# A Quantitative Assessment Method for Simulation-based E-learnings

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## Abstract

*For several years the software industry has been focused on improving its product´s quality by implementing different frameworks, models and standards like CMMI and ISO. It has been discovered that training team members is a must within these quality frameworks. Given the vast technologies differentiations and new methodologies for developing software, it is imminent that alternative faster, effective and more customized ways of training people are needed. One alternative way in training people is using simulation-based e-learning technologies. Due to the vast e-learnings market´s availability, evaluations on educational software must be done to verify the quality of the training that is been produced or acquired. This paper presents a method that provides a quantitative assessment of the training quality. The proposed method presents an approach towards assessing educational software through the quantitative evaluation of predefined attribute. A pilot experience is presented in this paper along with the method description and explanation.*

## 1. Introduction

For several years the software industry has been focused on improving its product´s quality by implementing different frameworks [8, 9, 35], models and standards like CMMI [1] and ISO [2]. It has been discovered that training team members is a must within these quality frameworks [4, 5]. For decades traditional trainings seemed to work fine [6, 7] but given the vast technologies differentiations [10, 11, 12] and new methodologies for developing software [3] it is imminent that alternative faster and effective ways of training people other than the traditional ones are needed. One alternative way in training people is using simulation-based e-learning technologies [13]. Simulation-based e-learning is an emerging approach towards providing electronically supported teaching and learning forms like self-training, mentoring and discussions [14] within controlled environments where people can practice and learn without consequences [15].

Some organizations have the resources to produce their own e-learnings tailored to their own specific needs while some of them must pay for outsourced trainings. In any case, an evaluation on educational software must be done to verify the quality of the training that is been produced or acquired in order to ensure the return on the investment.

This paper presents a proposed assessment method that provides a quantitative result of the training quality. It can be used to evaluate any kind of educational software implemented by e-learning through interactive simulations. The work is structured as follows, section 2 "Background" describes the context in which this work has been developed; section 3

"Exploration and Analysis" defines the steps followed to obtain general knowledge on e-learning and simulators and shows the categories and attributes that compose the method; section 4 "Experimentation" defines how to run the assessment method; section 5 Demonstration and Implementation presents results from pilot implementation; section 6 Discussion and Conclusions shows what the results mean and states the final conclusions of the proposed assessment method.

## 2. Background

According to C. Quinn [39], there are seven steps to better e-learning: meaningful skills, keep the things lean and light, emotional engagement, connected concepts, elaborated examples, pragmatic practices and refined reflection. Dr. Ruth Clark [41] defines six principles for effective e-learning as follows: The multimedia principle: Adding graphics to words can improve learning; the contiguity principle: placing text near graphics improves learning; the modality principle: explaining graphics with audio improves learning; the redundancy principle: explaining graphics with audio and redundant text can hurt learning; The coherence principle: using gratuitous visuals, text, and sounds can hurt learning and The personalization principle: use conversational tone and pedagogical agents to increase learning. JISC [42] presents a guide that establishes what are the most pedagogically sound and accessible ways of embedding e-learning into everyday practice. Bill Brandon [40] defines five guidelines for e-learning success, four related to the selection method and one related to the learning method.

Ahdell and Anfersen [43] identified e-learning's benefits (anytime-anywhere, cost savings, just-in-time education or updated information, fast development, personalized learning, feedback provides continuous improvement) and problems (boring, text-heavy content, effects are hard to measure, underuse) and proposed a model for learning´s effectiveness that contain the following factors: willingness to learn, expectations, content, learning design, engagement, collaboration and mentoring. Also they defined the following factors that influence user engagement in games and simulations, as follows: interactivity, flexibility, competition, reality, drama effects and usability.

As described in this work, there are many attributes and characteristics described by multiple authors [17, 20, 21, 22, 23, and 43] when planning a successful e-learning. Assessing those characteristics is key, not only to understand the quality of e-learnings but also to better design and develop new e-learnings.

