USE OF GAMES TO STUDENT TRAINING IN THE CIVIL ENGINEERING UNDERGRADUATION COURSE: A BIBLIOMETRIC ANALYSIS

FREIRE, A.[(a)], ELY, D.[(b)], SANTANA, L.[(c)], JUNGLES, A.[(d)], DALMAU, M.[(e)]

[(a)] Instituto Federal do Piauí
[(b)] Centro Federal de Educação Tecnológica de Minas Gerais
[©] Instituto Federal da Bahia
[(d)] Universidade Federal de Santa Catarina

[(a)]ailton.freire@ifpi.edu, [(b)]danielaely@civil.cefetmg.br,[(c)]santana.leiliane@gmail.com
[(d)]ajungle@ceped-ufsc.com, [(e)]marcos.dalmau@ufsc.br

ABSTRACT
This article is the result of a bibliographic portfolio selection process and bibliometric analysis made from a survey of information, knowledge and experiences from use of games to student training in civil engineering undergraduation courses available at periodicals in relevant databases to Teaching and Engineering area. The structure of this bibliographic review is based on the ProKnow-C (Knowledge Development Process – Constructivist) method (ENSSLIN, L et al., 2010) developed by the laboratory of Milticriteria Methodologies in Decision Support (Laboratório de Metodologias Multicritério em Apoio à Decisão - LabMCDA) from the Universidade Federal de Santa Catarina (UFSC). As a result of this analysis the keywords most used; the geographical location of the conducted researches highlighting the authors, universities and countries that publish the most; the journal with the greatest number of publications; the annual evolution of the scientific research related to this theme, furthermore also the identification relevant contributions of these researchers to student formation from the use of Serious games were pointed out.

Keywords: engineering education, simulation, gaming simulation, Case studies, ProKnow-C

1. INTRODUCTION

With each passing year, the search for use of games in undergratuation teaching to support the teaching and learn process increases (Sherif and Mekkawi 2010; Khenissi et. al. 2015).
The intention of using games in student training is to combine the serious aspect (learning, instruction, etc.) with the aspect of digital games (Sorense and Meyer 2007).
Learning from experimentation and simulation, together with the application of theoretical classes' results in a solid foundation, for students who need knowledge for decision making in real scenarios (Latorre and Jiménez 2012).
The main objective of this article is to present a bibliographic portfolio containing the relevant articles for the theme of use of games for student training in the engineering course, to serve as a guide to the construction of learning tools using games.
This set of articles raised will point to the most used keywords; The geographical location of the research carried out, highlighting the authors, universities and countries that publish the most; the journal with the greatest number of publications; the annual evolution of the scientific research related to this theme, furthermore also the identification relevant contributions of these researchers to the student formation from the use of Serious games were pointed out.

2. LITERATURE REVIEW

In this section the main concepts about the bibliometric studies and games in school and professional training will be presented.

2.1. Bibliometric studies

The bibliometric methods have been a widely used tool in many areas of science to measure scientific progress, to estimate the contribution of countries, institutions and researchers to world scientific production, and to identify new paths to be followed by knowledge (Noronha 2000).
The term Statistical Bibliography, now known as Bibliometrics, was first used in 1922 by researcher E. Wyndham Hulme to define a stage of knowledge responsible for counting and cataloging scientific documents.
In 1944, this term reappears in a work by Gosnell on the obsolescence of world scientific literature.
In an article entitled Statistical Bibliography in the Health Sciences written by L. Miles Raisig and published in the year 1962, the term Statistical Bibliography reappears, in this work which deals with analysis of citations in the area of health sciences for a period between the year 1931 and 1957.
Only in the year 1969, the researcher Alan Pritchard coined the term bibliometry as being the study that quantifies the processes of written communication (Prichard 1969).

Similar definition to the current, which says bibliometrics is a field of knowledge that uses mathematical and statistical technique, to quantify, describe and prognosticate the process of written communication (Pao 1989; Diodato 2012).

