

An approach for Analysis and Evaluation of Virtual Learning Environments

Galina Ivanova
University of Rousse
Rousse 7017
8, Studentska Str.
+359 82 888-827

givanova@ecs.ru.acad.bg

Angel Smrikarov
University of Rousse
Rousse 7017
8, Studentska Str.
+359 82 888-743

asmrikarov@ecs.ru.acad.bg

ABSTRACT

The paper gives an overview of some issues involved in evaluating and analyzing VLE. An approach for analysis and evaluation has been presented. A methodology for evaluation and analysis of VLE has been outlined. The paper briefly reviews some instruments that can be used for VLE evaluation and analysis. An example for VLE evaluation and analysis plan using the learning record online of Google Analytics is presented.

Categories and Subject Descriptors

H.4.0 [Information System Application - General]:

General Terms

Measurement, Experimentation, Verification.

Keywords

Virtual learning environments, e-learning, virtual university

1. INTRODUCTION

Evaluation and analysis are central to ensuring the quality of e-learning. A single model for analyzing and evaluating virtual learning environment is hard to define. Part of the problem is that this field is still in an early stage of development and appropriate framework for evaluation and analysis of different VLE has not been established. Other part of the problem is that the subject is too big to cover in detail. There are many different aspects and dimensions to VLE and the question is: what kinds of methods are appropriate for exploring them and how can different methods be aggregated to form complete framework for VLE evaluation and analysis? Britain, for example, focuses on the pedagogical aspects of VLE evaluation and proposed a framework for pedagogical evaluation of VLE [1].

We are going to use other point of view to evaluate and analysis VLE. The purpose of the paper is to draw one approach for VLE evaluation and analysis, which will combine different models, methods, techniques and instruments. This approach can be used for different VLE types.

2. METHODOLOGY FOR VLE EVALUATION AND ANALYSIS

A methodology for VLE evaluation and analysis is presented on Fig.1.

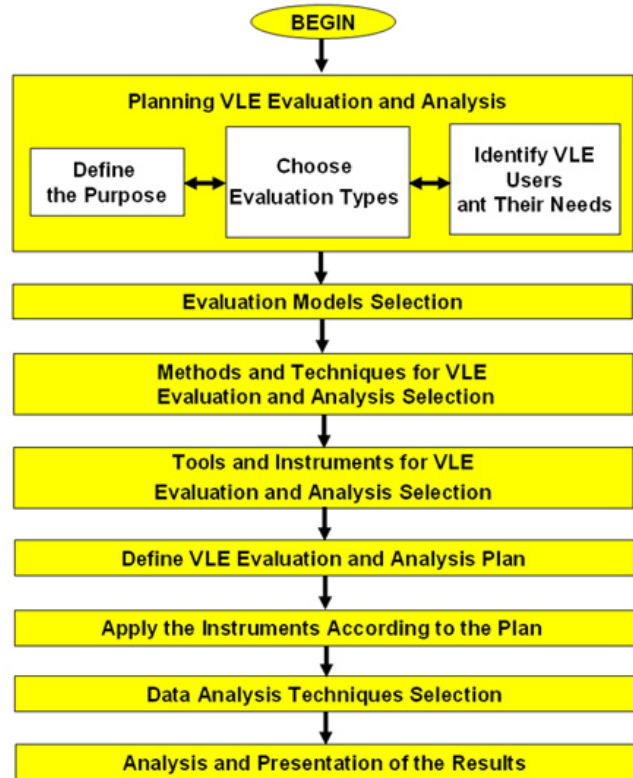


Fig. 1. A methodology for VLE evaluation and analysis

3. PLANNING VLE EVALUATION AND ANALYSIS

3.1 Define the purpose

The very first question is to define the purpose of the VLE evaluation is. It has to be defined whether the evaluation is for needs analysis (diagnostic), developmental (formative) or monitoring (summative) purposes [2, 4]:

- *diagnostic* – learning from the potential users to change practice;
- *formative* - learning from the process; to inform practice; or
- *summative* - learning from the product; to inform others about practice.

