

# Managing Search Engine Optimisation Experience Using the INRECA Methodology

Vani Aul and Thomas Roth-Berghofer

School of Computing and Engineering, University of West London, England  
[vani.aul@uwl.ac.uk](mailto:vani.aul@uwl.ac.uk), [thomas.roth-berghofer@uwl.ac.uk](mailto:thomas.roth-berghofer@uwl.ac.uk)

**Abstract.** This paper describes the reuse of Search Engine Optimisation (SEO) experience. The SEO domain is characterised by more than 200 factors leading to an obscurity of important factors. Such complex domains require experience-knowledge to enable the novice users adopt the domain. The Case Based Reasoning (CBR) approach is well suited to train new users in using this relatively new SEO technique to improve the visibility of their websites. Based on the principle of similarity, CBR enables the solution of similar recurring SEO problems for optimising websites for search engines. New users can effectively rely on SEO experience knowledge to solve new problems. Moreover, SEO techniques follow a similar procedure of implementation. Such procedural knowledge can be generalised and stored for future reference. For this purpose an experience base has been created to store SEO experience knowledge based on the principle of INRECA methodology. The experience is described using software process models. Until now the INRECA experience base has stored CBR system building experience. This research has extended the INRECA methodology for storing and retrieving SEO experience, taking into account the dynamic nature of the domain of SEO. An experiment illustrates the approach.

**Keywords:** INRECA methodology, case-based reasoning, search engine optimisation

## 1 Introduction

SEO has evolved constantly with a continuous development of search engine technology. Over a period of time many new factors have been introduced under the umbrella of SEO adding to the already existing factors. The formulation of a strategy to select the right factors and implement them accordingly requires specialist skill and knowledge, which is often resource and time intensive as well as heavily depends on previous experience.

Every SEO campaign executed for a specific website incorporates some implicit knowledge which could be useful for similar future SEO projects. Therefore it is quite useful to store the experience gained from successful SEO campaigns and make it available for its reuse for solving similar SEO problems. Such knowledge is particularly beneficial for SMEs as they usually lack the budget and time to hire such expertise or train themselves.

This paper describes the use of Case Based Reasoning (CBR) [4] as a novel form of experience-knowledge management to facilitate solution of recurring SEO problems faced by SME website owners. For this purpose an SEO experience base has been created based on INRECA methodology [3], to facilitate the reuse of SEO experience. The primary motive of the experience base is to provide implementation knowledge for essential on-page SEO elements for making websites visible in the search engines.

## 2 Background and Motivation

Search Engine Optimisation (SEO) is a complex technique, which has resulted from a constant amalgamation of different techniques. It consists of more than 200 factors<sup>1</sup>. These factors can be segregated as on-page (implemented directly on a webpage) and off-page (implemented on third party websites). From the identified categories, on-page is essential as it lays the foundation of an SEO campaign. Further, the implementation process of on-page SEO elements is largely similar in different instances, therefore CBR proves to help.

In this research we focus on the implementation process of on-page techniques. Furthermore, we focus on Google<sup>2</sup> as it is the most popular and widely used search engine. Amongst on-page techniques we focus on the most essential that forms the basis for implementing an SEO campaign irrespective of size, budget or category of the website.

We have enabled the reuse of our experience-knowledge by storing it in an experience base created on the principle of INRECA methodology. This experience-knowledge is gained from implementation of on-page SEO elements for five case study websites in the past [1]. Further, the authenticity of stored experience-knowledge has been verified by implementation on two case study websites for gaining visibility in the current search engine's (Google's) environment.

In the experience base we have presented the experience-knowledge on two levels of abstraction i.e. generic and project specific. The generic experience level can be referred to solve SEO problems of similar nature whereas the project specific experience level is particularly useful for solving SEO problems of websites in the same niche. For instance websites falling in the education category can directly take inspiration by referring the process models of the online educational website in our experience base i.e. Juniors.net and so on.