2.2. Games in education

Engineering is a profession that modifies the resources energy, materials, and information to transform into goods used by mankind, and the general objective of engineering education is "to prepare students to practice engineering and, in particular, to deal with the forces and materials of nature" (Feisel and Rosa 2005, p. 121).
The military were the first to realize the great advantage of using simulation and games in teaching - learning process (Michael and Chen 2006). In addition, this technique is also widely used in health and business training.
Games and simulations have been present in society for the past two centuries. It has been perceived that the use of these techniques can go beyond simple fun, and can add value to technical, scientific and intellectual training (Magee 2006).
The difference between serious games and games of entertainment is summarized in Table 1.

Table 1: Differences between Serious games and Entertainment games

	Serious games	**Entertainment games**
Task vs. rich experience	Problem solving in focus	Rich experiences preferred
Focus	Important elements of learning,	To have fun
Simulations	Assumptions necessary for workable simulations	Simplified simulation processes
Communication	Should reflect natural (i.e., non-perfect) communication	Communication is often perfect

Serious games usually refer to "games used for training, advertising, simulation, or education that are designed to run on personal computers or video game consoles" (Susi, Johannesson and Backlund 2007, p.3).
The use of serious games in teaching and learning process allows the student to experience real-world situations that are difficult to perform due to safety, cost or time to perform (Squire and Jenkins 2003; Corti 2006).
In this sense, Serius games cover all aspects of education - education, training and information (Michael and Chen 2006).
Serious games have been applied in several areas of knowledge for student formation, among these works we have: Herbsman 1986, AbouRizk and Sawhney 1994, Schumann et. al. 1997, Scott et. al. 2004, Philpot et. al. 2005, Rovner 2006, Freire et. al. 2016.
Serious game are also used in other domains (e.g. Logistics, Industry, Healthcare, Defense, etc.), how can it be found in: Raybourn 2007, Arnab et. al. 2013, Chittaro and Sioni 2015, Longo et. al. 2015, El-Beheiry et. al. 2017.

3. SELECTION OF THE BIBLIOMETRIC PORTFOLIO

In order to reach the result of selection and quantitative analysis of a bibliographic portfolio about the use of games in student training in the engineering courses, the ProKnow-C (KnowledgeDevelopmentProcess – Constructivist) method was used. It was developed by the laboratory of multicriteria Methodologies in Decision Support - LabMCDA (Multicriteria Methodologies in Decision Support) from Federal University of Santa Catarina (UFSC). This method has four main steps, as illustrated by figure 1:

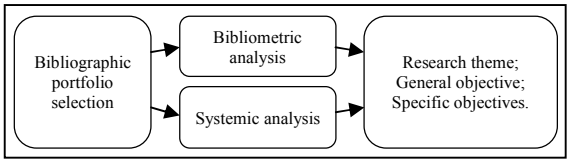

Figure 1: Process steps of ProKnow-C
Source: adaptaded from Ensslin et. al. 2010.

In general terms, the steps that were followed in the application of this method to reach the proposed goal in this work were to the selection of the bibliographic portfolio and the bibliometric analysis, made from the following steps: (1) Definition of keywords; (2) Selection of databases containing scientifically qualified journals on the researched topic; (3) Selection of articles related to the researched topic; (4) Creation of bibliographic portfolio relevant to the researched topic.
The first step was to define keywords related to the research theme; these should be in the title, abstract or keywords of the articles, when the database search was performed.
When these keywords were selected, a verification was performed in order to check if these actually discriminated scientific articles focus on the research topic, Defined the keywords (Table 2), the next step was to select the databases

Table 2: Keywords

Keywords
Engineering education
Serious games
Gaming simulation
Active learning
Innovative pedagogy

The selection of databases for constructing the gross articles bank should have a proven scientific relevance with periodicals related to the Engineering area. From this criterion, the selected databases were: ACM Digital Library; Elsevier (Science Direct); IEEE Xplore; Scopus and Springer.
With the databases defined, searches were performed using the keywords in each of these bases, thus generating the database of gross articles bank (Table 3).

The articles selected in these databases should be between January 2005 and December 2015.