3.2 Evaluation types

Oliver [3] identified four different evaluation types:

- **Needs analysis Evaluation** – An assessment of the current situation, its strengths and weaknesses, and to what extent and in what ways the resource in question may help. Information about whether suitable equipment is available, potential users' attitudes and skills may also be relevant here. Needs analysis is frequently omitted from the development process, often with disastrous results.

- **Formative Evaluation** – This involves collecting information about a prototype resource that will help in its development and ensure it works effectively. One of the problems of needs analysis is that it can be difficult for potential users to imagine the benefits of something that doesn't exist yet. At the formative evaluation stage there is something tangible that they can see and comment on. Emphasis at this point is typically on improving usability and refining content.

- **Summative Evaluation** – This takes place at the end of the developmental cycle, in order to prove the success of the resulting resource. For teaching and learning resources, this may involve demonstrating that the resource has made a difference in some tangible way. This may be to show that users have learned something from it, or that it has brought about a beneficial change in practice.

- **Integrative Evaluation** – This kind of evaluation acknowledges that it is difficult to demonstrate that a change in practice or in knowledge over time can be attributable to a single isolated resource. The Integrative approach therefore looks at how the resource is used in conjunction with all the other resources that are available to its users. It will focus on users' opinions and level of use of the resource, and on how it is embedded into the course as a whole.

3.3 Identify VLE users and their needs

In designing VLE evaluation and analysis, it is important to be clear on who it is being carried out for. VLE users might be:

- Students – may mainly be interested in how easy and enjoyable it is to use, and whether it will help them get through the overall process of e-learning
- Teachers – will perhaps be mostly interested in whether any content is of high quality, and whether it fits into the course
- Web programmers – will need to consider whether any changes required are feasible and how long they will take, as well as discovering any bugs in the program
- System administrators – will need to consider what the hardware implications of the resource will be, or for example whether it might cause any disruptions to the network
- Managers – will want to know whether the resource fits into the institutional strategy and whether it can enhance the status and attractiveness of the institution

A stakeholder analysis will assist you in further defining the purpose and focus of the evaluation. It will determine whether your evaluation is diagnostic, formative or summative.

4. EVALUATION MODELS

Evaluation models can be used to help you define the parameters of an evaluation. There are a wide range of learning evaluation frameworks and models:

- **Cybernetic Model for evaluating Virtual Learning Environments** - In [1] it is shown how the model can be adapted for use in an educational context. It is proposed that core processes within the adapted model, which could be used as

criteria to evaluate the functionality of VLEs. One of the main benefits of this model is that it probes a whether a system can support a resource-based, student-centred teaching approach, amplifying the teacher's variety and attenuating the variety in the learner group to make the teaching approach viable - BUT without treating all learners as if they were all the same.

- **Connoisseurship Model** - Based on principles borrowed from art criticism, claiming that the evaluator's background must include the ability to appreciate (perceive and criticize) at an expert's elite level. Method is highly subjective, and works well only in situations where concepts of mastery (training in surgery, sports, theatre, music) are widely shared [4].

- **Qualitative Evaluation Model** - These include the various naturalistic forms of evaluation, emphasizing the value of subjective human interpretation of the observations made. Evaluator's role is to provide expert judgments on the outcomes of interest [4].

- **Goals-Free Model** - Evaluation by induction: evaluator begins by examining outcomes of the program and attempts to infer the intended objectives from these observations. Evaluator identifies and interviews actual participants rather than program management and staff. Idea is to discover whether evaluator can match observed (implicit) goals with stated (explicit) goals without biasing the evaluation in advance by being told what they are "supposed to be" [4].

- **The Conversational Framework Model**

It is developed by Laurillard as an evaluation model for virtual learning environments. The model raises questions about the mechanisms that support conversations. How easy is it to track conversations relating to a particular issue? Can conversations be enhanced by presentation of additional resources? Yet other questions relate to the overall flexibility of the system. How adaptable are micro-world structures once they are in use? How easy is to tailor them to individual students needs?[1]

5. METHODS AND TECHNIQUES FOR VLE EVALUATION AND ANALYSIS

There are various methods and techniques for VLE evaluation and analysis [4]:

- **Interviews** - Interviews are a powerful means of collecting data about learner or instructor reactions to a new interactive multimedia program. However, interviews need to be carefully planned so that you get the kind and quality of information you are seeking. This "Interview Protocol" [5] is a brief example of a list of questions that might be addressed during an interview regarding an interactive multimedia program.

