International Journal of Engineering Education Vol. 30, No. 3, pp. 693–700, 2014
Printed in Great Britain

0949-149X/91 $3.00+0.00

Design of Courses under a Virtual Learning Environment based on Curriculum Plans for Competencies*

HUGO GALAZ LAZCANO
Engineering Faculty, University of Desarrollo, Av. Sanhueza 1750, Pedro de Valdivia, Concepción, Chile.
E-mail: hgalaz@ingenieros.udd.cl

MARÍA GRACIELA BADILLA QUINTANA
Educational Computing Unit and Knowledge Managment, Universidad Católica de la Santísima, Concepción, Alonso de Ribera Avenue 2850, Concepción, Chile. E-mail: mgbadilla@ucsc.cl

This research is focused on developing an approach for learning activities in a virtual learning environment employing Web 2.0. These activities are incorporated into the design of a course intended to contribute to the development of generic and specific competencies. Input from subject experts was utilized in developing the approach.

A pilot project was implemented and assessed in a Civil Engineering and Informatics course at the Universidad Católica de la Santísima Concepción. The approach was assessed through a developed guide to the most effective course design based on learning theories relating instructional design to learning outcomes.

Keywords: competencies; Web 2.0; engineering education, virtual learning environment.

1. Introduction

The strong connection that has emerged between Technology and Education has led some authors to relate it to the concept of connectivism. McLoughlin and Lee [1] propose a theory to describe the characteristics of contemporary learning, social, interconnected, communities-based learning. This social learning stems from dynamic technology evolution that supports making learning social activity. Online or e-learning supports learning by means of the incorporation of Information and communication Technologies (ICTs), under different innovative methods that reinforce the pedagogic aspect.

An example of the previous point is The Virtual Learning Environments (VLE), where courses are managed using the virtual formation.

A major challenge is faced when trying to change the traditional model of competences formation to a model utilizing VLE. The Objective of this work is to propose a model that allows to support the design of courses to be developed under VLE considering students competences development. This is proposed to be achieved by the inclusion of diverse resources and prescribed activities, such as forums, chats, wikis, tasks, questionnaires, among others.

2. Virtual learning environment

A Virtual Learning Environment (VLE) or Educational Virtual Environment (EVE) can be defined as a virtual environment that is based on a certain pedagogical model, incorporates or implies one or more didactic objectives, provides users with experiences they would otherwise not be able to experience in the physical world and redounds specific learning outcomes [2]. On the other hand, Mueller and Strohmeier [3] point out that VLE can be understood as electronic information systems for the full administrative and didactical support of learning processes in (higher) education(al) and vocational training settings by providing learners with adequate learning resources to develop intended qualifications systematically.

Suarez [4] raises that one VLE can be understood like an instrument of mediation that proposes a structure of specific action to learn and, where from, every student represents their opportunities and strategies for technologically half-full learning.

The development and application of VLE is justified on diverse advantages such grasp advanced collaboration and communication, convenience (costs, didactics, learning) efficiency, VLE user control, personalization, ubiquity, task orientation and timeliness of VLE driven learning and teaching [5, 6].

A methodology based on collaborative learning using Web 2.0 tools have enormous potential to aid autonomous learning creating spaces in which students have a more active role in the learning process [7]. Applications such as Moodle offer the students information about the committed errors and about the key terms of the programming language. Moreover, they also gather information about the type of errors committed by each student so that the teacher can graphically observe which concepts are more problematic and need to be clarified [8]. Other

* Accepted 20 October 2013.

examples are social platforms that allow a very interesting combination of formal and informal learning activities, as My Elvin, a Web-Based Platform for Languages Practice [9], Incubator experimental platform, where students have the opportunity to deal with hands-on real-life system-level problems and decisions, while simultaneously various fundamental key technologies of the information society are integrated into the systems [10], and ALICE, an Adaptive Learning via Intuitive/Interactive, Collaborative and Emotional systems' [11].

But in spite of its multiple benefits, it is necessary to bear in mind that they are just a way and not the end. It is necessary to understand VLE as an instrument of mediation, which makes possible to open the borders of the classroom, and which promotes the strengthening of skills that will allow an integral development of students and teachers, aspects known as competences.