Table 3: Data base

Data base	Papers
ACM Digital Library	936
Elsevier (Science Direct)	1142
IEEE Xplore	421
Scopus	831
Springer	495
Total	**3.825**

From this gross articles bank began the refining stage where repeated articles were separated when they appeared in different bases, this time database went from 3.825 articles to 1.426 articles.

This was followed by reading the article title for items that do not have grating to the subject of research were removed. These removed articles may have been incorporated since the keyword research was also done in the abstracts, which could contain the keyword without having a direct relationship with the searched subject. At this time database was reduced to 223 articles, representing approximately 15.64% of the total gross database after the withdrawal of the repeated articles.

Following, the moment of verification of scientific relevance of the article was performed, this relevance was made through the Google Scholar search tool, raising the amount of citations that each article has. ProKnow-C method suggests as a cut-off point for the permanence of the article in the portfolio, that it is in the representatively of 85% of the citations, here we selected articles with up to seventeen citations. This filtering moment resulted in 41 articles with confirmed scientific relevance and 82 articles with scientific relevance still to be confirmed.

In the next step, for articles with confirmed scientific relevance, the abstract was read and to confirm alignment with the research objective, thus discarding 30 articles remaining 11 articles.

For items with no proven scientific relevance an analysis was carried out in two stages: (1) reading the abstract of articles with up to two years of publication, as these articles usually have few or no quotations; (2) for other articles, the reading of abstracts which had authors in the group of articles with scientific relevance confirmed. These two steps resulted in 05 articles in relation to the objective of this work. The current bibliographic portfolio then contained 16 articles.

The next moment was the filtering regarding availability of the full articles for reading, the ones which could be accesses directly in search databases or journals in which this articles were published and likely to be accessed from an institutional library. Here the database lost 03 articles, getting a number of 13.

After a complete reading of the available texts, alignment with the objective of this work was carried out and it was verified that 02 could be removed from the bibliographic portfolio, resulting in 11 articles which integrate the bibliographic portfolio referring to the theme of this work. These articles are presented in table 4 highlighting the main contribution to the objective of this article:

Table 4: Bibliographic portfolio obtained

Author	Quotations	Contribuition
Ebner and Holzinger, 2007.	487	To know to what extent the serious games have power to contribute to the student's learning. Use of questionnaire as a tool to evaluate the game and as a feedback tool for the implementation of new versions.
Kebritchi and Hirumi, 2008.	300	To identify teaching strategies and pedagogical bases used to design educational games.
AbouRizk and Hague, 2009.	144	It presents a model for use in computer that simulates all the stages of the process of a construction, from the stage of design until the construction. Plans, analyzes and controls all stages of construction.
Whitton, 2007.	97	It identifies the motivations of the students to play and learn from serius games. Evaluation carried out from the application of questionnaires. Some serious games can provide pedagogical benefits beyond learning.
Mayer et al., 2014	86	It brings a review of the literature on the evaluation of serius games highlighting the following questions: what are the requirements and principles of the design; the extent to which these games contribute to learning; what factors contribute to or determine this learning; to what extent this learning can be transferred to the real world.
Deshpande and Huang, 2008.	72	It presents a review of the state of the art in the area of games for engineering education. Proper application maximizes the transfer of knowledge to professional practice.
Wall and Ahmed, 2008	65	It shows that simulation games can play a very effective role in providing lifelong learning opportunities geared to the construction industry.
Marfisi-Schottman, George and Tarpin-Bernard, 2010.	61	It details the process of designing a serius game and enumerating the various actors who collaborate in the process, such as: project manager, cognitive specialist, area experts, storyboard writer, artistic director, pedagogic specialist, programmers.
Kosmadoudi et. al., 2013	49	It reviews techniques and game mechanisms that can be developed from CAD systems in engineering, in particular to maintain cognitive engagement. It highlights CAD user graphical user interfaces and how they can be improved.
Philpot et. al. 2005.	47	Serius games developed for mechanical engineering, but with perfect application to civil engineering. Use of questionnaire as an instrument to evaluate the moment of learning.
Juang, Hung	17	The result of the simulation shows

and Kang, 2011.		the advantages of developing a construction simulation based on a game mechanism. It emphasizes that the quality of the simulation graphics should provide a high degree of reality and there should be interactivity between user and computer in the performance of the game.