- **Focus groups** - Focus groups are a somewhat informal technique that can help you assess user needs and feelings both before interface design and long after implementation, [6]. As with other methods based on asking users what they want -- instead of measuring or observing how they actually use things -- focus groups can produce inaccurate data because users may think they want one thing when they need another. You can minimize this problem by exposing users to the most concrete examples of the technology being discussed as possible.

- **Questionnaires** - Questionnaires are undoubtedly the single most frequently used type of evaluation methods, [9]. Poorly designed questionnaires are often administered at the close of a course or training session as a "happiness indicator." They are also often distributed to users of interactive multimedia programs.

If the only thing you find out about your interactive multimedia program with a questionnaire is whether the trainees liked it, you are not making good use of this strategy. As shown in the "Questionnaire," a wealth of information can be provided by a well-designed instrument.

- **Textual data** - One of the most powerful ways of evaluating courses or elements of courses that use text-based technologies such as email or computer mediated conferencing is to collect and examine the text that is produced during the course. This can tell you a lot about how many students participated and how often, the quality of the contributions, and the extent of the interaction that takes place. It may also possible to see the effect on learners' thinking of a given intervention, whether from the teacher or another learner.

- **System log data** - Using specialised computer software, it is possible to make a step by step recording of user interaction with a particular resource. This data is useful in tracking users preferences and navigational choices, and can be triangulated with observations, questionnaires and interviews. For resources on the world-wide web, most servers keep logs of every access to every page on the server, and these can tell you how users navigate through the site and which pages are most popular. A number of software programs are available that can analyse this data and present it in the format you require. However it should be borne in mind that web logs are very unreliable and should only be taken as a general guide to activity on the server.

6. TOOLS AND INSTRUMENTS FOR VLE EVALUATION AND ANALYSIS

- **Evaluation Matrix** - The "Evaluation Matrix" tool will help you consider the most appropriate and feasible data collection method for each of the questions identified in your evaluation plan. The tool prompts you to consider each evaluation question and to decide which of the many data collection options have the greatest potential for providing the desired information, [8].

- **The Motivational Orientation Scale** - It is used to assess students motivational orientations, [11].

- **Anecdotal Record Form** - Evaluation data does not have to be reported as "cold hard statistics." Often you will want to tell the "human story" involved in your development or implementation project. One way of capturing those important stories and critical incidents that provide the human story is the "Anecdotal Record Form." Participants in an interactive multimedia design project can use this instrument to describe a noteworthy event and to offer their own interpretation of its relevance, [10].

- **Flashlight Online** - The Flashlight Online tool [12] allows instructors to select pre-defined items from a database of 500 items that can be used in student surveys, interviews, or focus groups. Instructors can utilize Flashlight Online to develop course-specific surveys related to educational uses of technology, post surveys on the Web for student access, and retrieve basic data corresponding to student responses.

- **Web-based survey tools** - Web based survey tools are available as a hosted services via the internet. Utilizing web based survey tool allows you to focus entirely on the design and content of the surveys because all of the technical details are handled automatically. Virginia Tech offers a new Web-based survey tool [7]. It is available for use to every V.T. faculty, staff, and students.

- **Google Analytics** - Google Analytics offers a host of compelling features and benefits for web-site analysis. It provides

useful analysis information about: visitor's types; visitors interaction within website; identification of the navigational bottlenecks; keywords usage and other capabilities that experienced web analytics professionals expect, [13].

7. EVALUATION AND ANALYSIS PLAN

We are going to present one approach for analysis of virtual learning environments using the learning record online of Google Analytics. The data in the example are taken for Virtual INFO Center for PHD Students and Bulgarian Virtual University web sites.

Virtual INFO Center is created for all Bulgarian PhD Students. The Center is free for use and doctoral students can find a lot of useful information and learning materials for 13 PhD courses.

Bulgarian Virtual University is a national educational portal to Bulgarian high institutions and their virtual learning environments.