Gasalla [12] defines competences as those personal, relatively stable characteristics in the time, and straight related to the attainment of top results in a function or activity.

Nevertheless, there is no consensus yet in the scientific community regarding how to identify them, how to incorporate them into the university curricula or how to develop them in university.

A way of relating the activities that compose a course with the pedagogic aspects is by means of the use of the Model of Conole [13]. This model classifies aspects of a course in accordance with six dimensions grouped in three axes: Individual—Social, Non Reflection-Reflection and Experience—Information.

This model, allows to associate the activities that shape a course with some of the pedagogic dimensions.

3. A new model to support the design of courses based on curriculum plans for competencies, under a VLE

The model of Galaz, Badilla and Vidal [14] suggests present Activities in VLE, which must be incorporated in the design of the course into the target to achieve the development of the competences defined for a course.

By means of the experts' opinion, a correspondence was made between the dimensions of the Model of Conole and the activities that compose a course in VLE. On the other hand, also by means of experts it was possible to relate the competences of a course to the Conole dimensions.

This way, in this new model, the suggestions for the design of a course are realized based on the biggest correspondence between Competences and Activities of Learning associated with the pedagogical dimensions: Individual–Social, Non Reflection–Reflection and Experience–Information.

3.1 Description of the phases

The new model by Galaz, Badilla and Vidal contemplates the development of seven phases to support the design of courses based on curricula plans for competences, under VLE:

1. Review of the competences associated with the Institution where the course will be given, called Institutional Competencies.
2. Selection of a subset of competences, which are considered to be pertinent with the reality of every career, identified as Competencies of Career. Other Additional Competences can be annexed, if it is determined that it is a contribution related to the nature and functioning of the career.
3. Selection of the competences associated with every course of the Career, so called Course Competences.
4. Identification of the competences that possibly could be expired or made inside VLE, called VLE/Course Competences.
5. Evaluation and classification of the VLE/Course Competences according to the dimensions: Individual–Social, Non Reflection–Reflection and Experience–Information.
6. Identification of the exact coincidences or those that turn out to be more seemed, to the results of the Classification of VLE Activities made by experts, under the analysis of the dimensions mentioned in the point 5.
7. With the exposed correspondence analysis, it is possible to suggest the activities of a VLE which should be incorporated and executed to fulfill the established competencies for a determined course.

4. Implementation of a new model in an Engineering Career

The design of this research is based on a case study, of descriptive type. The implementation of the new model developed in the Career of Computer Civil Engineering, from Universidad Católica de la Santísima Concepción, which, having embraced a tendency that takes many years to develop on a global scale in this discipline, proposed to adapt its plans and study programs to a Model Based on Competencies.

This university is provided with an Institutional Virtual Environment of Learning (VLE) [15] which is aimed to serve as a support to the process of teaching-learning developed in classroom, which

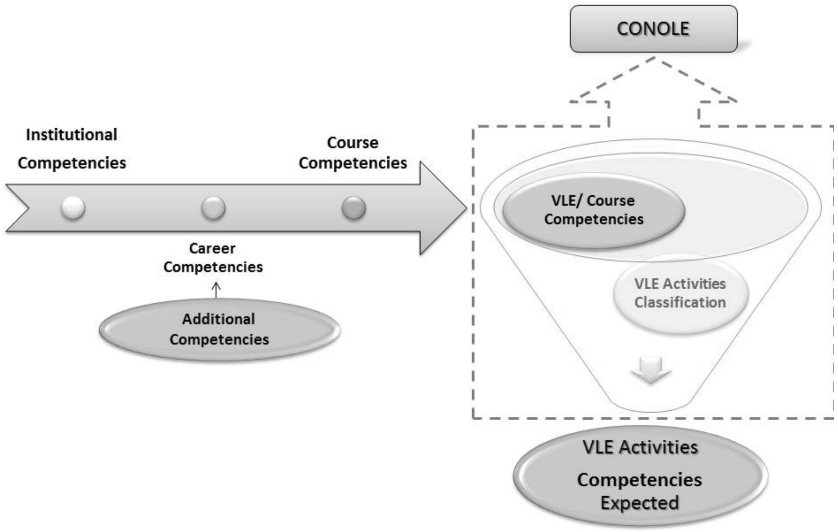


Fig. 1. Model of Galaz, Badilla and Vidal Based on Competencies and VLE (source: own elaboration).

allows to add characteristics of B-learning methodology to each of the courses dictated by this University. This allows the student to be provided with digital material, both in a synchronous and asynchronous additionally to face-face classes, which helps to strengthen their knowledge.