The formatting of the chart above from the number of citations, obtained on scholar.google.com in December 2015, is based on the premise that authors cite work that is important for development of their research so the most cited documents will have a greater influence on an area of knowledge than the less quoted ones (Culnan1987, Tahai1999).

4. BIBLIOMETRIC ANALYSIS

In order to achieve at the presented result, a bibliometric analysis was performed in the 123 featured articles, a quantity of these with confirmed scientific relevance and others with relevance to be confirmed.

The analysis was conducted through the searching of the most relevant keywords; the authors, universities and countries COM DESTAQUE in the theme area of this work; the most relevant articles. With the portfolio presented in chart 2 it was possible to verify the evolution of the research in the area to see the current contribution to construction of games for pedagogical purposes.

4.1. Keywords

In the screening phase of the scientific articles, which resulted in the 123 articles with scientific relevance confirmed and yet to be confirmed, an analysis of key words was carried out with greater frequency and of these the first five, presented in the table 5.

Table 5: Most mentioned keywords

Keyword	% ofthesample
Game-based learning	21,4
Simulations	15,6
Educational computer games	9,5
Serious Games	8,3

These key words represent approximately 54.8% of the references, the surprise was due to the word serious games only in the fourth position among the most cited key words.

4.2. Geographic location

For the geographical location of the scientific articles, Europe and North America are highlighted with more than 75% of the world production in this theme, as seen in the graph shown in figure 2 below.

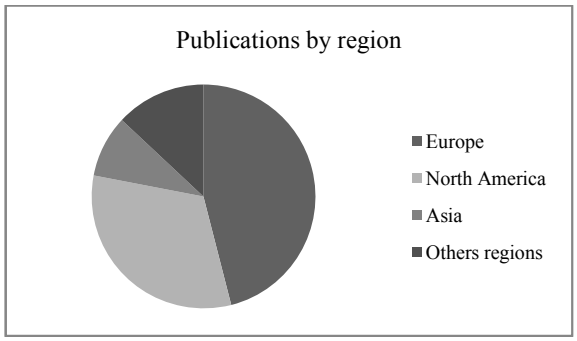

Figure 2: Geographical location of the articles raised.

During the construction of the portfolio, in the identification of articles, some universities appeared repeatedly among those that produced pedagogical tools for engineering teaching, among them we have: University of Alberta, University of Central Florida and University of Calabria. It is believed that this fact occurred due to the proximity of the terms "serious games" and "simulation" in the construction of these pedagogical tools.

Among the authors, the distribution in the portfolio did not highlight any, but each of these authors had a prominent importance in the "contributions" column presented in chart 2.

4.3. Featured journals

Among the journals that stood out (Figure 3); the Computers & Education e British Journal of educational Technology, with a contribution of approximately 54% of the references presented, among the 123 articles with scientific prominence.

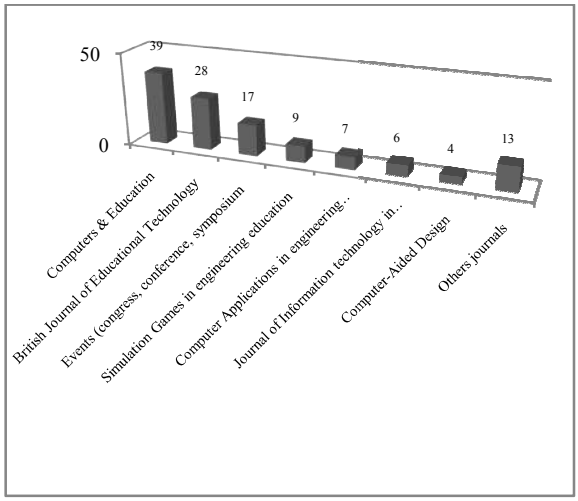

Figure 3: Featured scientific journals

The articles published in events (congress, conference, symposium) also deserve prominence, since they contributed with approximately 7% of the articles.

