# New Method in Quality Assurance of Electronic-based Teaching Materials

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**Index Terms**: 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 areas of the application for the syllabus package are teacher training and in-service teacher training as well. 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 also in a form downloadable from an FTP server.

The electronic syllabus package was comprised of the following parts:

- Basic skills module: it presents the basic terminology of educational technology and multimedia development and expectations towards such materials.
- Editing Individual media module: its purpose is to learn the skills necessary for the activities related to the planning and editing of digital media. This module consists of two pats. One presents the tools of editing time-independent (images and figures) while the other those of time-dependent (audio and video) media.
- Multimedia Editing module: to learn the skills related to Authorware shell necessary for the development of e-learning software.

Two methodological aids were also developed to accompany 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 considered it 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 set as its aim 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;
- 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.

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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 following 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 get to know 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 upon 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].

Figure 1 shows the screen design of the electronic teaching materials. In the top left hand corner of the screen, we can see the current unit, in the top right hand corner, navigation links to the chapters, the glossary and to help, while in the bottom right hand corner we can see sequential navigation links within the unit itself. In addition to the time-dependent parts of the subject matter (text and images), time-dependent meadia (narratives, animations and videos) may be started in the bottom left hand corner. In order to avoid packed screens, in justified cases there are floating windows to present further textual information.

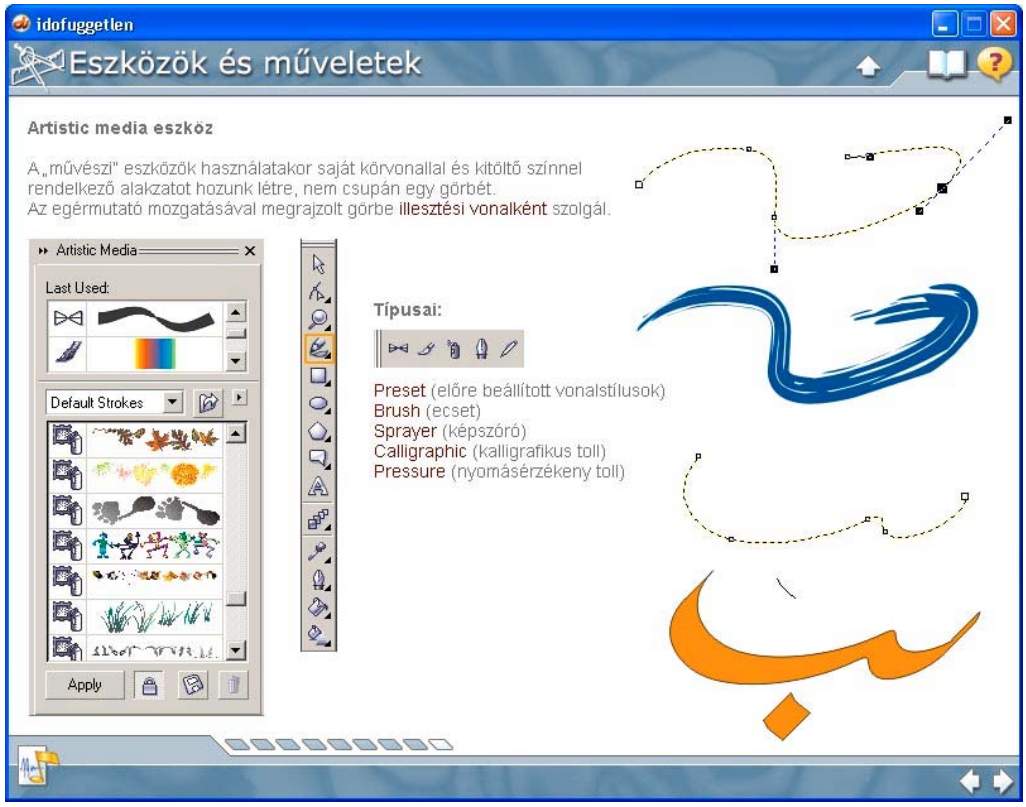



Fig. 1. The graphic surface of the electronic teaching material

This quality testing must cover the content and structure of the syllabus as well as such elements of the user interface as for example 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 2 shows the structure of the course under scrutiny. Having entered Moodle, the learner selects first the course to be studied then the most appropriate ones 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 depending on whether the student has obtained a given test score or not.