The SEO experience base addresses the information needs of novice and mid-level users. The cases in the experience base store the experience information that has proven to work and provided desired results. Such information has real value and can provide the intended benefit to the advantage of the user and his website. Hence such an information resource could prove very beneficial for providing information to SMEs and training needs of new users. Gradually, with the addition of new cases the case base will continue to expand and grow in information, further enhancing its utility.

<sup>1</sup> <http://backlinko.com/google-ranking-factors>

<sup>2</sup> <http://www.ebizmba.com/articles/search-engines>

The INRECA methodology supports the development process of Case Based Reasoning (CBR) applications [3]. It consists of a collection of CBR development experience (experience packets), represented as software process models, which are stored in an experience base of an experience factory [2]. An experience packet consists of software process models or parts of it such as processes, products, or method(s). As the implementation of SEO follows this simple process structure, the INRECA process model is well suited for representing SEO implementation techniques.

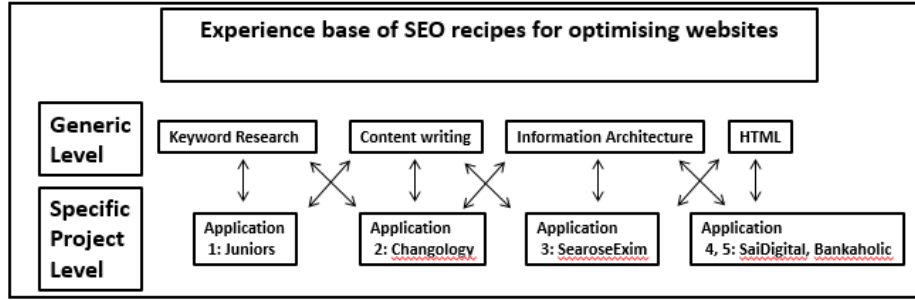


Fig. 1. Structure of the SEO experience base

The implementation of essential on-page techniques namely keyword research, information architecture, content writing and HTML code have been presented as process models and stored as cases in the experience base at the generic level and specific project level. The specific project level process models contain the implementation details of the certain case study projects. The proven experience-knowledge gained from case study websites has been abstracted into a generic level to facilitate SEO techniques implementation for a website that has a different niche from the websites stored at the specific project level. These process models can be retrieved and reused by potential users. The structure of the SEO experience base is shown in Figure 1.

### 3 Related Work

Literature on SEO just mentions SEO techniques without giving the context and details of its implementation. For non-technical SME website owners it is very difficult to apprehend and implement SEO for their websites.

Pellucid is a framework to use past experience for aiding the workers in public organisations in performing their respective jobs [10]. An intelligent assistant was built that is activated within the work environment or workstation of a worker. The basic aim behind building this framework is to support and enhance performance of employees by providing them the knowledge or active hints in context

of the activity they are performing at the time they are actually performing that activity. Pellucid supports context based information retrieval.

On-page and off-page SEO optimisation techniques are addressed in [15] distinguishing between white hat (recommended by search engines) and black hat (abhorred by search engines) techniques. It specifies the usage of keywords in Title tag, URL, meta tag, anchor text and achieving a keyword density of up to 8 percent, etc. Further it mentions the variants of the technique of link building (link popularity, incoming-outgoing links, etc.).

Similar techniques of SEO, e.g., keywords, link building, etc. are emphasised on in [8]. The authors also make a distinction between white hat and black hat practices. Further they notify the evolving SEO practices as a side effect of algorithm updates of major search engine (Google in this case).

A study looking at search engine strategies for small, medium and micro enterprise (SMME) websites reports the use of SEO on-page factors in the top 144 ranking websites at that time [5]. The author devised a SEO model consisting of on-page techniques (inclusion of meta tags, prominent link popularity, etc.) to be implemented for optimising a website. Other researchers have also undertaken research in the SEO field with similar results and recommendations.

