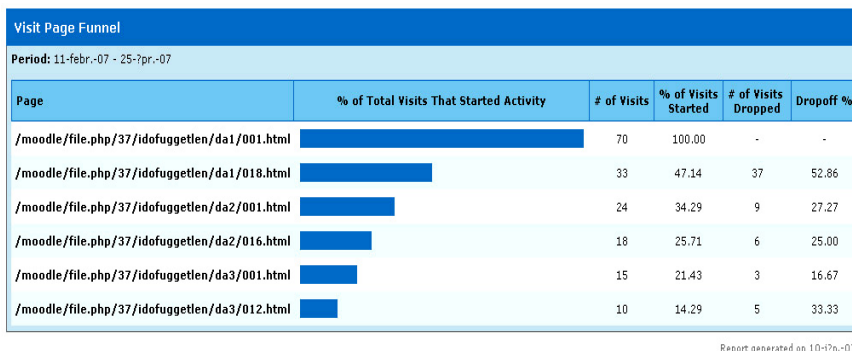
Visit Page Funnel						
Period: 11-febr.-07 - 25-?pr.-07						
Page	% of Total Visits That Started Activity	# of Visits	% of Visits Started	# of Visits Dropped	Dropoff %	
/moodle/file.php/37/idofuggetlen/da1/001.html		70	100.00	-	-	
/moodle/file.php/37/idofuggetlen/da1/018.html		33	47.14	37	52.86	
/moodle/file.php/37/idofuggetlen/da2/001.html		24	34.29	9	27.27	
/moodle/file.php/37/idofuggetlen/da2/016.html		18	25.71	6	25.00	
/moodle/file.php/37/idofuggetlen/da3/001.html		15	21.43	3	16.67	
/moodle/file.php/37/idofuggetlen/da3/012.html		10	14.29	5	33.33	

Report generated on 10-j?n.-07

Figure 5

The complete learning process in the module "Digital image editing"

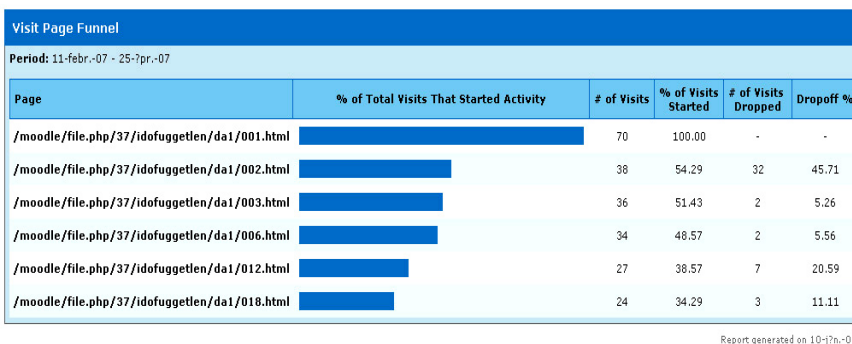| Visit Page Funnel						
Period: 11-febr.-07 - 25-?pr.-07						
Page	% of Total Visits That Started Activity	# of Visits	% of Visits Started	# of Visits Dropped	Dropoff %	
/moodle/file.php/37/idofuggetlen/da1/001.html		70	100.00	-	-	
/moodle/file.php/37/idofuggetlen/da1/002.html		38	54.29	32	45.71	
/moodle/file.php/37/idofuggetlen/da1/003.html		36	51.43	2	5.26	
/moodle/file.php/37/idofuggetlen/da1/006.html		34	48.57	2	5.56	
/moodle/file.php/37/idofuggetlen/da1/012.html		27	38.57	7	20.59	
/moodle/file.php/37/idofuggetlen/da1/018.html		24	34.29	3	11.11	

Report generated on 10-j?n.-07

Figure 6

Details of the learning process in the first syllabus unit

The number of students who started the learning process by first doing the self-check test and then continued by one of the syllabus units is negligible. However, the role of the test was examined from another point of view, too. We did not provide the module "Digital image editing" with a self-check test, being curious to see its effect on the learning process. It turned out that several electronic messages arrived through the system, enquiring about the lack of the self-check test. According to Figures 5-6, "dropping off" during both the complete learning cycle or a part of it decreased in the case when no self check test was attached to the particular module.

With the help of "Clickstream Visualisation" it can be shown where students have arrived from at a selected screen page and where they are moving forward during

a particular learning process. The most frequent direction of syllabus processing is indicated by the bold line in Fig. 7. The figure shows that the number of those students who within the first syllabus unit of the module "Digital picture editing" moved from screen page 1 to page 3 is quite high (33). The reason for this must obviously be that students supposed screen page 2 to belong to the introductory part of the chapter and they wanted to move on to the substantial parts.
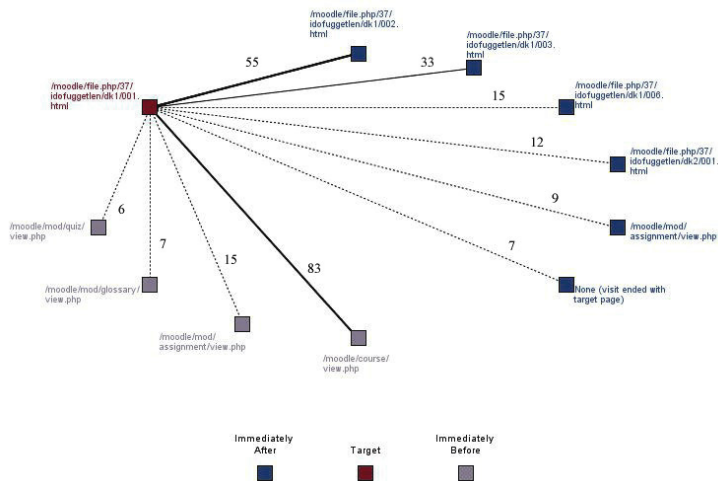

Figure 7

The representation of the learning process in the first syllabus unit

The streams called "Most Common Clickstreams" are appropriate for the presentation and analysis of complete learning processes. This helps to follow through learners' progress in processing the syllabus. It may be shown where the learning process interrupted and whether the time dependent media (narrative audio, animation, video) in the electronic syllabus were eventually played or not. It can be seen that "dropping off" was more significant in the case of longer syllabus units. It is practical to maximise the syllabus units in 14-15 screen pages.