The assessment method presented in this paper is intended to provide assistance in such endeavor. It is the result of the first phase of the "*Sistema generador de e-learnings de procesos de desarrollo de software mediante simulaciones interactivas*" (Software development process e-learnings generator through interactive simulations) [16] research project at the Universidad Tecnológica Nacional – Facultad Regional Córdoba [36], Argentina. The objective of the project is to develop software that automatically generates simulation-based e-learnings [37]. The project was divided into three main phases. The first one aimed at defining an assessment method that, based on predefined attributes, enables a quantitative evaluation of the quality and effectiveness of e-learning implemented through interactive simulations – which is presented in this work. The second one aimed at developing the software that automatically generates e-learnings. Finally, the third one aimed at evaluating the resulting e-learning generated during the second phase through the quantitative assessment method defined in the first phase.

## 3. Exploration and Analysis

The principal objective of this step is the creation, validation and prioritization of a key attributes list for both e-learnings and simulators based on general knowledge acquired on what e-learnings and simulators are and what the main components they must possess. To this end common concepts have been adopted, as follows:

E-learning: comprises all forms of electronically supported learning and teaching, which are procedural in character and aim to effect the construction of knowledge with reference to individual experience, practice and knowledge of the learner. Acronyms like CBT (Computer-Based Training), IBT (Internet-Based Training) or WBT (Web-Based Training) have been used as synonyms to e-learning. [14]. E-learning components are [17]: 1) Content, 2) Learning Management Systems (LMS) - the essential function is to organize and manage learning and competencies and 3) Learning Content Management System (LCMS) - is used to address the team process of the creation and maintenance of content.

On the other hand the Oxford English Dictionary [18] describes simulators as: "A program enabling a computer to execute programs written for a different operating system." Ruth Thomas [15] specifies that simulations must have two key characteristics:

- A real world computer model exists that contains all the information on how the system really behaves.
- Experimentation can take place. For example: changes to the input change the output.

A concept that is very closely related to simulation-based e-learning is game-based learning. [45] defines simulation game as "simulations that contain multiple game-like elements but retain some environmental fidelity. The environment, objects and rules simulate a performance environment. This is ideal for Problem solving – using procedures, applying principles, analytical skills". In this work we will call simulation-based e-learning to e-learning through iterative simulations and serious games (Educational games; video games; game-based learning; instructional games; sim games; gamesims) as they possess similar characteristics [44, 45, 46].

Categories are a group of attributes that have common characteristics and were defined considering the e-learning´s components (Content, LMS and LCMS) and simulator key characteristics (real world entities are modeled and experimentation can take place). Categories were then subdivided into more manageable subcategories, such as: measurable objectives, logical structure, feedback, etc. then subcategories were divided into quantitative attributes.

Attributes are question-like statements that facilitate the evaluation of the software. To this end a total of seventeen (17) categories and 165 (one hundred sixty five) attributes were defined. These question-like statements were defined, validated and prioritized based on e-learning´s characteristics, game-based e-learnings and simulations [17, 20, 21, 22, 23, 43, 44]. The logarithmic scale [38] was selected to specify the attribute's priorities as follows: 1 the lowest, 3 medium and 9 the highest. The prioritization gives relative weight depending on the importance [17, 20, 21, 22, 23, 43, 44] of the attribute and will be used to calculate the final evaluation result at the end of the assessment.

Table 1 and Table 2 show the description of the defined categories and subcategories for both e-learnings and simulators.

**Table 1: E-learning categories' and subcategories' description**

| Category | Subcategory | Description |
|---|---|---|
| **Content** | Customization | Refers to the delivery formats, PDFs, consistent look and feel, technical writing. It evaluates: text, table, multimedia. |
| | Usability | Refers to the elements the end user has to better manipulate the software. This category evaluates: links, style sheets, layout, navigational controls and search mechanisms. |
| | Measurable objectives | Refers to the evaluation to the way the training objectives and the target audience are defined. |
| | Logical structure | Refers to the evaluation to the way the training is structured, which is, clearly divided into modules, the time stipulated for each one of the sub modules, the activities that need to be done in each module. |
| | Training strategies | Refers to the strategies that are used in the training: mentoring, forums, work groups, collaborative learning, case studies, discussions, conferences, self training. |
| | Feedback | Refers to how quickly and effective is the feedback given to the student, and evaluates the training´s capacity to obtain student´s feedback. |
| | Progress evaluation | Refers to the Kirkpatrick´s levels of evaluation [20]. In this case we only assess the first 2 levels as the followings are meant to be evaluated within the student´s work environment. |
| | Motivation | Refers to the evaluation of the way the training keeps the student´s motivation to finish it. It evaluates both Synchronous and Asynchronous communication |
| | Increasing difficulty | Refers to the evaluation on the ability of the training to increase the difficulty as the student advances on the knowledge acquired |
| **LMS** | | Refers to the way the training manages learning and competencies. It evaluates: Standards, Module configuration, Hardware, Registration procedures, Reports, Student performance. |
| **LCMS** | | Refers to the evaluation on the way the training is presented, that is: Formats (E.g.: html. Java, Flash, PDF), Types of multimedia (E.g.: embedded multimedia, animations) |