## 4 Experience Base

This section briefly describes those case study websites for which some or all on-page SEO techniques (keywords, information architecture, content writing, and optimisation of HTML code) have been implemented by first author:

- Juniors.net<sup>3</sup> was an online education site for primary school (grades 3-6, keystage 2 students) in the UK.
- Bankaholic.com<sup>4</sup> is a US based financial portal providing information on interest rates, credit card reviews, insurance quotes, and personal finance tips.
- Searose Exim<sup>5</sup> was a bicycle basket manufacturer, selling PVC coated front bicycle baskets in India.
- Changology<sup>6</sup> was an independent consultant providing IT change management services for integrating information technology into businesses.
- Sai Digital<sup>7</sup> is an independent Asian wedding photographer providing photography services for Indian Asian weddings held in the UK.

### 4.1 Creating Process Models

The experience base was represented as HTML pages consisting of cases as process models. The experience-knowledge was formalised into process models

<sup>3</sup> <http://juniors.net> [Last access: 03/2006] [Operational 2000 - 2009]

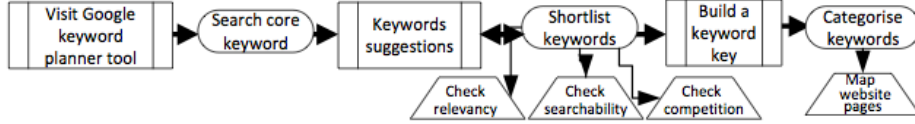
<sup>4</sup> <http://cdrates.bankaholic.com> [Last access: 06/2008] Operational 2006-present]

<sup>5</sup> <http://www.searoseexim.com> [Last accessed 08/2012] [Operational 2011 - 2012]

<sup>6</sup> <http://www.changology.co.uk> [Last accessed 07/2012] [Operational 2011 - 2012]

<sup>7</sup> <http://saidigital.co.uk> [Last accessed 06/2015] [Operational 2009 - present]

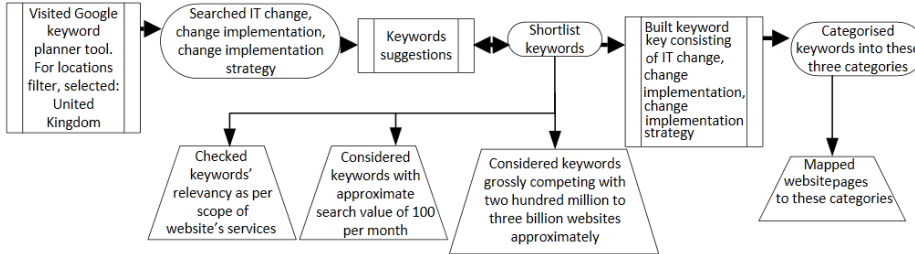
at two levels of abstraction. At the generic level, six process models were created and explained via 92 description sheets published as HTML pages. The specific level contains 19 process models, explained via 323 description sheets. One such generic model is explained in (Figure 2).



**Fig. 2.** Generic keyword tool method [1]

The main aim of keyword tool method (Figure 2) is to find keywords using a keyword suggestion tool, i.e., Google keyword tool in this case. The basic keywords are searched using the keyword planner for getting keyword suggestions. The bi-directional arrow between Keyword Suggestions and Shortlisted Keywords indicates that the shortlisted keywords would be used to generate more keyword suggestions. In order to shortlist the keywords, the relevancy of the keywords are checked, as well as the searchability (to find if the shortlisted keywords are searched by the searchers) and the competition is checked as well to avoid keywords having huge competition. From the shortlisted keywords, a keyword key is created in order to categorise the shortlisted keywords which are further mapped to the website pages.

A specific version of the keyword tool method was implemented for shortlisting keywords for the Changology website (Figure 3).



**Fig. 3.** Specific keyword tool method

This version of the keyword tool method involved using the Google keyword suggestion tool. The location filter of the tool was set to United Kingdom as this website was targeting the UK audience. The key phrases searched for getting keyword suggestions included 'IT change', 'change implementation', and 'change implementation strategy'. Further, the keyword suggestions were provided for

each of these phrases. The suggested keywords were shortlisted on the basis of relevancy, average monthly search frequency, and competing websites. For relevancy it was checked that the considered keyword falls within the scope of the website's services. For average monthly search the considered keyword needed to be searched for at least 100 times a month.