Animations incorporated in the syllabus greatly facilitated the understanding of the syllabus, since processes of program application had to be learnt and animation is an excellent tool for this. Animations can be replayed and stopped at any number of times. Students certainly took these opportunities. The stream called "Most Common Clickstreams" is highly appropriate for the examination of these processes.

According to Fig. 8, narrative explanations also played a decisive role in processing the syllabus. Primarily explanations to aid understanding were audible here. This list was made by "Page Usage Metrics" stream.

Top 100 Pages By Average Time Spent Per Page	
Period: 11-febr.-07 - 25-?pr.-07	
Page	**Average Time Spent on the Page (Seconds)**
/moodle/file.php/37/idofuggetlen/dk3/hangok/003.mp3	1041
/moodle/file.php/37/idofuggetlen/da1/fogalomtar.html	660
/moodle/mod/forum/discuss.php	591
/moodle/login	558
/moodle/file.php/37/idofuggetlen/e2/hangok/008.mp3	555
/moodle/file.php/37/idofuggetlen/da2/hangok/006.mp3	498
/moodle/file.php/37/idofuggetlen/dk1/fogalomtar.html	460
/moodle/file.php/37/idofuggetlen/dk1/hangok/015.mp3	455
/moodle/file.php/37/idofuggetlen/da2/hangok/013.mp3	337
/moodle/file.php/37/idofuggetlen/da3/hangok/004.mp3	321
/moodle/mod/forum/view.php	319
/moodle/file.php/37/idofuggetlen/dk1/hangok/014.mp3	280
/moodle/file.php/37/idofuggetlen/e1/hangok/009.mp3	270
/moodle/file.php/37/idofuggetlen/dk2/hangok/004.mp3	266
/moodle/mod/forum/post.php	257
/moodle/file.php/37/idofuggetlen/da1/hangok/017.mp3	251
/moodle/mod/glossary/index.php	244

Figure 8

The series of subsequent learning operations in the first syllabus unit

Conclusions

The following conclusions are to be drawn after the evaluation of the results.

- Within a particular module students do not prefer the complete learning cycle, that is, the subsequent processing of syllabus units and the completion of the self-check test. During one visit, the processing of one, or occasionally two syllabuses was dominant.

- The so-called reverse learning cycle, that is, the preference of self-check tests to information imparting parts was not typical.

- Within a particular syllabus unit, mainly with respect to page 1-2, a significant "dropping off" was seen, which is to be interpreted as students' orientation preceding actual learning.

- The analysis also indicated that time dependent media (narrative audio, animation, video) play a decisive role in processing the syllabus. They significantly promote the understanding of the syllabus.

Taking the above aspects into consideration, the directions of the electronic learning environment upgrade may be formulated as follows.

- It is practical to maximise the syllabus units in 14-15 screen pages.

- It is practical to incorporate self-check tests, similarly to the glossary, in the electronic syllabus, particularly at the end of the syllabus unit, the accomplishment of which is the prerequisite for opening the following syllabus unit.

- During development, a page finder window was also placed at the bottom of each page. This interfered with the sequential processing of the syllabus and resulted several times in the omission of substantial pages. A little more detailed exposition of the first, i.e. the introductory page makes it redundant to break the sequence.

- The inclusion of further time dependent media in the electronic syllabus makes learning more productive and efficient in this environment.

References

[1]   Pál Pentelényi (ed.): Virtual Learning Environments – Training Material. Ligatura Ltd., Budapest, 2006, p. 131

[2]   János Abonyi (ed.) Adatbányászat a hatékonyság eszköze. (Data mining as Device of the Efficiency). ComputerBooks, Budapest, 2006, p. 400

[3]   László Ketskeméty, Lajos Izsó: Bevezetés az SPSS programrendszerbe. Módszertani útmutató és feladatgyűjtemény statisztikai elemzésekhez (Introduction to SPSS. A Methodological Guide and a Workbook for Statistical Analyses). Eötvös Kiadó, Budapest, 2005, p. 459

[4]   Lajos Izsó: Applying Web-Mining Methods for Quality Assurance of Internet-based Educational Materials. (A revised and extended version of the plenary presentation given at the "13th Multimedia in Education Conference") Journal of Applied Multimedia, 2/II/2007, pp. 15-20

[5]   SPSS Inc.: Web Mining for Clementine® 1.5. User's Guide Powered by NetGenesis, Chicago, 2005, p. 89

[6]   Péter Tóth: Virtual Learning Approach in Vocational Initial Teacher Training. Proceedings of the International Conference on Engineering Education, 2007, Coimbra, ID 76

[7]   SCORM 2004 3rd Edition, version 1.0, ADL, 2006, http://adlnet.gov

[8]   Gilly Salmon: E-tivities. The Key to Active Online Learning. Taylor & Francis, London, 2002, p. 244