Evaluation and Analysis Plan:

1. Period of analysis: 01 April 2006 – 01 June 2006

2. Number of unique visitors: 4 608 (BVU); 3 758 (PHD Center)

3. Unique visitors tracking

On Fig.1 it is shown the number of visits per day and the number of web pages viewed for the analysis period. The data is taken from the Bulgarian Virtual University web site.

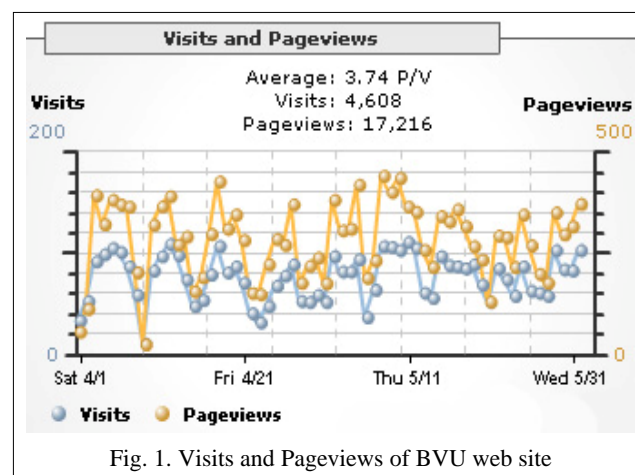


Fig. 1. Visits and Pageviews of BVU web site

Using these analysis data some conclusions about visitor's activity for each week day can be made.

4. New and Returning Visitors

This report compares new and returning visitors with respect to conversions and average per visit value, Fig.2. The figure gives information, what part of the users has found useful information in the web site and have returned. The big number of the new visitors shows that the interest of the web site is growing and web site advertisement is good. New visitor is the number of visitors (counting each visitor only once) who visited the web site for the first time during the active period. Returning visitors is the number of visitors (counting each visitor only once) who first visited the web site prior to the active period and who returned for one or more visits during that period.

