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Steffens, Karl; Bannan, Brenda; Dalgarno, Barney; Bartolomé, Antonio R.; Esteve-  
González, Vanessa; Cela-Ranilla, José María

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# Recent Developments in Technology-Enhanced Learning: A Critical Assessment

**Karl Steffens<sup>1</sup>, Brenda Bannan<sup>2</sup>, Barney Dalgarno<sup>3</sup>, Antonio R. Bartolomé<sup>4</sup>,  
Vanessa Esteve-González<sup>5</sup> and José María Cela-Ranilla<sup>6</sup>**

1. University of Cologne (UoC), Germany | [Karl.Steffens@uni-koeln.de](mailto:Karl.Steffens@uni-koeln.de)

2. George Mason University (GMU), USA | [bbannan@gmu.edu](mailto:bbannan@gmu.edu)

3. Charles Sturt University (CSU), Australia | [bdalgarno@csu.edu.au](mailto:bdalgarno@csu.edu.au)

4. University of Barcelona (UB), Spain | [abartolomepina@gmail.com](mailto:abartolomepina@gmail.com)

5. Rovira i Virgili University (URV), Spain | [vanessa.esteve@urv.cat](mailto:vanessa.esteve@urv.cat)

6. Rovira i Virgili University (URV), Spain | [josemaria.cela@urv.cat](mailto:josemaria.cela@urv.cat)

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## Abstract

Our societies are considered knowledge societies in which lifelong learning is becoming increasingly important. At the same time, digital technologies are entering almost every aspect of our lives and now play an important role in education. The last decade has seen numerous new developments in the field of technology-enhanced learning. In 2004, George Siemens presented connectivism as a learning theory for the digital age. His ideas inspired the creation of Massive Open Online Courses (MOOCs), which have recently received a great deal of attention. Theoretical works on the use of digital devices for learning have focused on the affordances users perceive in these devices. Design research has also shown us that learning environments enriched by digital technologies are extremely complex and should be viewed as learning ecologies. The discussions on connectivism and MOOCs, affordances of digital devices, and design research have taken place in different discourses that have paid hardly any attention to each other. It is important to point out, however, that the developments in technology-enhanced learning not only can but need to be related to each other.

## Keywords

affordances, connectivism, design research, digital technologies, MOOCs, technology-enhanced learning

## **Avances en el aprendizaje enriquecido con la tecnología: una evaluación enriquecida**

### **Resumen**

Nuestras sociedades son consideradas sociedades del conocimiento, donde el aprendizaje a lo largo de la vida obtiene cada vez más importancia. Al mismo tiempo, las tecnologías digitales forman parte de casi todos los aspectos de nuestra vida y juegan un papel importante en la educación. En la última década se han visto numerosos avances en el ámbito del aprendizaje enriquecido por la tecnología. En 2004, George Siemens presentó el conectivismo como teoría del aprendizaje para la era digital. Sus ideas inspiraron la creación de cursos online masivos abiertos (MOOCs), que han sido objeto de gran atención recientemente. La literatura científica relacionada con el uso de dispositivos digitales para el aprendizaje se ha centrado en las potencialidades que los usuarios perciben de estos dispositivos. La investigación del diseño también nos ha mostrado que los entornos de aprendizaje enriquecidos por la tecnología son complejos y deben ser vistos como ecologías de aprendizaje. Las discusiones sobre conectivismo y MOOCs, las potencialidades de los dispositivos digitales y la investigación del diseño han aparecido en diferentes discursos observados de manera aislada. En este sentido, es importante señalar que los avances en el aprendizaje enriquecido por la tecnología no solo pueden sino que deben mostrarse relacionados entre sí.

### **Palabras clave**

potencialidades, conectivismo, diseño de investigación, tecnología digital, MOOCs, aprendizaje enriquecido con la tecnología

## Introduction

The last decade has seen numerous new developments in the field of technology-enhanced learning. The one that has attracted by far the greatest deal of public attention is the advent of Massive Open Online Courses (MOOCs), which was triggered by Siemens' (2004) vision of connectivism as a learning theory for the digital age.

The use students make of the digital devices used in technology-enhanced learning environments depends to a large extent on their attitudes towards these devices and on the affordances they perceive in them.

New developments in learning theory with regard to digital devices have also made it necessary to rethink conceptions of instructional designs for the new technology-enhanced learning environments. Posited as a form of integrated research and applied development in education, design research investigates complex pedagogical and technological learning contexts.