# 4. Experimentation

This step´s purpose is the definition of how the method calculates the final evaluation result based on the prioritized categories´ attributes. After weighting was assigned, predefined numerical value for assessing each attributes was defined. These values are described as follows:

- -1 = the criteria does not apply to the software being evaluated.
- 0 = the software does not comply with the attribute at all.
- 1 = the software complies with the attribute but it does not fully satisfies the criteria.
- 2 = the software complies with the attribute and it fully satisfies the criteria.
- 3 = the software complies with the attribute and it exceeds the criteria.

It is requested to the evaluator to assign a predefined numerical value to each attribute, then the tool automatically calculates the total value for each one by multiplying the relative weight * the assigned predefined numerical value:

Total value per attribute = Relative weight * assigned value

Once all predefined numerical values have been assigned to each attribute the total values are summarized:

TOTAL = $\sum$ Total value per attribute

Table 3 shows a screenshot of the defined attributes grouped by subcategory and the relative weight assigned to each of the attributes.

**Table 2: Simulators categories' and subcategories' description**

| Category | Subcategory | Description |
|---|---|---|
| **Experimentation** | Complexity | Refers to the elements the training has in order to make the learning more suitable to specific needs of a student. An example of such configuration is an interface where all essential parameters can be modified according to the previous knowledge and experiences the student possess. |
| | Feedback | Idem e-learning attributes. The difference is that the feedback obtained is focus from the simulator point of view. |
| **Real world** | Content and knowledge | Refers to the information the simulators give to the student in order to help him make the right decision. |
| | Realism | Refers to real world elements to be represented. For example: employees, plans, templates, customers. |
| **Misc** | | Refers to issues related to trainings, installability, documentation, simulator´s response speed. |

## 5. Demonstration and Implementation

In order to validate the effectiveness of the assessment method it was decided to execute it on available educational software as a pilot test – in this case SimSE [26]. SimSE was selected as it was awarded the 2009 Premier Award for Excellence in Engineering Education Courseware [31]. SimSE allows students to practice a "virtual" software engineering process (or sub-process) in a fully graphical, interactive, and fun setting in which direct, graphical feedback enables them to learn the complex cause and effect relationships underlying the processes of software engineering [25, 26, 27, 28, 29, 30]. SimSE presents several development models as alternatives. Cascade [31] and incremental [32] were selected for the purpose of this experimentation. Also, to provide a better evaluation of the method in terms of reproducibility and repeatability, five investigators run the assessment separately and then analyses were done on their evaluations. An average of 1 ½ hours took the investigators to perform the evaluation. As a result, an observation of the lack of instructions on how to run the evaluation was done. In order to improve the method a detailed instructions list was developed and added to the method.

The method presents the evaluation results in two different ways. The first one is a detailed numerical list that discriminates total available criteria, criteria that apply to the software that is

being evaluated and the scores obtained in each category. Table 4 is a screenshot of the detailed numerical information.