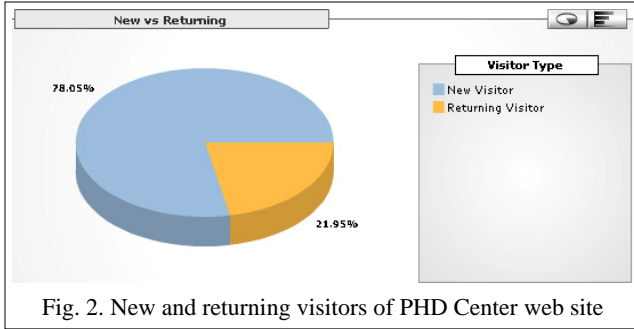


Fig. 2. New and returning visitors of PHD Center web site

5. Visitors geo location, Fig. 3, Fig. 4

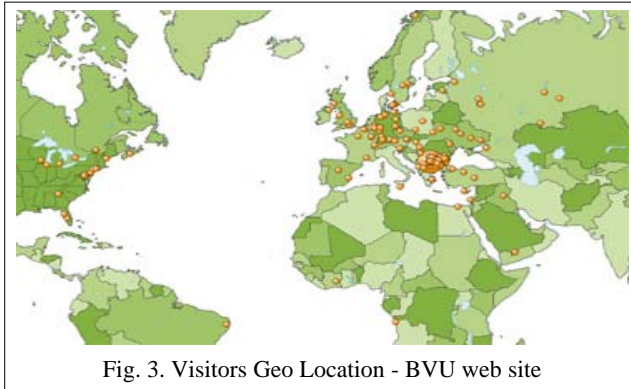


Fig. 3. Visitors Geo Location - BVU web site

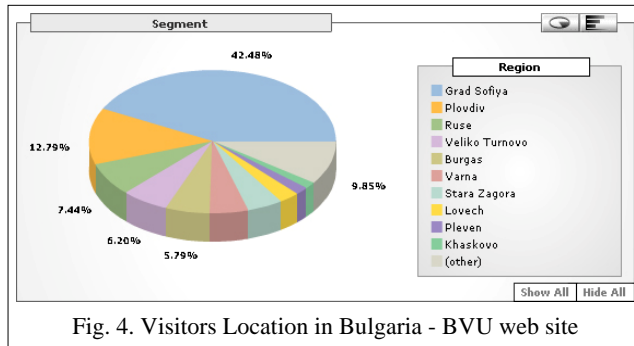


Fig. 4. Visitors Location in Bulgaria - BVU web site

Using these analysis data, some conclusions about visitor's interest all over the world can be made. This analysis gives information that one of the aims of BVU to be useful not only in Bulgaria, but also for Bulgarians all over the world, is realized. At this stage of the Plan can be analyzed also the Visitors Network Location (ISP and corporate network), Visitors domains (ISP domains the user resolves to).

6. Referring visitors source

At that stage can be analyzed the referring visitor's source (such as search engine, newsletter, or referral site). On Fig. 5 the keywords usage to find the PHD Center in Google search engine is presented. Using these analysis data, some conclusions about visitor's specific interest can be made. For example PhD thesis is the most used keyword.

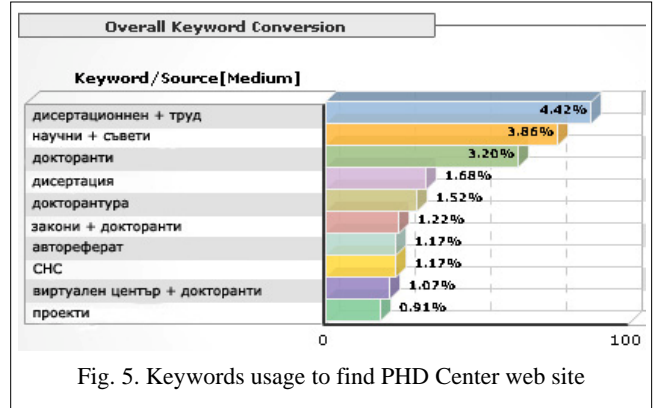


Fig. 5. Keywords usage to find PHD Center web site

The data can be used in order to enrich the information in the web site with more useful materials about PHD thesis structure, layout and presentation.

7. Content Performance

At this stage can be analyzed which pages of VLE web site are the most popular, how well do they capture users' interest, and how valuable are they to VLE web site?

On Fig.6 it is shown an example about a report compares pages by HTML title tag. Pages are compared in terms of the number of unique views.

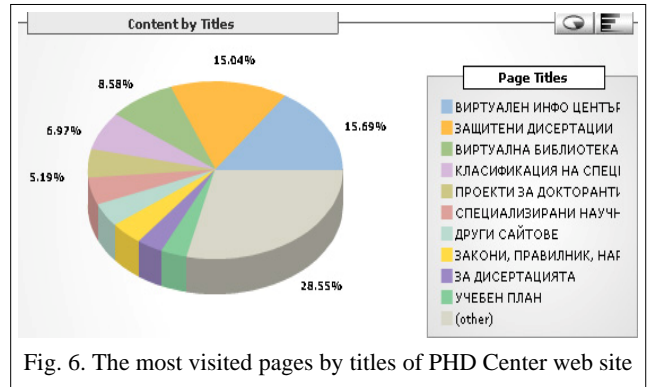


Fig. 6. The most visited pages by titles of PHD Center web site

One of the most visited pages is Virtual library. The page includes 13 online learning courses for PhD students. The analysis data shows that students find the learning materials in the library very useful.

8. Navigational analysis

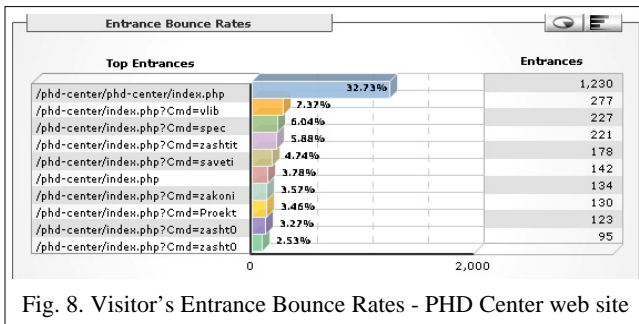
The navigational analysis includes several steps. The analysis on Fig. 7 shows how the content of VLE becomes more or less effective at retaining visitors. The report shows whether site entrances have increased or decreased from a previous date range to the current date range. The data in Fig.6 are taken for one week period.