The three topics we will discuss in this paper –connectivism and MOOCs, the affordances of digital devices, and design research– are all recent development in the field of technology-enhanced learning. However, they have been developed in different discourses that have paid hardly any attention to each other. In this paper we would like to point out that these topics are interrelated and that all three of them can be integrated into a common theoretical framework.

## Learning with digital technologies

In 2004, George Siemens published an article on the Internet entitled "Connectivism: A Learning Theory for the Digital Age". His basic arguments were that classical theories of learning (on behaviorism, cognitivism and constructivism) were developed when today's technologies were not available and that these theories did not address the learning that takes place outside people and within organizations. According to Siemens, "The act of learning... is one of creating an external network of nodes—where we connect and form information and knowledge sources. The learning that happens in our heads is an internal network (neural)" (Siemens, 2006, p. 29).

Siemens' ideas on connectivism also triggered the development of Massive Open Online Courses (MOOCs). In 2008, Siemens and Downes created an open online course on "Connectivism and Connective Knowledge" (CC08). In total, 2,300 students enrolled on the course, which led Cormier and Alexander to call it a "massive open online course" or MOOC (Siemens, 2012). The MOOCs that Siemens and Downes created (cMOOCs) were based on their ideas on connectivist learning. In cMOOCs, interaction is intended to take place among all members of the course. On the other hand, in xMOOCs, where x stands for exponential or extended and alludes to the large number of participants, the typical interaction patterns are more likely to resemble those in traditional classrooms, where a teacher provides students with knowledge and the students interact mainly with the teacher.

MOOCs in higher education have received a great deal of attention (Martin, 2012; Armstrong, 2013; Karsenti, 2013; UNESCO, 2013). MOOCs may be considered special forms of online courses, which have a long tradition in distance education. Their innovative aspect lies in the fact that they are online courses in which huge numbers of students participate.

## The role of digital devices in technology-enhanced learning

The use of digital devices in learning depends not only on their availability but also on the students' attitudes towards these devices (Kirkwood, & Price, 2005) and the affordances the students perceive in these devices. The notion of affordance, which originated in the work of Gibson (1977), is frequently used to provide a lens or a language to frame an analysis of the capability and learning potential of educational technologies (see, for example Conole, & Dyke, 2004; Bower, 2008; Dalgarno, & Lee, 2010). It is important to differentiate, however, between two competing articulations of the notion of affordance. James J. Gibson's (1977) notion is encapsulated in the following quotations: "the affordance of anything is a specific combination of the properties of its substances and its surfaces taken with reference to an animal" (p. 67) and "although an affordance consists of physical properties taken with reference to a certain animal it does not depend on that animal... an affordance is not what is called a subjective quality of a thing..." (p. 69).

Donald Norman's (1988) definition of the term is similar but, by introducing the idea that the perceived properties as well as the actual ones of an object affect its potential use, the notion is changed in subtle and important ways: "... the term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used..." (p. 9). In his later writing (see, for example, Norman, 1999), he emphasizes the importance of the perception of affordance in a more definitive way: "When I get around to revising [The Psychology of Everyday Things], I will make a global change, replacing all instances of the word 'affordance' with the phrase 'perceived affordance' ... the designer cares more about what actions the user perceives to be possible than what is true". When applied in an educational context, Gibson's notion encourages a focus solely on what is possible using the technology irrespective of the prior experience of the educator or students. Norman's notion, on the other hand, which we subscribe to, has the ability to explain decisions taken by educators or students not to adopt an educational technology even in situations where the technology apparently has a clear capability for relevance to the learning situation.

Recent papers on digital devices in education vary in the degree to which they critically analyze the unique affordances of the newer devices and their educational implications. Sharples, Taylor and Vavoula (2010), for example, highlight the consequences of the mobile nature of digital devices for more flexible and social approaches to learning and teaching that go well beyond the traditional classroom context. In a similar vein, Kukulska-Hulme and Traxler (2007) emphasize the ubiquitousness, affordability, and portability of new digital devices and how they open up new possibilities for spontaneous communication and collaboration in the context of teaching and learning activities in both formal and informal settings.