### Table 3: Method's attributes

| Attributes | Weight | Value |
|---|---|---|
| **Customization (delivery format, PDFs, appearance, technical writing)** | | |
| **Does the software provide an equivalent text for each non-text element? This includes: imagines', graphical text representations (including symbols), map regions, animations, audio, video** | 9 | |
| **Does all the color information is provided also in non-color information?** | 9 | |
| **Does the natural language changes are clearly specified) (Example: match case)?** | 9 | |
| **Are the acronyms specified in a specific section?** | 1 | |
| **Can the students download the courseware material?** | 3 | |
| **Are the headers and rows clearly identified?** | 9 | |
| **Is there a table resume provided?** | 9 | |
| **Is there an auditory description on how important is the information in a multimedia presentation?** | 3 | |
| **For multimedia presentation based on time (Example: movie, animation) Are the equivalent alternatives synchronized with the presentation?** | 9 | |
| **Is the option to turn on and off the audio provided?** | 1 | |
| **Can the audio be set up?** | 3 | |
| **Can the video be set up?** | 3 | |
| **Can the audio and the video be repeated if that is what the student wants?** | 3 | |

As shown in the table below the score obtained in the evaluation is compared to the maximum score that can be obtained taking into account two different levels of evaluations. Note that these columns show the maximum possible score to be obtained taking into account the criteria defined in the method:

1. "Maximum possible score (value 3)" 4th column - when the software exceeds the criteria (predefined numerical value 3, as described in section 4. Experimentation).

2. "Maximum possible score (value 2)" 6th column - when the software fully satisfies the criteria (predefined numerical value 2, as described in section 4. Experimentation).

Also the score obtained is compared to the maximum possible score taking into account only those attributes selected by the evaluator, that is all attributes that do not have a -1 predefined numerical value assigned during the evaluation (as described in section Experimentation).

The second way of visualizing evaluation information is a quick view trough graphical diagram. This graphical representation allows the evaluator to rapidly compare the software that is being evaluated with the two defined levels. Figure 1 shows the comparison between score obtained from the evaluation and the maximum possible score for both values 2 (satisfy the criteria) and 3(exceeds the criteria) taking into account only those attributes that applied to the evaluation.

**Table 4: Detailed numerical information example**

| Categories | # Criteria | # Criteria (only those that apply) | Maximun possible score (value 3) | Maximun possible score (only those that apply) (value 3) | Maximun possible score (value 2) | Maximun possible score (only those that apply) (value 2) | Score |
|---|---|---|---|---|---|---|---|
| Customization | 11 | 10 | 195 | 159 | 130 | 119 | 64 |
| Usability | 20 | 18 | 216 | 180 | 144 | 138 | 117 |
| Measurable objectives | 3 | 3 | 57 | 57 | 38 | 38 | 28 |
| Logical structure | 2 | 2 | 36 | 36 | 24 | 24 | 12 |
| Training strategies | 6 | 6 | 54 | 54 | 36 | 36 | 18 |
| Feedback | 4 | 4 | 72 | 72 | 48 | 48 | 30 |
| … | | | | | | | |
| TOTALS | 99 | 81 | 1425 | 1074 | 950 | 747 | 473 |

The method also provides a second representation on the results obtained. This representation allows highlighting the strengths and weaknesses of the software. This is done by comparing each one of the categories identified. Figure 2 shows the comparison of the categories and the scores obtained in the evaluation to the maximum possible scores for both values 2 (satisfy the criteria) and 3(exceeds the criteria), taking into account only those attributes that applied to the evaluation.
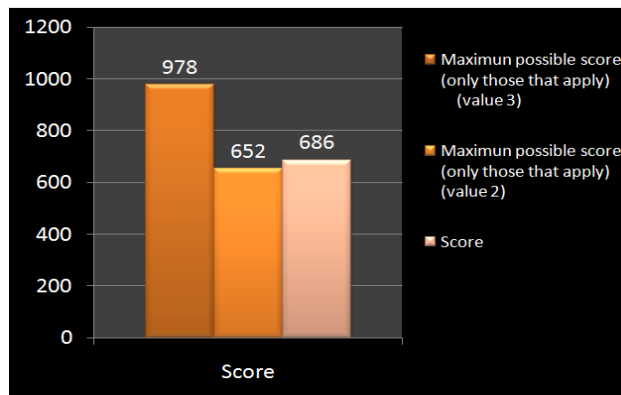