The report on Fig. 8 lists the top entrance pages on which visitors land and their respective number of Bounces and Bounce Rates. Bounce is the number of times visitors immediately exit your site from the entrance page. Bounce rate is calculated by taking the number of bounces and dividing it by the number of entrances.

Top 5 Entrances			Entrances	%±
1.	/phd-center/phd-center/index.php		123	↓ -2%
2.	/phd-center/index.php?Cmd=zasht05		98	↑ 139%
3.	/phd-center/index.php?Cmd=zasht04		79	↑ 316%
4.	/phd-center/index.php?Cmd=zasht01		65	↑ 67%
5.	/phd-center/index.php?Cmd=zasht02		62	↑ 77%

Top 5 Content			Visits	%±
1.	/phd-center/index.php?Cmd=zasht05		137	↑ 108%
2.	/phd-center/index.php?Cmd=vlib		129	↑ 17%
3.	/phd-center/phd-center/index.php		125	↓ -5%
4.	/phd-center/index.php?Cmd=zashtiti		122	↑ 51%
5.	/phd-center/index.php?Cmd=spec		92	↓ -3%

Fig. 7. Top 5 Entrances and Content variations
- PHD Center web site



On Fig. 9 the page "Virtual Library" of PHD Center is analyzed. The number of clicks is displayed for each Click From and Click To page. Pages with the highest average score are those pages with most commonly visited priorities. The example shows that about 20 % of the visitors are well known with the VLE site and go directly to Virtual Library site and leave it also directly.

Top 10 Clicks From				
	Clicks	Clicks %	G1/Clicks	Avg. Score
1. /phd-center/index.php?Cmd=vlib	459	29.84%	0.00%	0.00
2. (entrance)	277	18.01%	0.00%	0.00
3. /phd-center/phd-center/index.php	179	11.64%	0.00%	0.00
4. /phd-center/index.php?Cmd=uplan	87	5.66%	0.00%	0.00
5. /phd-center/index.php?Cmd=spec	49	3.19%	0.00%	0.00
6. /phd-center/index.php	46	2.99%	0.00%	0.00
7. /phd-center/index.php?Cmd=Proekti	45	2.93%	0.00%	0.00
8. /phd-center/index.php?Cmd=saveti	42	2.73%	0.00%	0.00
9. /phd-center/index.php?Cmd=zakoni	34	2.21%	0.00%	0.00
10. /phd-center/index.php?Cmd=sites	31	2.02%	0.00%	0.00

/phd-center/index.php?Cmd=vlib (1,538)

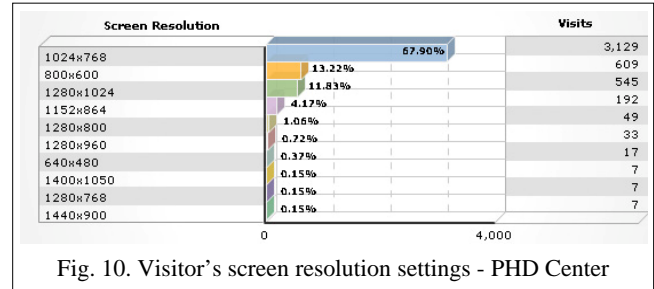
Top 10 Clicks To				
	Clicks	Clicks %	G1/Clicks	Avg. Score
1. /phd-center/index.php?Cmd=vlib	459	29.84%	0.00%	0.00
2. (exit)	357	23.21%	0.00%	0.00
3. /phd-center/index.php?Cmd=Proekti	72	4.68%	0.00%	0.00
4. /phd-center/phd-center/index.php	62	4.03%	0.00%	0.00
5. /phd-center/index.php?Cmd=iplan	60	3.90%	0.00%	0.00
6. /phd-center/index.php?Cmd=vlib&Cmd=	51	3.32%	0.00%	0.00
7. /phd-center/index.php?Cmd=spec	49	3.19%	0.00%	0.00
8. /phd-center/index.php?Cmd=sites	46	2.99%	0.00%	0.00
9. /phd-center/index.php?Cmd=zashtiti	39	2.54%	0.00%	0.00
10. /phd-center/index.php?Cmd=disert	38	2.47%	0.00%	0.00