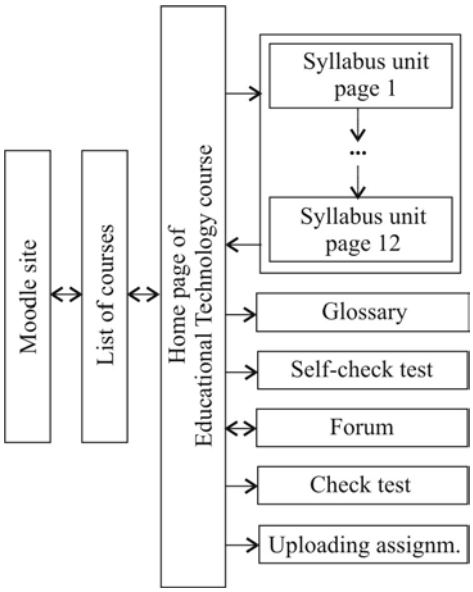



Fig. 2. The structure of the syllabus content

The SCORM standard recognises two kinds of navigation: one within the content object, 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. 3):

- 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.
- net-like (d)
  Net-like navigation makes it possible for students to navigate from any one page to an optional other 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.

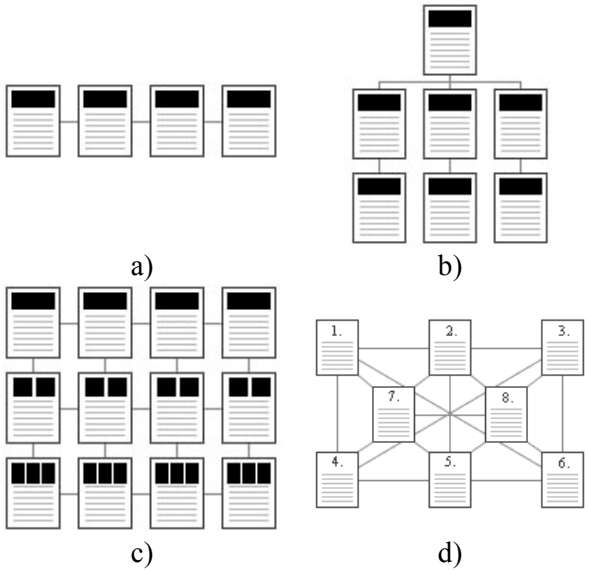



Fig. 3. The basic type of navigation

## 3. CO-OPERATIVE AND COLLABORATIVE LEARNING IN VLE

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 her own learning. She 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 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 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 copies of each new posting in their email. A teacher can impose subscription on everyone if they want to.

3. 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 distribution of these assessments in a variety of ways.

4. Wiki

Wikis enable participants to work together on web pages to add, expand and change the content. Wikis are often used to create collaborative websites and to power community websites, e. g the collaborative encyclopedia "Wikipedia" is the best known wiki.

## 4. WEB-MINING METHOD

Web-mining, was first mentioned by Etzioni [9], who suggested that traditional data-mining techniques for finding hidden patterns in huge databases, can be used to web-based information. Web-mining is an emerging method in education research, assisting instructors and developers in improving learning environments and supporting decision-making of policymakers [10].

Models for applying usage mining as a research method in education were suggested by Pahl [11] and Zaïane [12], although earlier research already discussed the potential of analysing on-line courses using this method [13]. According to Pahl, usage mining of e-learning is totally different from usage mining of e-commerce, since the learning process is far more complicated than the shopping process, and its cognitive aspects are much more difficult to track by means of log files.