The experience-knowledge enabled the implementation of on-page SEO elements for two case study websites Beds Linen<sup>8</sup> and Rachel's Roastery<sup>9</sup>, and it provided SEO information to an SME owner from the created SEO experience base. On-page SEO techniques including keyword research, information architecture and content creation were implemented for these websites.

## 5 Experiment Setup

An empirical evaluation was conducted at two levels via technical experiment and user-testing session. On the technical level, the on-page SEO techniques information presented in the process models was implemented on two new case study websites to check if it yields the desired results in the current search engine (Google) environment. Further a user testing session was conducted to check if the information presented in the process models is legible to the intended target audience i.e. SME website owner.

### 5.1 Case study 1: Beds Linen

Beds Linen is a small-scale set up in India manufacturing custom bed sheets, bed covers, duvets, pillows, baby sheets, baby quilts, etc. This business had not have any web presence before. In this experiment a basic website consisting of eight pages was created. These pages featured textual information on the product range covered by the company. Please note, that the product images and online ordering functionality is still to be added which will enable the website visitors to instantly pay and purchase online.

As this company has a very low budget allocated to digital marketing, every incremental step in setting up their web presence will be evaluated in terms of additional cost incurred and added value generated for the business. Additional value generated for business could be seen in terms of expanding its popularity, generating more customers, etc.

As a result of implementation of on-page SEO elements (keyword research, information architecture, content creation), this website has achieved the desired visibility in the main targeted search engine (Google page ranking within top 500 search listing results for targeted keywords), which is a very positive outcome for a new website having zero to some presence for its targeted phrases for potentially selling targeted products. For example, for the key phrase: bed linen manufacturers india, this website is ranking on 63rd position on google.co.in

<sup>8</sup> [www.bedslinen.com](http://www.bedslinen.com) [Last access: 03/2016] [Operational 2016 - Present]

<sup>9</sup> [www.rachelsroastery.com](http://www.rachelsroastery.com) [Last access: 04/2016] [Operational 2015 - Present]

and 43rd position on google.co.uk. The homepage is ranking for this key phrase. Similarly, each web page is ranking for its targeted key phrase. Earlier this website had absolutely no rankings.

## 5.2 Case study 2: Rachel's Roastery

Rachel's Roastery is operated by a coffee roaster who is passionate about coffee and is a work-from-home mother. It imports specialist region specific coffee from different regions like Brazil, Costa Rica, Colombia, Kenya, etc. This business mainly roasts coffee for its customers as per their desired roast levels specified in their orders and delivers it to them free of charge within UK.

The website is built on the ecommerce platform, Shopify. It features its products on the website and accepts online orders and payment online. Therefore this website is fully functional. It has been operating since September 2015, which is less than a year. The on-page SEO elements of keyword research, information architecture and content creation were implemented for this website and as a result this website has enhanced in ranking for some of its targeted keywords. Additionally the improved search engine rankings (in Google) has won more clients for this website. The implementation was done at the end of February 2016. The changes were interpreted positively by the targeted search engine, Google, and within a span of one month this SME website was enjoying increased business leads, customers and revenue.

As on 13 April 2016, the website has secured top twenty rankings in google.co.uk for such generic keywords as 'santa lucia estate coffee' ranking on 9th position, 'lake tawar coffee' ranking on 14th position, 'arusha coffee beans' ranking on 13th position, etc. Although it is a common practice of searchers not to browse beyond top 10 results [7] searchers with a buying intent do browse beyond top 20, 30 or even further results. This is also evident from the search analytics report of this website where a keyword ranking at 144th position has received one click and that page was selling specialist Costa Rican coffee.