In this context, two essential inputs can be used for the proposed Model: the interaction of a Model Based on Competencies and VLE (see Fig. 1). Next, the development of the execution can be shown of the model, which is based on the course, Programming Workshop I, dictated by the career defined as case of study.

4.1 Development of the model phases

Phase 1: Identification of the institutional competencies

The Universidad Católica de la Santísima Concepción (UCSC), across the decree Rectory N° 88-2009 [16] defined eleven generic competencies to be achieved for the student at the end of its respective careers:

1. Respect the person.
2. Ethical performance.
3. Oral and Written communication.
4. Self Regulated Learning.
5. Team work.
6. Decision making.
7. Management Information.
8. Adaptation to Change.
9. Entrepreneurship: Creativity and Innovation.
10. Use of ICT.
11. Communication in English.

Phase 2: Identification of competencies of the career

On the other hand, and as a way of being updated to the new world tendencies for the educational processes, the careers belonging to the UCSC, its plans and original programs should have been adjusted , from Models Based on Contents to a Model Based on Competences. In this sense an analysis was made about what are the pertinent competences to be developed by the career, from a general point of view and more specifically, by each of its courses.

To execute this task, the Faculty of Engineering developed a project based on an International Standard named CDIO [17], which intends to redesign the curricula of engineering from four axes: to conceive, to design, to implement and to produce products, processes and systems in real engineering contexts and to promote the personal and discipline competences development. Thereby, it tries to develop an education based on the global context, incorporating fundamental actors, such as the industry and the reality of the country.

As a result of this project, it was possible to determine the pertinent competences for the career of Computer Civil Engineering, based on the analysis of the competences identified by the institution, incorporating those that were considered pertinent as a result of the analysis between experts who took part of the project.

Phase 3: Identification of the competencies of the course

Based on the result of the previous stage, the competences defined for the course in which VLE activities will be created, were examined For the case of the chosen course for this study, Programming Workshop I, the competences were:

1. To solve Problems by means of reasoning engineering.

2. To develop the Systemic Thought.
3. To develop Self Regulated Learning.
4. To act ethically and morally in the personal, professional and social enviroments.
5. To work in a autonomous form.
6. To use information and communications technologies in a suitable form.
7. To conceive and to apply engineering to the systems.
8. To design systems.
9. To implement processes and to manage the implementation procedures.

Phase 4: Identification of the EVA/Course competencies

This stage is relevant, since of the totality of the identified Competencies in the previous stage, only those which can develop through the activities inherent in VLE, must be selected.

For the course of study, all the competencies defined in the phase 3, can be developed through the activities that are in VLE.

Phase 5: Evaluation of the VLE/Course competencies according to the six dimensions

To facilitate this Evaluation, the program Microsoft Excel was used, which is frequently used to evaluate the VLE / Course Competences (Stage 5) as well as to evaluate the VLE Activities (Stage 6). The Fig. 2 identifies the present areas in this evaluation.

- **Name of the competence and/or activity**: It is one of the competences (VLE/Course Competences) and/or activities that are present in VLE such as chat, wikis or tasks, among others. One speaks about Competence and/or Activities, because the same chart is useful to evaluate two cases.
- **Factor tendency**: It is calculated by columns, obtained by counting the quantity of X, whose result multiplies by the factor on the column.
- **Tendency of learning**: An area that analyzes towards what learning tendency the activity is aimed, based on the answer of the expert. The tendencies can be behaviorist, constructivist and behaviorist-constructivist. These are determined according to the result of adding the values calculated in Tendency Factor.
- **Conole's dimensions:** Here the dimensions are present: Individual–Social, Non Reflection–Reflection and Experience–Information.
- **Area of answer**: It is here where, through lines, the expert marks the option of the dimension that, according to its criterion, it represents the analyzed activity. The more it approaches to the ends, it indicates that there is more accuracy between the answer and the elected dimension. To choose the option in the middle ("0, zero"), means that two dimensions have the same importance.
- **Calculation of average**: This area takes part in the phase of creation of the *Chart of Consolidation of Answers* delivered by different actors who took part of the evaluation. The (a) column indicates the obtained average of the answers of the actors, being the (b) column the one that cuts this value, to be able to obtain a value that is inside the status that each of the heads determine of the answer area. Given this value the answers area is completed with the consolidated average of the individual answers of the actors.