**Figure 1: Score comparison**

As mentioned before the method allows the evaluator to customize his own evaluation. That is, the evaluator can either assign the -1 value to a particular attribute or he can assign it to a whole category. This value excludes the selected attribute/category from the final calculation and from the evaluation. This gives the evaluator full flexibility if he wants to assess only one particular aspect of the software.
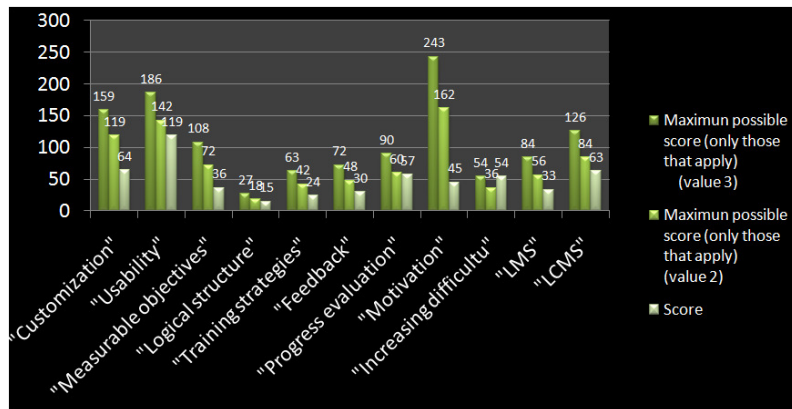
**Figure 2: Evaluated criteria by category**

# 6. Discussions and Conclusions

The proposed method presents an approach towards assessing educational software through the evaluation of predefined attributes. The attributes definition was based on e-learning´s and simulator´s key characteristics and components. In order to prioritize the attributes, they have been weighted through a logarithmic. After the evaluator performs the evaluation by first selecting which attributes/categories will be considered (method customization) and then by assigning a predefined numerical value to each attribute, the method automatically calculates the final score.

Based on the attributes considered for the evaluation, the method provides quantitative information on the quality of the software. The results are shown in two different ways: 1) numerically by showing the comparison between the score obtained and the maximum possible scores for both values 2 and 3; and 2) graphically by providing feedback on the strengths and weaknesses by attributes' category.

In order to decide whether educational software is effective or not, its final score must be greater or equal to the maximum possible score for value 2. If the evaluator is looking for software that exceeds the defined criteria, the software´s final score must equal to the maximum possible score for value 3.

As the method provides a quantitative evaluation it is easier and faster to compare different educational software. All that needs to be done is compare the numerical scores obtained by each and see which one has the higher score. This comparison is only useful if the same criteria (list of attributes/categories) are selected for the evaluation

# 7. Acknowledgments

# 8. References

[1]     CMMI Product Team. "CMMI for Development, version 1.2". Pittsburgh, Pennsylvania, USA: Software Engineering Institute (SEI), August 2006. CMU/SEI-2006-TR-008.

[2]     International Organization for Standardization. "ISO9001:2000 Quality management systems -- Requirements. s.l.: ISO copyright office, 2002. ICS 01.04|0.03.

[3]     SCRUM Alliance. http://www.scrumalliance.org/

[4]     J.L.Pfleeger; Ingeniería del Software: Teoría y Práctica; Buenos Aires: Prentice Hall, 2002.

[5]     Rolland, C., Souveyet, C. and Moreno, M., 1995. An Approach for Defining Ways-of- Working, Information Systems, 20(4), 337-359

[6]     Laycock, Martyn. Collaborating to compete: achieving effective knowledge sharing in organizations. The Learning Organization: Emerald Group Publishing Limited, 2005. DOI:10.1108/09696470510626739.

[7]     Miller, Jerry. The Internet's Impact On Business Relationships. Information Week. [Online] Sears, Roebuck and Co, September 17, 2001. http://www.informationweek.com/news/management/showArticle.jhtml?articleID=6506627.

[8]     Rico, David F. ROI of Software Process Improvement (Foreword by Roger S. Pressman). s.l. : J. Ross Publishing, Inc., January 2004. ISBN: 1-932159-24-X.

[9]     Thomas McGibbon; Daniel Ferens; Robert L. Vienneau. A Business Case for Software Process Improvement (2007 Update). s.l. : Measuring Return on Investment from Software Engineering and Management, 2007. DACS Report Number 347616.