Ai and Laffey compared the data mining questions in business, traditional education and e-learning, Table 1 shows the approach differences. [14]

| Business | Face-to-face higher education | E-learning |
|---|---|---|
| Who are my most profitable customers? | Who are the students taking most credit hours? | Who are the students with highest frequency of logging-in? |
| Who are my repeat Web-site visitors? | Who are the ones likely to return for more classes? | Who are the students most engaged on discussion boards? |
| Who are my loyal customers? | Who are the persistent students at our university, college? | What pages do the students access most? |
| What clients are likely to defect to my rivals? | What type of courses can we offer to attract more students? | What kinds of students are likely to get a high score on-line? |

Table 1.Comparison of data mining philosophy in business, traditional higher education and e-learning

That is to say 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 websites.

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 length of the time period studied – 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 pieces of information characterising the visitors’ behaviour and motivation should be gained from it. [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 analysis 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.

A 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 above mentioned 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 – for the analogy of the quality control of industrial manufacturing processes – 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 for them. 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.

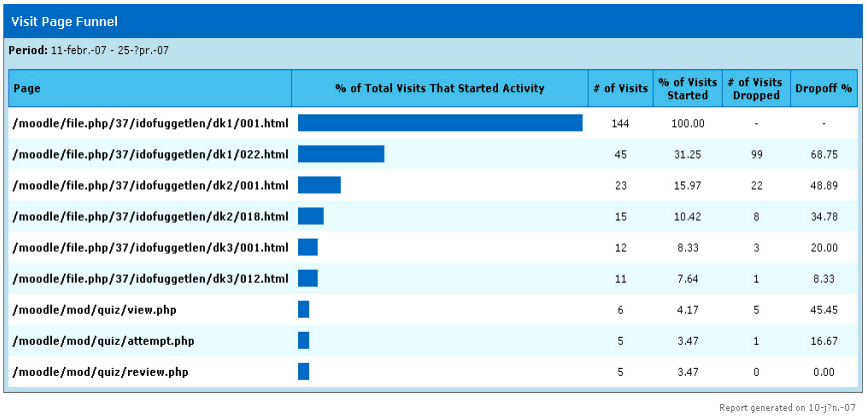
This approach is radically different from the traditional ones, as it is not based upon some "representative sampling" concerning the interaction of the learners and the material, but of the contrary, all interactions of all learners can be analysed at the fine resolution of single keystrokes and mouse 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.

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 the activities of whom 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. 2, 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 |

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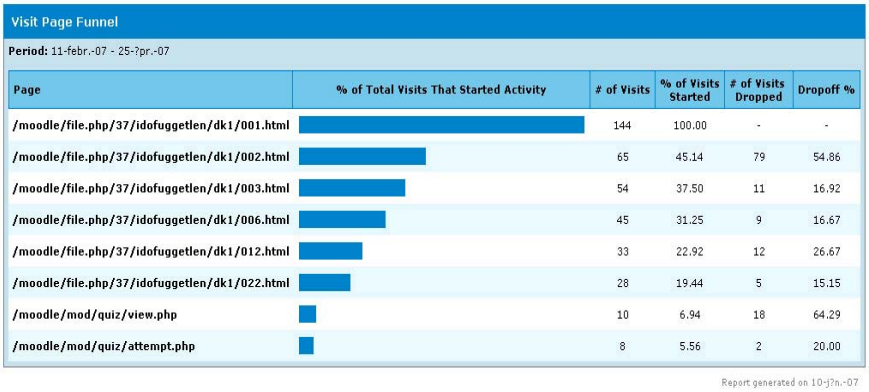
Fig. 4.The complete learning process in the module "Digital picture editing"



Visit Page Funnel

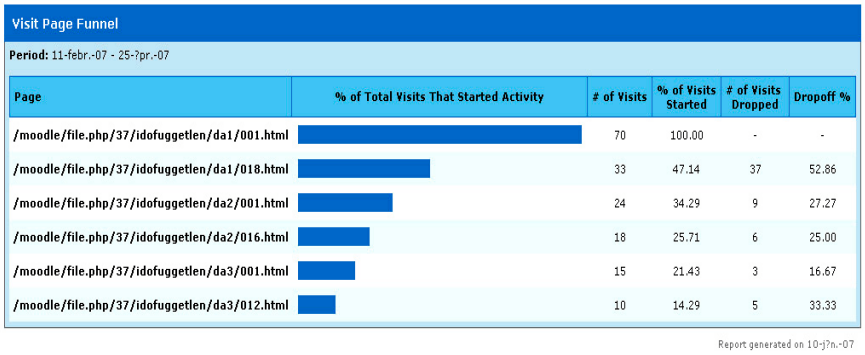
Period: 11-febr.-07 - 25-?pr.-07

| 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

Fig. 5. 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 is to be seen from Fig. 4 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. 5). 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 |