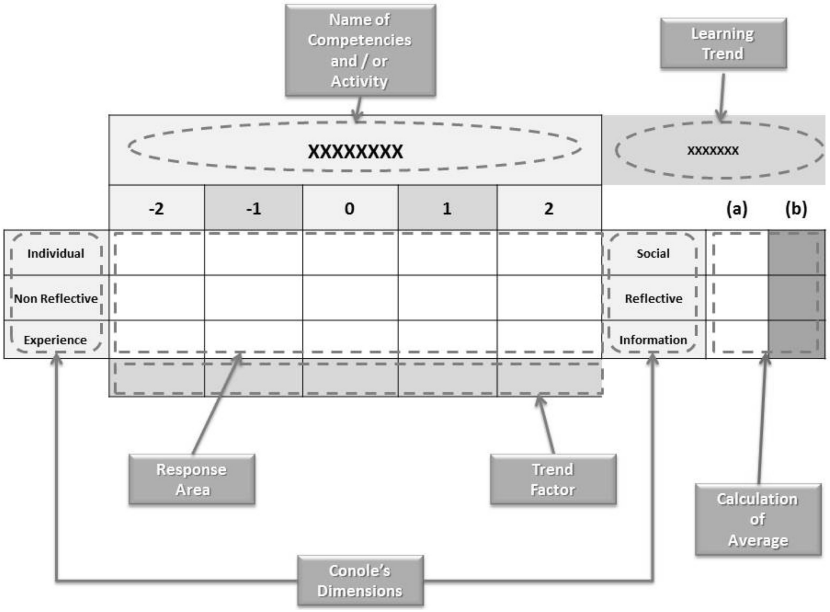


Fig. 2. Evaluation of VLE/Course Competences according to the six dimensions.

This evaluation can be developed by the course teacher, as well as a group of experts. This stays to criterion of the unit where this model is meant to be applied.

For the specific case in study, the evaluation was in charge of the responsible teacher of the course as a whole with another teacher of the area. As an example of the result of this work, the evaluations obtained in three of the competencies of the course and in all the VLE activities are shown in Fig. 3 and Fig. 4.

Phase 6: To identify coincidences between VLE activities and VLE/Course competencies

In this stage the quadrature is realized between the values obtained by dimensions, so much in the VLE Activities as in VLE/Course Competences, after having being evaluated.

For example, if the *To work autonomously'* competence is analyzed, it is demonstrated that the obtained values correspond completely to the Activity consulted. This means, that it is possible to contribute to all the dimensions of the above mentioned competence through this activity. But this is only a coincidence.

In most cases there is not a finished equality between Activities and Competences. That is why the analysis is done by dimensions. If the analysis of the same competence is continued, and based on the activities that were presented as an example, it is analyzed as the obtained value in the dimensions Reflective / Not Reflective is "1", this allows to glimpse that it also might be represented by the Activities SCORM and questions, since they have the same value in these dimensions.

This way, and in the case of an activity which exists to represent or contribute to some analyzed competences, the person in charge of the course must choose.

5. Initial results

For the application of this model in the course Programming Workshop I, of the Universidad Católica de la Santísima Concepción, Chile, a total of nine defined competences were considered for the course. A summary of the obtained results by the students in the defined Activities for the course implemented in VLE, can be seen in the Table 1.