From the search analytics report generated for the last 28 days it shows that the website received 8 clicks for different keywords with an average ranking position of 10.5 and the report for last 7 days shows that it received 2 clicks with an average ranking position of 7.3. Hence from the above pattern we can conclude that this website has started receiving 2 visitors (referred via ranking on search engine) on a weekly basis who are potential clients from the search engine rankings built by implementing the on-page SEO elements.

The feedback received on 12 April 2016 from this business shows that they have generated new clients. It is evident that some of the visitors generated through search engine rankings are certainly being converted into clients for this website thus increasing their revenue stream. Hence it can be concluded that by incurring no additional cost but implementing essential on-page SEO techniques has increased the popularity and clients of this business.

### 5.3 User Testing Session With Target Audience

SME website owners are the main target audience for this experience base with whom a usability testing session was conducted. The usability testing has been found to be quite efficient to find existing problems and shortcomings. Therefore it has been particularly adopted for improving the usability of applications. ‘Usability is a quality attribute that evaluates how easy a user interface is to use’ [13]. Usability is defined by the following five key characteristics: learnability, effectiveness, memorability, error tolerance, and user satisfaction.

- a Learnability: how easy does a new user find to accomplish required tasks while using the application for the first time [11].
- b Effectiveness: the design of applications should offer increased productivity in relation to the increased level of performance of the user, with high speed and fewer errors [11, 18].
- c Memorability: how easy is it for the user to re-use the system after periods of non-use.
- d Errors: the number of errors made by the user while using the application, the severity of these errors and the feasibility to recover from these errors. The application design should facilitate the users to recover from errors without much difficulty [12, 17].
- e User Satisfaction: how pleasant is it was for the user to use the application. A balance should be created between the user satisfaction and effort by the individual to cause a constant and increased usage of the application [11].

The usability characteristics explained above should be evaluated in a usability test in order to improve the design and quality of interactive application. For checking the effectiveness of experience base it was important to evaluate if it offers learnability and memorability to its user(s).

There are various methods for usability testing serving different purposes which are used appropriately in different circumstances. There are six conventional methods of usability testing [6], i.e., heuristic evaluation, formal design analysis, formal usability inspection, pluralistic walkthrough, cognitive walkthrough and empirical method as explained in Table 1.

The cognitive walkthrough evaluates an application for its ease of learning, specifically by exploration [16]. Generally users prefer learning a software via exploration [9]. Therefore this usability inspection method was found suitable in this situation, as it involved learning the SEO implementation methods by exploring the software process models as stored in the experience base to support the users for implementation of these techniques.

The technique of cognitive walkthrough embeds the characteristics of learnability and memorability hence it was implemented. The user accessed some of the process models independently and provided feedback on the interpretation of the information. Table 2 and Section 6 contains information on the usability testing session conducted.



**Table 1.** Usability testing methods

Method	Advantage	Disadvantage
<b>Heuristic Evaluation:</b> involves the usage of pre-defined list of heuristics in order to spot the problems in usability.	Helps in identifying problems in early stages of development.	Necessity to have debriefing for finding out how to fix the spotted problems.
<b>Formal Design Analysis:</b> involves the testing of understanding of how to perform the required tasks.	Helps in finding problems in the initial evolving stages.	It's difficult in learning and using it.
<b>Formal Usability Inspection:</b> the testing as per the user profiles and the pre-defined goals.	Helps in finding obstacles as well as solutions for improving usability.	The non-involvement of end users.
<b>Pluralistic Walkthrough:</b> involves the evaluation of the product with an aspect of the end-user.	It allows iterative testing.	Difficult to find the accurate context of task executed in the process of usability testing.
<b>Cognitive Walkthrough:</b> involves the testing of feasibility in learning to use the application by exploring it.	Helps in depicting problems via exploration.	Only skilled evaluator can conduct this method.
<b>Empirical Methods:</b> involves an experiment for proving/disproving a hypothesis.	Helps in finding cause and effect relations which is effective for addressing specific problem.	Time consuming and expensive to undertake.