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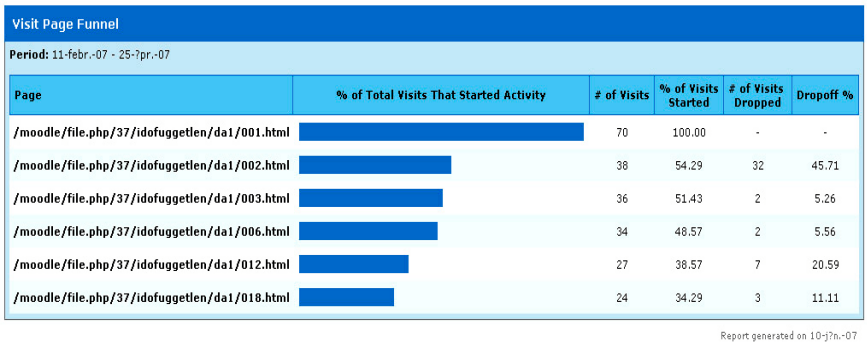
Fig. 6. The complete learning process in the module ”Digital image editing”



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

Fig. 7. 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. Naturally, several electronic messages arrived through the

system, enquiring about the lack of the self-check test. According to Figures 6-7, ”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. 8. 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 substantial parts.

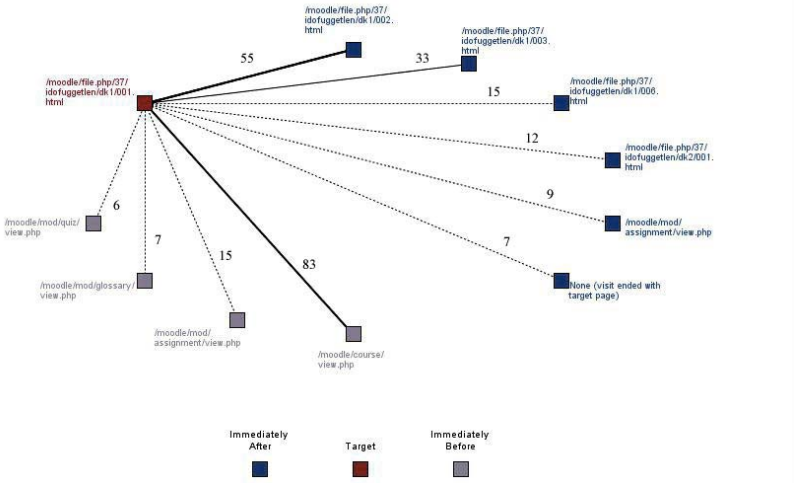



Fig. 8. The representation of the learning process in the first syllabus unit

The streams called Most Common Clickstreams is 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 syllable were eventually played or not. It is to be seen that ”dropping off” was more significant in the case of longer syllabus units. It is practical to maximise the syllabus units in 15-17 screen pages.