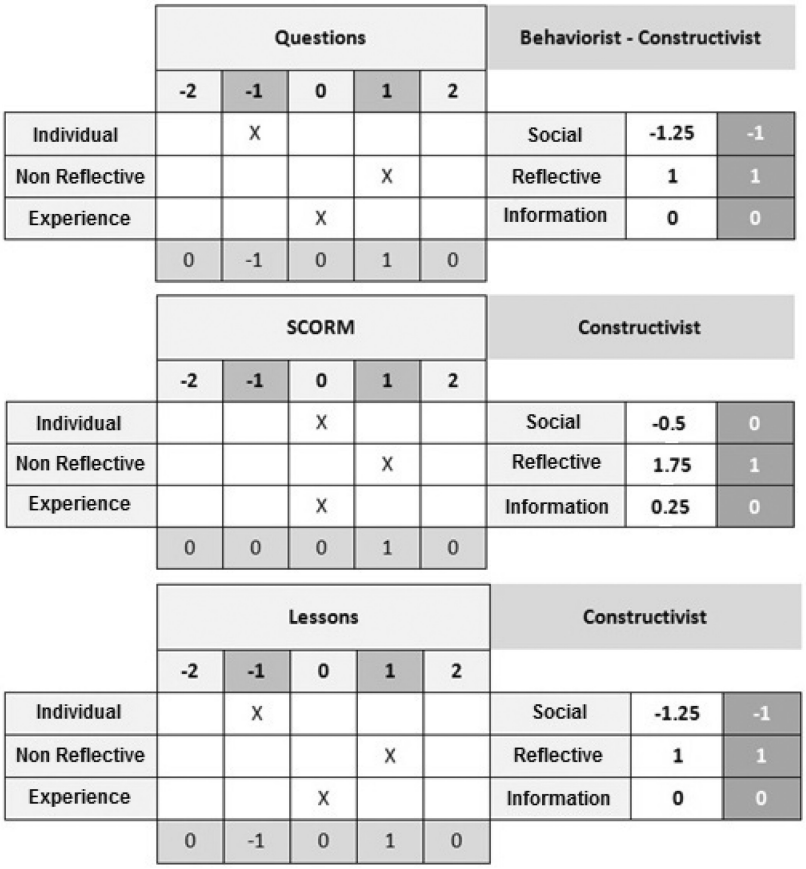
Here it is possible to see that a Competence is defined as not achieved, when the percentage of fulfillment of the activity that contributes to the above mentioned competence, it is more under that the awaited one. The above mentioned percentage

	Develop Self Regulated Learning					Behaviorist - Constructivist		
	-2	-1	0	1	2			
Individual		X				Social	-1.5	-1
Non Reflective					X	Reflective	2	2
Experience		X				Information	-1	-1
	0	-2	0	0	2			

	To solve Problems by means of Engineering Reasoning					Constructivist		
	-2	-1	0	1	2			
Individual			X			Social	-0.5	0
Non Reflective				X		Reflective	1.5	1
Experience			X			Information	0	0
	0	0	0	1	0			

	To work at autonomous form					Behaviorist - Constructivist		
	-2	-1	0	1	2			
Individual		X				Social	-1	-1
Non Reflective				X		Reflective	1	1
Experience			X			Information	-0.5	0
	0	-1	0	1	0			

Fig. 3. Example of the result of one evaluation obtained in three of the competencies of the course Programming Workshop I.



	Questions					Behaviorist - Constructivist		
	-2	-1	0	1	2			
Individual		X				Social	-1.25	-1
Non Reflective				X		Reflective	1	1
Experience			X			Information	0	0
	0	-1	0	1	0			

	SCORM					Constructivist		
	-2	-1	0	1	2			
Individual			X			Social	-0.5	0
Non Reflective				X		Reflective	1.75	1
Experience			X			Information	0.25	0
	0	0	0	1	0			

	Lessons					Constructivist		
	-2	-1	0	1	2			
Individual		X				Social	-1.25	-1
Non Reflective				X		Reflective	1	1
Experience			X			Information	0	0
	0	-1	0	1	0			

Fig. 4. Example of the result of one evaluation obtained in VLE activities of the course Programming Workshop I.