## 6 Usability Testing Session

This section presents the usability testing results and evaluation of the SEO experience base. The purpose of this usability testing was to find if the users could understand the information as presented in process models for implementing on-page SEO techniques.

The first task was to decide if generic or specific project level process models are to be viewed. Accordingly, the links were clicked in the presented user interface. The experience base contains the process models. The details of actual usability testing have been presented below.

### 6.1 Environment, Application Prototype Tested and Method Used

1. Environment: The Usability Test was conducted with one participant at the Graduate School at the University of West London.
2. Application prototype: The usability test was conducted for the prototype of an SEO experience base. As this application is in its early stages of development so the findings of the usability test had been extremely useful for

its development. The prototype contained information in the form of process models to enable the participant to implement on-page SEO techniques.

3. Method: A Cooperative Usability Testing (CUT) technique had been implemented for conducting the usability test which helped in understanding usability problems and identifying the 'gulfs of execution' through Norman's Seven Stages of Action [14]. In this test, there is a conversation between the user and evaluator to uncover the problems existing in the application.
  - a Interaction session (IAS): The interaction session was led by the user while performing the tasks. He thought aloud and asked relative queries. As it was an electronic mock up the evaluator also played an active role in the session.
  - b Interpretation session (IPS): This session was conducted in cooperation between the user and the evaluator with an objective of identifying and understanding the most common usability problems as found in IAS.

## 6.2 Conducting the Usability Test

**Profile of Participants** One participant was selected to conduct this usability test who operates an SME website and has some basic SEO know how with a keenness to learn and implement this technique for the website.

**Tasks** The tasks are presented in the sequential order in Table 2.

**Data Collection for the Usability Test** The participant viewed 9 process models (6 generic and 3 specific).

**Interpretation of Results** The overall feedback was positive which shows that the candidate was able to interpret the process models' information. The candidate's learning experience illustrated that the experience base integrates the characteristic of learnability as the candidate was able to understand the information presented in the process models, which was evident from the 'Further comments' column of the feedback form. Further the characteristic of memorability tests if the application is easy to use after an interval of non-use. As the experience base has just been used for the first time by the users, therefore we have not been able to measure the characteristic of memorability yet.

Moreover, the presentation of techniques in the form of a process model using input-process-output method of INRECA methodology was particularly appreciated. As evident from the interpretation of the usability testing session, we can say that the experience base has made a qualitative difference in terms of transferring SEO knowledge to its targeted audience, i.e., SME website owner(s).

## 7 Summary, Conclusion and Future Work

To sum up the above experiment, we conclude that the implementation of on-page SEO elements for a new or an existing website does result in increased

**Table 2.** Cognitive walkthrough session details

<b>Website name</b>	SEO Experience Base
<b>URLs</b>	..\user testing\omsite\third.html ..\user testing\omsite\fourth.html ..\user testing\omsite\fifth.html
<b>User Group Name</b>	SME Owner
<b>Sample tasks for evaluation</b>	<p>1. Read the instructions on the homepage of experience base</p> <p>2. Click ‘General explanation’ for seeking information on generic level <b>OR</b> Click ‘Project level explanation’ for seeking information on project level</p> <p>3. Click on respective process models to get the information on that process model  3.1 Navigate through the sub-pages of the process model  3.2 After going through the process model fill in the feedback form for each of the process models</p> <p>4. Browse through the next process model and repeat the above steps (until viewing all the generic process models) and optionally looking at project level process models</p>
<b>Action sequences for each of the task</b>	The user is presumed to walk through the tasks effectively as it involves navigating through a software process model. It instructs the user on the implementation of SEO on-page techniques.
<b>User knowledge requirements / assumptions</b>	The users are expected to have an existing SME website and a basic familiarity of SEO.

visibility in the search engine results. Further this enhanced visibility in search engine generates more visitors or potential visitors to the website which means increased revenue for the website.