Among the events (congress, conference, symposium) that include articles in this bibliometric analysis, we highlight: European Conference on Games Based Learning, Winter Simulation Conference e International

Multidisciplinary Modeling & Simulation Multiconference.
It is also worth highlighting the journals: Simulation Games in engineering education, Computer Applications in Engineering Education, Journal of Information Technology in Construction e Computer-Aided Design.

4.4. Evolution of research

Over the years analyzed it is possible to perceive a passage from simple application of the games, almost always adapted games, for application of games built for specific purposes of the subject to be taught.
In the analysis of the bibliographic portfolio one can arrive at the construction of the flow chart below, from contributions identified in the table 4.

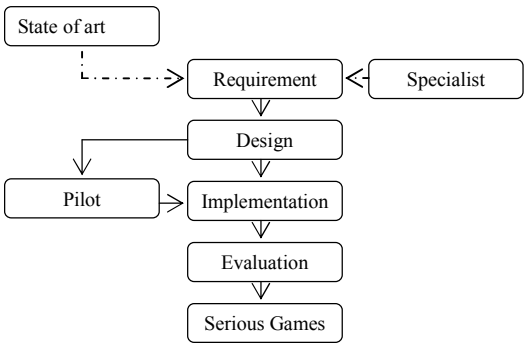

Figure 4: Construction of the pedagogical tool.

The flowchart presented, which summarizes the logical sequence of the portfolio is in line with the one presented by Preece, Rogers and Sharp 2011, which starts from the establishment of requirements arriving at the presentation of a framework for evaluation.
Literature review comes in to provide the state of the art and make contributions when defining the requirements. The expert consultation to help define the requirements from some method of consultation, such as the Delphi Delphi method[1].
The next steps are the construction of the pedagogical tool (Serious Games), following the construction of the design, passing through the pilot/implementation and arriving at the evaluation process, in this review, based on the application of questionnaires.

5. FINAL CONSIDERATIONS

It was possible to verify in this bibliographic review that the application of serious games to the formation of the engineer is something promising and viable, however, there is still a long way to be covered for the inclusion of serious games as a pedagogical tool.
In the reading of the articles it was possible to perceive, with regard to construction or choice of games, a need already verified by Squire et. Al. 2005, where students are more involved with games that have interactivity similar to their entertainment games.

[1]O método Delphi foi desenvolvido pela *Rand Corporation* para estudar o impacto da tecnologia sobre a guerra (Dalkey and Helmer 1962).

REFERENCES

AbouRizk, S. M., Hague, S., 2009. An overview of the COSYE environment for construction simulation, In Proceedings of the 2009 Winter Simulation Conference (WSC), pp. 2624 – 2634. Dec. 13-16, Austin (Austin – Texas, USA).

AbouRizk, S. M., Sawhney, A., 1994. Simulation and Gaming in Construction Engineering Education, ASEE/C2E2/C2EI Conference, Edmonton (Edmonton – Alberta, CANADÁ).

Arnab, S., Brown, K., Clarke, S., Dunwell, I., Lim, T., Suttie, S. L., Louchart, S., Hendrix, M., Freitas, S. 2013.The development approach of a pedagogically-driven serious game to support Relationship and Sex Education (RSE) within a classroom setting. Computers & Education, 69 (November), 15 – 30.

Chittaro, L., Sioni, R., 2015. Serious games for emergency preparedness: Evaluation of an interactive vs. a non-interactive simulation of a terror attack. Computers in Human Behavior, 50, 508 – 519.

Corti, K., 2006. Games-based Learning; a serious business application. PIXELearning Limited. Available from:www.pixelearning.com/docs/games_basedlearning_pixelearning.pdf [accessed 15 July 2005].

Culnan, M. J., 1987. Mapping the intellectual structure of MIS, 1980 – 1985: a co-citation analysis. Management of Information System Quartely, 11 (3), 341 – 353.

Dalkey, N. C.; Helmer, O., 1963.An experimental application of the Delphi method to the use of experts. Management Science, 9 (3), 458 – 467.

Deshpande, A. A., Huang, S. H., 2011.Simulation games in engineering education: A state-of-the-art review. Computer Applications in Engineering Education, 19 (3), 399 - 410.