Fig. 9. Page navigation analysis from and to
- PHD Center web site

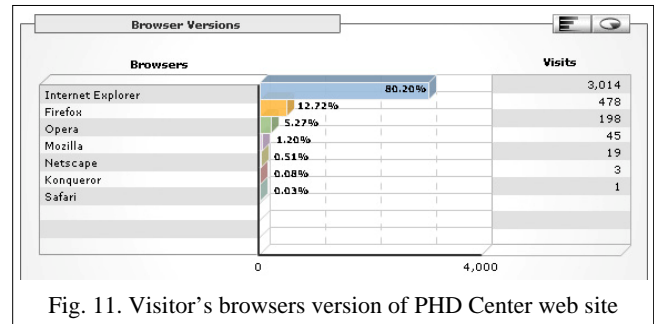
9. Web Design Parameters

At that stage can be analyzed the visitor's preferences settings: screen resolution, colors, languages, browsers version, browsers and platforms combinations.

On Fig. 10 the report allows examining which screen resolutions the VLE users are seeing the site in. If the majority are using a lower resolution (for example as it shown 1024x768) than the web master can examine VLE site's functionality using the common resolution.



On Fig. 11 the report provides a list of browser versions used to access VLE site.



On Fig.12 the report allows reviewing which browser version, platform type and their combinations VLE visitors are using. This information can be used in the process of VLE development and optimization. For example Netscape browser was popular in the past, but nowadays his usage become smaller, as is shown on Fig.11.

Browsers - Platform	Visits
1. Internet Explorer 6.0 - Windows XP	3,200
2. Internet Explorer 6.0 - Windows 98	144
3. Firefox 1.5.0.3 - Windows XP	140
4. Firefox 1.0.7 - Windows XP	100
5. Internet Explorer 5.0 - Windows 98	93
6. Firefox 1.5.0.1 - Windows XP	86
7. Internet Explorer 6.0 - Windows 2000	76
8. Firefox 1.5.0.2 - Windows XP	61
9. Opera 8.54 - Windows XP	50
10. Opera 8.0 - Windows XP	40

Fig. 12. Visitor's browsers and platform combination
- BVU web site

10. Visitor's speed connection

The data on Fig. 13 give an answer of one very important question: "For which connection speeds should I optimize my VLE web site and its learning content?". On Fig.13 percent refers to the percentage of total visits that came from browsers with this connection speed.