[10]    Nien-Lin Hsueh, Wen-Hsiang Shen, Zhi-Wei Yang, Don-Lin Yang: Applying UML and software simulation for process definition, verification, and validation. 897-911

[11]    O.J. Dahl, E. W. Dijkstra, C. A. R. Hoare; Structured Programming; Academic Press; England; 1972.

[12]    Ambler, Scott W. Agile Modeling (AM) Home Page Effective Practices for Modeling and Documentation .Ambysoft Copyright 2001-2009 http://www.agilemodeling.com/

[13]    Goldschneider, Bob. e-learning Best Practices.http://www.syberworks.com/articles/bestpractices.htm

[14]    Kontis.       "What        is        e-learning".       s.r.o.       Web       Page: http://onlinelearning.kontis.net/uvod_coje.asp?menu=elearning&submenu=coje

[15]    Thomas, Ruth. "What Are Simulations? – The JeLSIM Perspective". JeLSIM. Web Page: http://www.jelsim.org/resources/whataresimulations.pdf

[16]    Rubio Diego, Izaurralde Paula, Andriano Natalia, Silclir Mauricio. "Un entorno de aprendizaje activo de ingeniería de software basado en la integración Universidad-Industria." Universidad Tecnológica Nacional – Facultad Regional Córdoba. 2010

[17]    Berman, Pamela. "E-learning concepts and techniques - instructional strategies for e-learnings." Institute for Interactive Technologies, Bloomsburg University of Pennsylvania, USA. Web Page: http://iit.bloomu.edu/Spring2006_eBook_files/chapter5.htm

[18]    Oxford English Dictionary - http://oxforddictionaries.com/definition/simulator

[19]    Advanced Distributed Learning. The Power of global collaboration. "SCORM. Advanced distributed learning". Web Page: http://www.adlnet.gov/Technologies/scorm/default.aspx

[20]    Berman, Pamela. "E-learning concepts and techniques - e-learning evaluation". Institute for Interactive Technologies, Bloomsburg University of Pennsylvania, USA. Web Page: http://iit.bloomu.edu/Spring2006_eBook_files/chapter9.htm

[21]    W3C. "Checklist of Checkpoints for Web Content Accessibility Guidelines 1.0.". Web Page: http://www.w3.org/TR/WCAG10/full-checklist.html

[22]    Ehlers, Ulf-D.. "Quality in e-Learning from a Learner's Perspective." University of Duisburg-Essen Campus Essen; Universitaetsstr. 9; 45141 Essen; Germany. Web Page: http://www.eurodl.org/materials/contrib/2004/Online_Master_COPs.html

[23]    SPI – Sociedade Portuguesa de Inovação. "Best Practices in e-Learning Study. INNOELEARNING – Fostering Innovative Self-Learning for Work in the EU Through Dissemination of Innovative Structures and Applications Identified in the USA and Europe" Project IST – 2001 – 32633. Web Page: http://www.spi.pt/innoelearning/results/best_practices_in_e-learning_study.pdf

[24]    Aviation industry CBT Committee AICC. "AICC Guidelines and recommendations version 1.5 - TRAINING DEVELOPMENT CHECKLIST." Web Page: http://www.aicc.org/docs/AGRs/agr012v15.pdf

[25]    Oh Navarro, Emily; van der Hoek, André. "Design and Evaluation of an Education Software Process Simulation Environment and Associated Model," In Proceedings of the Eighteenth Conference on Software Engineering Education and Training. Ottawa, Canada: IEEE, 2005. Web Page: http://www.ics.uci.edu/~emilyo/papers/CSEET2005-2.pdf

[26]    Oh Navarro, Emily. "An educational, Game Based Software Engineering Simulation Enviroment". University of California, Irvine. Copyright ©2009. Web Page: http://www.ics.uci.edu/~emilyo/SimSE/

[27]    Oh Navarro, Emily; van der Hoek, André. "Comprehensive Evaluation of an Educational Software

Engineering Simulation Environment." Donald Bren School of Information and Computer Sciences University of California, Irvine. Web Page: http://www.ics.uci.edu/~emilyo/papers/CSEET2007.pdf