Diodato, V. P., 2012. Dictionary of bibliometrics.Taylor & Francis Group. New York, New York state.204 p.

Ebner, M., Holzinger, A., 2007.Successful implementation of user-centered game based learning in higher education: An example from civil engineering. Computers & Education, 49 (3), 873 – 890.

El-Beheiry, M., McCreery, G., Schlachta, C. M., 2017. A serious game skills competition increases voluntary usage and proficiency of a virtual reality laparoscopic simulator during first-year surgical residents' simulation curriculum. Surgical Endoscopy and Other Interventional Techniques, 31 (4), 1643-1650.

Ensslin, L., Ensslin, S. R., Lacerda, R. T. O., Tasca, J. E., 2010.ProKnow-C, Knowledge Development Process – Construtivist. Technical file with registration patent pending with INPI, Brazil.

Feisel, L. D., Rosa, A. J., 2005. The Role of the Laboratory in Undergraduate Engineering

Education. Journal of Engineering Education, 1, 121 – 131.
Freire, A., Cavalheiro, C., Ely, D. M., Jungles, A. E., 2016. The competencies acquisition with simulation application in the course 'construction planning and controlling'. International Journal of Simulation and Process Modelling, 11 (6), 443 – 452.
Herbsman, Z., 1986. Project management training using microcomputers, Journal of Management in Engineering, 2 (3), 165 - 176.
Juang, J. R., Hung, W. H., Kang, S. C., 2011. Using game engines for physics-based simulations - A forklift.Journal of Information Technology in Construction, 16, 3 - 22.
Kebritchi, M.; Hirumi, A., 2008.Examining the pedagogical foundations of modern educational computer games. Computers & Education, 51 (4), 1729 – 1743.
Khenissi, M. A., Essalmi, F., Jemni, M., 2015. Comparison Between Serious Games and Learning Version of Existing Games. Procedia - Social and Behavioral Sciences, 191, 487– 494.
Kosmadoudi, Z., Lim, T., Ritchie, J., Louchart, S., Liu, Y., Sung, R., 2013.Engineering design using game-enhanced CAD: The potential to augment the user experience with game elements. Computer-Aided Design, 45 (3), 777 - 795.
Latorre, J.I., Jiménez, E., 2012. Simulation for Education in Business decision-Making. Magazine of the Society for Modeling & Simulation International (SCS M&S Magazine), 2, 59–65.
Longo, F., Chiurco, A., Musmanno, R., Nicoletti, L., 2015. Operative and procedural cooperative training in marine ports. Journal of Computational Science, 10 (September 01), 97-107.
Magee, M., 2006. State of the Field Review: Simulation in Education. Internal report. Alberta Online Learning Consortium. Calgary AB.
Marfisi-Schottman, I.,;Sébastien, G.,Tarpin-Bernad, F. 2010. Tools and methods for efficiently designing serious games.In: 4th European Conference on Games-Based Learning: ECGBL 2009. Oct 21-22, Copenhagen (Copenhgen, DENMARK).
Mayer, I., Bekebrede, G., Harteveld, C.,Warmelink, H., Zhou, Q., Ruijven, T., Lo, J., Kortmann, R., Wenzler, I., 2014.The research and evaluation of serious games: Toward a comprehensive methodology. British Journal of Educational Technology, 45 (3), 502 – 527.
Michael, D., Chen, S., 2006. Serious games: Games that educate, train, and information. Boston, MA.: Thomson Course Technology.
Noronha, D. P., Ferreira, S. M. S. P., 2000. Revisão da literature. In: B. S. Campello, B. V. Cendón, J. M. Kremer, Fontes de informação para Pesquisadores e Profissionais, Federal Universityof Minas Gerais, 2000, 197 – 198.
Pao, M. L., 1989. Concepts of information retrieval. Englewood.Colorado: Libraries Unlimited, Inc., 1989. 285 p.
Philpot, T. A., Hall, R. H., Hubing, N., Flori, R., 2005.Using games to teach statics calculation procedures: Application and assessment. Computer Applications in Engineering Education, 13 (3), 222 - 232.
Preece, J.; Rogers, Y.; Sharp, H., 2011. Interaction Design: Beyond Human-Computer Interaction. Chichester: John Wiley & Sons Ltd.
Pritchard, A., 1969. Statistical bibliography or bibliometrics?. Journal of documentation, 25, (4), 348 – 349.
Raybourn, E. M., 2007. Applying simulation experience design methods to creating serious game-based adaptive training systems. Interacting with Computers, 19 (2), 206-214.
Rovner, S. L., 2006. Video game aims to engage students. Chemical & Engineering News, 84 (15), 76-77.
Schumann, P. L., Anderson, P. H., Scott, T. W., 1997. Using computer based simulation exercises to teach business ethics. Teaching business ethics, 1 (2), 163 – 181.
Scott, D., Mawdesley, M., Al-Jibouri, S., 2004.The use and efficacy of a simulation model for teaching project control in construction. In First International Conference on world of construction project management, pp. 563 - 568, Toronto (Toronto, CANADÁ).
Sherif, A., Mekkawi, H., 2010.Excavation Game: Computer-Aided-Learning Toolfor Teaching Construction Engineering Decision Making. Journal of Professional Issues in Engineering Education and Practice, 136 (4), 188-196.
Sorense, B. H., Meyer, B., 2007.Serious games in language learning and teaching-a theoretical perspective. In Proceedings of the 2007 Digital Games research Association Conference, pp. 559-566.Sep 24-28, Tokyo (Tokyo, JAPAN).
Squire, K. & Jenkins, H., 2003. Harnessing the power of games in education. Insight, 3(1), 5- 33.
Squire, K., Giovanetto, L., Devane, B., 2005. From users to designers: Building a self-organizing game-based learning environment. TechTrends: Linking Research &Practice to Improve Learning, 49(5), 33-44.
Susi, T., Johannesson, M., Backlund, P., 2007.Serious Games: An Overview. IKI Technical Reports, Skövde: Institutionen för kommunikation och information , 28 p.
Tahai, A., Meyer, M. J., 1999. A reveled preference study of management journals' direct influences. Strategic Management Journal, 20 (3), 279 – 296.
Walla, J., Ahmed, V., 2008.Use of a simulation game in delivering blended lifelong learning in the construction industry – Opportunities and Challenges. Computers & Education, 50 (4), 1383 - 1393.