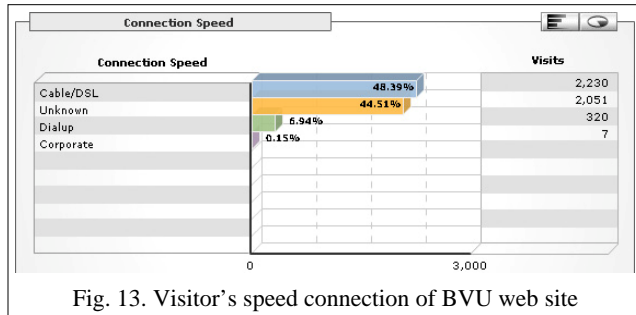


Fig. 13. Visitor's speed connection of BVU web site

11. Analysis Visitors loyalty

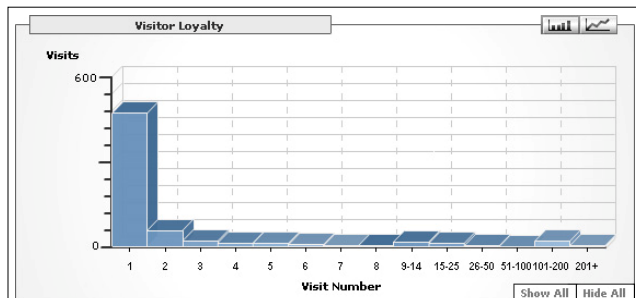


Fig. 14. Visitor's loyalty - BVU web site

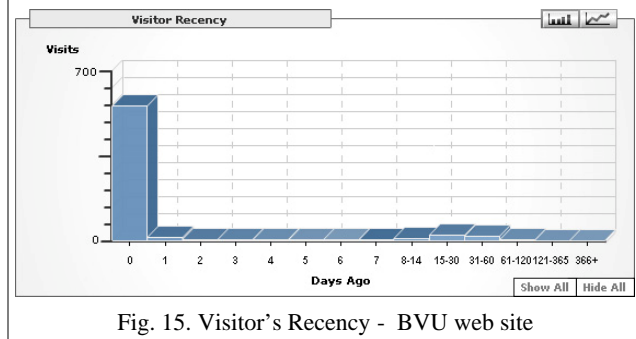


Fig. 15. Visitor's Recency - BVU web site

The graphs on Fig. 14 and Fig.15 track the number of visits by visitor frequency. The number of visits by visitors who never returned (no loyalty) are indicated on the left of the histogram. The number of visits by visitors who returned over 200 times (very loyal) are indicated on the far right.

Each visitor who visits VLE site during the active date range is categorized according to the number of days that have elapsed since their last visit. New visitors and those who are returning from a previous visit are on the left of the histogram. Visitors who last visited the site one year ago are shown on the far right.

8. ANALYSIS THE RESULTS

After the data are collected, evaluators need to see whether their expectations regarding data characteristics and quality have been met. Choice among possible analyses should be based partly on the nature of the data - for example,

whether many observed values are small and a few are large and whether the data are complete There is a variety of data analysis methods, [14]:

- **Quantitative data analysis** - Quantitative data rely on correlation and regression methods – 't' tests, analysis of variance, statistical outputs. Software applications for statistical analysis may be helpful here .

- **Qualitative data analysis** - Qualitative data may include transcripts from questionnaires, interviews or focus groups.

6. CONCLUSIONS

In recent years considerable emphasis has been placed on application of effective evaluation of e-learning. A number of web based tools and applications that tackle the task of evaluating web-based learning in specific areas exists [15]. The proposed approach for evaluation and analysis of VLE aims to provide online adaptive way by using Google Analytics, which is free and easy for use. As a result of the research, a methodology for VLE evaluation and analysis has been drawn. The methodology can be used for more general use.

7. REFERENCES

- [1] Britain, S., Liber, O. A Framework for Pedagogical Evaluation of Virtual Learning Environments, JTAP, 1998.
- [2] Rice, M., Evaluation and redevelopment in the context of online developments, 2003
<http://www.deakin.edu.au/teachlearn/cases/files/2003oltf/resources/eddesign/eval01.doc>
- [3] Oliver, M., ELT Toolkit. University of North London, 1998.
<http://www.unl.ac.uk/iltc/elt/toolkit.pdf>
- [4] Five Generations of Evaluation: A Meta-Evaluation
<http://www.theorywatch.com/ist501/evalact.html>
- [5] *Interview Protocol*
http://mime1.marc.gatech.edu/MM_Tools/IP.html
- [6] Krueger R. A., Casey M.A., Focus Groups: A Practical Guide for Applied Research
- [7] Virginia Tech Web-based survey tool Survey.vt.edu
<http://survey.vt.edu/>
- [8] Evaluation Matrix
http://mime1.marc.gatech.edu/MM_Tools/EM.html
- [9] Questionnaires
http://mime1.marc.gatech.edu/MM_Tools/Ques.html
- [10] Anecdotal Record Form
http://mime1.marc.gatech.edu/MM_Tools/ARF.htm
- [11] Kramer K., Spangler G. , Motivational Orientations in Apprentices with Learning Disabilities, Proc. of the 3rd International Biennial SELF Research Conference, 2004
- [12] Flashlight Online - <http://flashlightonline.wsu.edu>
- [13] Google analytics – www.google.com/analytics
- [14] Bernard, R., Qualitative Data, Quantitative Analysis, The Cultural Anthropology Methods Journal, Vol. 8 no. 1, 1996
- [15] Stergioulas L.K., Ahmed H., Xydeas C. S., Adaptive Web-based Engine for the Evaluation of eLearning Resources, Educational Technology & Society 5(3), 2002