Table 1. Achievement of Competencies in Programming Workshop I in VLE

Achievement of Competencies														
Student	Final Score	Scorm	Consults	Chat	Lessons	Solve Problems by Engineering Reasoning	Develop Systematic Thought	Develop Self Regulated Learning	Act ethically y morally en the two environments of personal, professional and social	Work Auto-nonmously	Use information Technologies and Communi-cation in a suitable manner	Conscience and apply engineering to the systems	Design systems	Implement processes and manage implementation procedures
1	1.0	0%	0%	0%	0%	No	No	No	No	No	No	No	No	No
2	5.3	100%	100%	100%	100%	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3	1.0	0%	0%	0%	0%	No	No	No	No	No	No	No	No	No
4	6.2	100%	100%	100%	100%	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5	4.2	100%	100%	66%	100%	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
6	5.6	100%	100%	100%	100%	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

of fulfillment, it must be defined within the standards accepted by the institution where the model will be applied, being able to change from one institution to another. For this case of study, the definite percentage was 75%.

It becomes clear again, that a VLE Activity can contribute to more than one competence, therefore , non-obtain the percentage of achievement expected in one of these VLE Activities, can mean that more than one Competence remains as not Successful.

6. Discussions

The model of Galaz, Badilla and Vidal [14] suggests present Activities in VLE, which must be incorporated in the design of the course into the target to

achieve the development of the competencies defined for a course.

Using the dimensions of the Model of Conole, we believe that it is possible to relate the activities considering designing a course with the dimensions proposed by Conole, Dyke, Oliver and Seale [13]. The innovation that this new Model proposes is to incorporate the competencies performance, which is present in most of the current curricula.

But this model by itself will not succeed, if it does not have a clear and specific policy to adopt the changes of new digital age in relation to curricular adaptation and the role that teachers develop in teaching-learning processes. Cabrero and Llórente [18] present this changes, arguing that how students learn and what they learn, are the irrefutable result of being immersed in a digital society that is demanding a set of technological skills so far unnecessary.

Barroso [19] states that this involves making a series of changes, starting with the technological resources that must be acquired, and how this technology must integrate to the teaching processes, that is what and how to teach to contribute to the development of generic and specific competences defined for a course, under a Virtual Learning Environment.

But the task is not easy, and even if there is progress, there is much work ahead, particularly in regard to the VLE. According to Olsson [20] much work remains so that digital learning platforms are fully integrated into education, mainly because lack of time for training teachers.

7. Conclusions

A model to support the design of engineering courses using a Virtual Learning Environment (VLE) was put forward. The designed courses are based on a curriculum that has the objective of developing general and specific competences in students. Several design phases were described to take into account the prescribed institutional competences, the specific subject competences, competences that could be developed using VLE. The model was assessed through a pilot project using the model in delivering specific course in Civil Engineering and Informatics. Through this model it is possible to analyze how to develop skills through various virtual platforms tools like Moodle provide. A clear example is the development of activities through resources such as Forums and Chat, where students can achieve basic skills enhance oral and written communication, Wikis, or questionnaires.

Additionally, fruit of this pilot experience, it can be noticed that one of the future projections is to be able to automate the described tasks in this model, being able to develop a plug-in that could be added to some of the existing versions of Moodle.

On the other hand, to rely on a model that should be capable of creating and favouring environments of learning, which involves and relates the students to activities adapted for their own comprehension of the material to study and to accompany them in the best possible way in the learning process and in the fulfillment of the competencies to achieve, facilitates the teaching work and promotes even more the process of teaching and learning produced in VLE.