Whitton, N., 2007. Motivation and computer game based learning. In Proceedings ascilite Singapore 2007, pp. 1063 – 1067.Dec 2 – 5, Singapore (Singapore, REPUBLIC OF SINGAPORE).

AUTHORS BIOGRAPHY

Ailton Soares Freire – Professor at *Instituto de Educação, Ciência e Tecnologia do Piauí* in Brazil, Master in Civil Construction by *Universidade Federal de São Carlos* in Brazil and doctor in Civil Engineering by *Universidade Federal de Santa Catarina* in Brazil.

Daniela Matchulat Ely – Professor at *Centro Federal de Educação Tecnologica de Minas Gerais* in Brazil, Master in Civil Engineering by *Universidade Federal de Santa Catarina* in Brazil and doctor in Civil Engineering by *Universidade Federal de Santa Catarina* in Brazil.

Leiliane Santana Souza – Professor at *Instituto de Educação, Ciência e Tecnologia da Bahia* in Brazil, Master in Civil Engineering by *Universidade Estadual de Goias* in Brazil and doctoral student in Civil Engineering by *Universidade Federal de Santa Catarina* in Brazil.

Antônio Edésio Jungles – Associate professor at *Universidade Federal de Santa Catarina*, with doctorade in Production Engineering by *Universidade Federal de Santa Catarina* and internship (sandwich) at University of Waterloo in Canada. General coordinator at CEPED/UFSC (University Center for Studies and Research on Disasters), and GestCon (Construction Management Group) in Brazil.

Marcos Baptista Lopez Dalmau – Associate professor at *Universidade Federal de Santa Catarina*, with doctorade in Production Engineering by *Universidade Federal de Santa Catarina*. Technical director at CEPED/UFSC (University Center for Studies and Research on Disasters) in Brazil.