**Top 100 Pages By Average Time Spent Per Page**

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

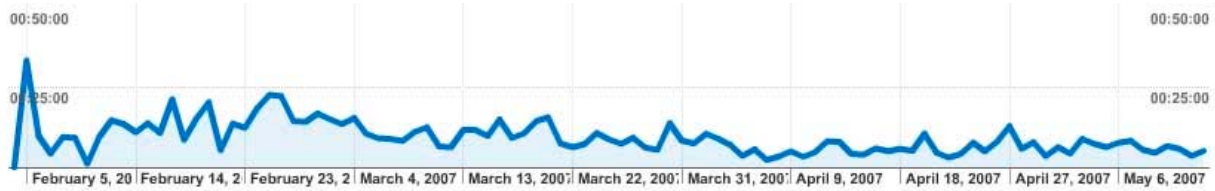
| Page | Average Time Spent on the Page (Seconds) |
|---|---|
| /moodle/file.php/37/idofuggetlen/dk3/hangok/003.mp3 | 1041 |
| /moodle/file.php/37/idofuggetlen/da1/fogalomtar.html | 660 |
| /moodle/mod/forum/discuss.php | 591 |
| /moodle/login | 558 |
| /moodle/file.php/37/idofuggetlen/e2/hangok/008.mp3 | 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 |

Fig. 9.The series of subsequent learning operations in the first syllabus unit

Animations incorporated in the syllabus largely facilitated the understanding of the syllabus, since processes of programme application had to be learnt and animation is an excellent instrument for it.

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. 9, narrative explanations (mp3 files) 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.


a)




b)

| Length of Visit | Visits | Percentage of all visitors |
|---|---|---|
| 0-10 seconds | 1,166 | 12.26% |
| 11-30 seconds | 1,235 | 12.98% |
| 31-60 seconds | 1,252 | 13.16% |
| 61-180 seconds | 2,045 | 21.49% |
| 181-600 seconds | 1,707 | 17.94% |
| 601-1,800 seconds | 1,335 | 14.03% |
| 1,801+ seconds | 774 | 8.14% |

c)

| Number of Visits | Visits | Percentage of all visitors |
|---|---|---|
| 1 times | 2,349 | 24.69% |
| 2 times | 949 | 9.97% |
| 3 times | 482 | 5.07% |
| 4 times | 332 | 3.49% |
| 5 times | 268 | 2.82% |
| 6 times | 235 | 2.47% |
| 7 times | 221 | 2.32% |
| 8 times | 195 | 2.05% |
| 9-14 times | 917 | 9.64% |
| 15-25 times | 1,100 | 11.56% |
| 26-50 times | 1,155 | 12.14% |
| 51-100 times | 681 | 7.16% |
| 101-200 times | 470 | 4.94% |
| 201+ times | 160 | 1.68% |

e)

| Depth of Visit | Visits | Percentage of all visitors |
|---|---|---|
| 1 pages | 889 | 9.34% |
| 2 pages | 352 | 3.70% |
| 3 pages | 689 | 7.24% |
| 4 pages | 880 | 9.25% |
| 5 pages | 898 | 9.44% |
| 6 pages | 823 | 8.65% |
| 7 pages | 635 | 6.67% |
| 8 pages | 517 | 5.43% |
| 9 pages | 466 | 4.90% |
| 10 pages | 359 | 3.77% |
| 11 pages | 294 | 3.09% |
| 12 pages | 251 | 2.64% |
| 13 pages | 244 | 2.56% |
| 14 pages | 192 | 2.02% |
| 15 pages | 168 | 1.77% |
| 16 pages | 151 | 1.59% |
| 17 pages | 130 | 1.37% |
| 18 pages | 130 | 1.37% |
| 19 pages | 106 | 1.11% |
| 20+ pages | 1,340 | 14.08% |

d)

Fig. 10. Further typical data for describing students' behaviour by Google Analytics

Figure 10 shows further data for describing students' behaviour: pageview (a), spending time on the given VLE course (b), length of visit (c), depth of visit (d), loyality of students (e).

A *pageview* may be defined as a view of a page in the course. If a visitor hits reload after reaching the page, this will be counted as an additional pageview. If a user navigates to a different page and then returns to the original page, a second pageview will be recorded as well. *Time on site* is one way of measuring visit quality. If students spend a long time visiting the course, they may be interacting extensively with it. *Length and depth of visit* is a measure of visit quality. A large number of lengthy visits and high pageviews per visit suggests that students interact more extensively with the VLE course. *Loyal students* are frequently highly engaged with the brand and a high number of multiple visits indicates good student retention. A high number of new students indicates strong student recruitment. (Fig. 10)

## 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 less frequently 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 pp 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.

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