References

1. C. McLoughlin and M. J. W. Lee, Social software and participatory learning: Extending pedagogical choices with technology affordances in the Web 2.0 era. In ICT: Providing choices for learners and learning. *Proceedings ascilite,* Singapore, 2007.
2. T. Mikropoulos And A. Natsis, Educational virtual environments: A ten-year review of empirical research (1999–2009), *Computers & Education*, **56**(3), 2011, pp.769–780.
3. D. Mueller and S. Strohmeier, Design characteristics of virtual learning environments: state of research Original Research Article, *Computers & Education*, **57**(4), 2011, pp. 2505–2516.
4. C. Suárez Guerrero, Los entornos virtuales de aprendizaje como instrumento de mediación, *Investigación Educativa*, **10**(18), pp. 41–56.
5. S. Ozkan and R. Koseler, Multi-dimensional students' evaluation of e-learning systems in the higher education context: an empirical investigation, *Computers & Education*, **53**(4), 2009, 1285–1296
6. T. Sitzmann, K. Kraiger, D. Stewart and R. Wisher, The comparative effectiveness of web-based and classroom instruction: a meta-analysis, *Personnel Psychology*, **59**, 2006, pp. 623–664.
7. B. B. Telles and R. L. Jaguarive, Collaborative Learning Concept Implementation through Web.2.0 Tools: The Case of Industrial Engineering Fundamentals' Discipline, *The International Journal of Engineering Education*, **29**(1), 2013, pp. 205–214.
8. M. Antón-Rodríguez, M. A. Pérez-Juárez, F. J. Díaz-Pernas, F. J. Perozo-Rondón, M. Martínez-Zarzuela and D. González-Ortega, Moodle-Based Software to Support the Learning of Web Programming, *International Journal of Knowledge Society Research*, **3**(3), 2012, pp. 16–28.
9. F. J. García-Peñalvo, J. C. González-González, M. Murray, MyElvin: A Web-Based Informal Learning Platform for Languages Practice, *International Journal of Knowledge Society Research*, **3**(1), 2012, pp. 26–39.
10. E. Nigussie, L. Guang, A. Boyko, A. Hakkala, P. Sainio, S. Virtanen, et al., Incubator Platform for Multidisciplinary Innovation in Research and Education, *International Journal of Knowledge Society Research*, **3**(3), 2012, pp. 29–44.
11. J. Jovanovic, R. Chiong, *Technological and Social Environments for Interactive*, Informing Science Press, California, 2013.
12. J. M. Gasalla, *La nueva dirección de personas*, Editorial Pirámide, Madrid, 2004.
13. G. Conole, M. Dyke, M. Oliver and J. Seale, Mapping pedagogy and tools for effective learning design, *Computers & Education,* **43**(1–2), 2004, pp. 17–33.
14. H. Galaz, M. G. Badilla and Ch. Vidal, Un modelo de apoyo al diseño de cursos basados en EVA. *Infonor Proceeding*, Antofagasta, August 2012, http://www.infonorchile2012.uta.cl/index.php?var=11
15. Entorno Virtual de Aprendizaje, Universidad Católica de la Santísima Concepción. http://www.ucsc.cl/estudiante, Accessed 17 August 2013.

16. Universidad Católica de la Santísima Concepción. *Competencias Genéricas UCSC*. Decreto Rectoría N° 88, 2009.
17. CDIO, http://www.cdio.org, Accessed 17 August 2013.
18. J. Cabrero and J. M Llórente, La rosa de los vientos. Dominios tecnológicos de las TIC por los estudiantes. 1-152, GID Universidad de Sevilla, Sevilla, España, 2006.
19. J. Barroso, *Las Nuevas Tecnologías de la Información y la Comunicación y la Formación del Profesorado Universitario*. Actas del III Congreso Internacional Virtual de Educación. Internet, April 2003.
20. L. Olsson, *The Learning Resource Centre as a strategic tool to implement and change the use of ICT in Teacher Education*, Proceedings of Society for Information Technology & Teacher Education International Conference, 2596–2602, 2007.

Hugo Galaz Lazcano is a computer engineer. He works as a Technology Coordinator at the Faculty of Engineering of the Universidad del Desarrollo, Chile. He teaches courses on Algorithms and Programming Methodologies. His research focuses on the educational applications of ICT, educational innovation with ICT support, and ICT integration in engineering solutions.

María Graciela Badilla Quintana is a teacher in primary education and journalist. She has a Licentiate in Social Communication, Master in Education, and Doctorate in Pedagogical Investigation. She obtained scholarships from the Government of Chile for postgraduate studies and from the Agency for Management of University and Research Scholarship, Generalitat of Catalonia for a predoctoral Stage in England. She works as the Head of the Educational Computing Unit and Knowledge Management at the Universidad Católica de la Santísima Concepción, Chile. She teaches courses related to integration information and communication technologies in pre and postgraduate studies in education. Dr Badilla's research focuses on investigation surrounding the educative applications of ICTs, strategies and resources for the leadership, formation and advising of the educative innovation with ICT support and Impact of ICT in the educative organizations.