[28] Oh Navarro, Emily. "SimSE: A Software Engineering Simulation Environment for Software Process Education. Dissertation". UNIVERSITY OF CALIFORNIA, IRVINE. Web Page: http://www.ics.uci.edu/~emilyo/papers/Dissertation.pdf

[29] Navarro, Emily; van der Hoek, André. "SIMSE: AN INTERACTIVE SIMULATION GAME FOR SOFTWARE ENGINEERING EDUCATION". School of Information and Computer Science University of California Irvine. Web Page: http://www.ics.uci.edu/~emilyo/papers/CATE2004.pdf

[30] Oh Navarro, Emily; van der Hoek, André. "Software Process Modeling for an Educational Software Engineering Simulation Game". Department of Informatics Donald Bren School of Information and Computer Sciences University of California, Irvine. Web Page: http://www.ics.uci.edu/~emilyo/papers/SPIP2004.pdf

[31] Engineering Pathway. 2009 Premier Courseware Award Winner SIMSE. http://www.k-grayengineeringeducation.com/blog/index.php/2009/10/22/classroom-presenter-is-the-2009-premier-courseware-award-winner/

[32] "SIMSE cascade model". Web Page: http://www.ics.uci.edu/~emilyo/SimSE/downloads/WaterfallModel-v-11.zip

[33] "SIMSE incremental model". Web Page: http://www.ics.uci.edu/~emilyo/SimSE/downloads/IncrementalModel-v-3.zip

[34] LIDICALSO. Laboratorio de Investigación en Ingeniería y Calidad de Software. Web Page: http://www.institucional.frc.utn.edu.ar/sistemas/gidicalso/

[35] Jennifer Gremba and Chuch Myers. The Ideal(SM) Model: A practical Guide for process improvement. Pittsburgh, Pennsylvania, USA : Software Engineering Institute (SEI), Bridge, issue three, 1997

[36] Universidad Tecnológica Nacional-Facultad Regional Córdoba. [Online] http://www.frc.utn.edu.ar/

[37] Roger C. Schank. Designing World-Class E-Learning: How IBM, GE, Harvard Business School and Columbia University Are Succeding at e-Learning. s.l. : McGraw-Hill, 2002. ISBN:0-07-137772-7.

[38] Teixeira, Joe. "The difference between the Linear and the Logarithmic Scales" - http://www.morevisibility.com/analyticsblog/the-difference-between-the-linear-and-the-logarithmic-scales.html

[39] Clark N. Quinn, Director, Quinnovation. "Seven Steps to Better E-learning" http://www.elearnmag.org/subpage.cfm?section=best_practices&article=35-1

[40] Brandon, Bill. "Leading Through Design: Five Guidelines for e-Learning Success" http://www.learningsolutionsmag.com/articles/277/leading-through-design-five-guidelines-for-e-learning-success

[41] Dr. Ruth Clark. "Six Principles of Effective e-Learning: What Works and Why". September 10, 2002. http://www.elearningguild.com/pdf/2/091002DES-H.pdf

[42] JISC. "Effective Practice with e-Learning A good practice guide in designing for learning". http://www.jisc.ac.uk/media/documents/publications/effectivepracticeelearning.pdf

[43] Rolf Ahdell, Guttorm Andresen. "Games and simulations in workplace eLearning - "How to align eLearning content with learner needs". Norwegian University of Science and Technology Department of Industrial Economics and Technology Management http://www.twitchspeed.com/site/download/thesis_final.pdf

[44] Sara de Freitas - JICS "Learning in Immersive worlds - A review of game-based learning" http://www.jisc.ac.uk/media/documents/programmes/elearninginnovation/gamingreport_v3.pdf

[45] "Game-based Learning - Learning that is fun and engaging" - Copyright © 2009 - 2010 Upside Learning Solutions Pvt. Ltd - http://www.upsidelearning.com/game-based-learning.asp

[46] "Human Capital Management e-learning - Simulation-Based E-Learning from Percepsys / Second Generation 3D Simulation" http://www.percepsys.com/images/Percepsys_SIMSTUDIO.pdf