However it is important to emphasise that the implementation of essential on-page SEO elements lays the foundation of optimisation for promoting a website in the search engines, which needs further input on a constant basis in terms of off-page promotion which involves promoting on third party websites, etc. the description of which also lays within the scope of the future work of this research. As per the feedback from the user testing session it was emphasised that a better design of the HTML pages containing the process models would enhance the usability of the created experience base, which could be implemented in the future. In nutshell the implementation of SEO, results in business revenue.

## References

1. Aul, V., Roth-Berghofer, T.: Towards experience management for search engine optimisation. In: Petridis, M., Roth-Berghofer, T. (eds.) 20th UK Workshop on

- Case-Based Reasoning. pp. 15–26. University of Brighton, Peterhouse College, Cambridge, England (2015)
2. Basili, V.R., Caldiera, G., Rombach, H.D.: The experience factory. In: Marciniak, J. (ed.) *Encyclopedia of Software Engineering*, pp. 469–476. Wiley, New York (1994)
  3. Bergmann, R.: *Experience management: foundations, development methodology, and internet-based applications*. Springer-Verlag (2002)
  4. Bergmann, R., Breen, S., Göker, M., Manago, M., Wess, S.: *Developing Industrial Case-Based Reasoning Applications: The INRECA Methodology*. Lecture Notes in Artificial Intelligence, LNAI 1612, Springer-Verlag, Berlin (1999)
  5. Chambers, R.: *Search engine strategies: a model to improve website visibility for Small, Medium and Micro Enterprises (SMME) websites*. Ph.D. thesis, Cape Peninsula University of Technology (2005)
  6. Conyer, M.: User and usability testing—how it should be undertaken? *Australian journal of educational technology* 11(2), 38–51 (1995)
  7. Cutrell, E., Guan, Z.: What are you looking for? an eye-tracking study of information usage in web search. In: *Proceedings of the SIGCHI conference on Human factors in computing systems*. pp. 407–416. ACM (2007)
  8. Duk, S., Bjelobrk, D., Carapina, M.: Seo in e-commerce: balancing between white and black hat methods. In: *Information & Communication Technology Electronics & Microelectronics (MIPRO), 2013 36th International Convention on*. pp. 390–395. IEEE (2013)
  9. Fischer, G.: Supporting learning on demand with design environments. In: *Proceedings of the International Conference on the Learning Sciences*. pp. 165–172. Association for the Advancement of Computing in Education, Charlottesville, VA (1991)
  10. Lambert, S., Arenas, A., Delaitre, S., Raposo, J.M., Ferrentino, P., Majewska, M., Krawczyk, K., Fassone, M., Procopio, V., Parcheggi, C.d.G.M.T.: A framework for experience management in e-government: The Pellucid project. *Electronic Journal of e-Government* 2(3), 167–176 (2004)
  11. Lindgaard, G.: *Usability testing and system evaluation: A guide for designing useful computer systems*. Nelson Thornes (1994)
  12. Nielsen, J.: Evaluating hypertext usability. In: *Designing hypermedia for learning*, pp. 147–168. Springer (1990)
  13. Nielsen, J.: Usability 101 (2003), <http://www.useit.com/alertbox/20030825.html>, [Last access: 2016-05-15]
  14. Norman, D.A., Draper, S.W.: *User centered system design*. Hillsdale, NJ (1986)
  15. Patil Swati P., P.B., S., P.A.: Search engine optimization: A study. *Research Journal of Computer and Information Technology Sciences* 1(1), 10–13 (February 2012)
  16. Polson, P., Lewis, C., Rieman, J., Wharton, C.: *Cognitive Walkthrough method: A practitioners guide*. John Wiley & Sons, Inc., New York, NY, USA (1994)
  17. Robertson, J.W.: Usability and children’s software: A user-centered design methodology. *Journal of Computing in Childhood Education* (1994)
  18. Shackel, B.: Usability-context, framework, definition, design and evaluation. *Human factors for informatics usability* pp. 21–37 (1991)