Some media commentaries on devices such as the iPad have tended to treat these devices as though they are entirely unique and do not acknowledge the fact that iPad applications, for example, are generally not conceptually different to other interactive learning resources that have been available on other devices for many years. Some commentators have treated apps on mobile devices as though they are something completely new and therefore consider as somehow revolutionary, new technology (when clearly it is not) a drill and practice application on the iPad that is conceptually similar to something we might have seen on the Apple II in the 1980s. In reality, as was demonstrated in a review of 315 iPad applications conducted by Murray and Olcese (2011), very few applications really capitalize on the device's unique educational affordances to allow educators to design learning activities beyond what would be capable without the device.

## Design research and technology-enhanced learning

The intersection of new emergent learning technologies, learning design and design research requires a reconceptualization of these methods individually as well as collectively (Bannan, Cook, & Pachler, in press). For example, the complexities inherent in educational research in a global context, the natural ambiguity of the creative design process, and the drive for rigor in research methods all present significant challenges. In combination, these challenges multiply but they also provide opportunities for reconsidering and reconceptualizing educational technology or technology-enhanced learning research.

Sandoval (2013) recently defined design research as: 1) pursuing the joint goals of improving practice and refining theory; 2) occurring through iterated cycles of design, enactment and analysis; 3) employing methods that link processes of enactment to outcomes; 4) involving sustained engagement with stakeholders; and 5) striving to produce usable knowledge (p. 389). Reimann (2013; p. 44) states that design-based research “brings a qualitative change in the relation between design and research” in that the research is “fully integrated as a key component of an ongoing design process and from engaging in long-term collaborations with researchers and practitioners” (p. 45).

From the point of view of education-based research, education and learning take place in very complex environments that may be considered learning ecologies (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003; Gravemeijer, & Cobb, 2006). Education-based research is especially oriented towards research on new themes, new learning tools and new ways of organizing learning environments (Confrey, 2006). Of special interest are learning environments that incorporate digital technologies (Fishman, Marx, Blumenfeld, & Krajcik, 2004; de Jong, & Pieters, 2006; Lajoie, & Azevedo, 2006).

Design research has gained attention over the last ten years in multiple publications and academic practices (McKenney, & Reeves, 2012; Anderson, & Shattuck, 2012; Kelly, Lesh, & Baek, 2008). Posited as a form of integrated research and applied development in education, design research has been leveraged to investigate complex pedagogical and technological learning contexts. One aim of design research is to identify and model technology-mediated, social learning and behaviors in order to design tools that support and promote the practices under investigation. Researchers have embraced this type of research as a form of inquiry that will best position them to generate learning theory and to generate and test solutions for complex problems in contexts for which no clear guidelines or solutions are available (McKenney, & Reeves, 2012).

Accordingly, conducting educational design research on a global level presents unforeseen challenges for design research, design process and learning research. For example, Traxler (2013) presents evidence to suggest mobile technology now dictates the agenda for prior educational technologies by providing learning opportunities to disenfranchised populations across the world who were “previously too distant or expensive to reach” and that their inclusion is “enhancing, enriching and challenging the conceptions of learning itself” (p. 237).

The global reach of emerging forms of technology-enhanced learning environments can provide challenges and affordances for systematically collecting and analyzing multiple forms of data. Fortunately, several theoretical frameworks, design processes and examples have begun to emerge that are beginning to frame and examine the intersection of the challenges of mobile learning design and mobile design research. Pachler, Bachmair and Cook (2010), for example, have presented a socio-cultural pedagogical framework for mobile learning that describes the interrelationship between three components: agency (the user’s capacity to act in the world); cultural practices (the routines users engage in their everyday lives); and the socio-cultural and technological structures that govern their

being in the world viewed as an ecology that, in turn, manifests itself in the form of an emerging cultural transformation. These perspectives have much to offer design research as we grapple with new perspectives on learning, new tools, new forms of data collection, and technological affordances germane to the particular learning space.

## Discussion

Siemens' ideas on connectivism are certainly some of the most interesting proposals on technology-enhanced learning presented in the last decade. Although Siemens suggests that connectivism is a learning theory for the digital age, it may be queried whether connectivism actually is one (Kop, & Hill, 2008). According to Verhagen (2006), it is more of a pedagogical view than a learning theory. In their critical analysis of Siemens' approach, Duke, Harper and Johnston (2013) reached the conclusion that connectivism as described by Siemens is "a tool to be used in the learning process for instruction or curriculum rather than a standalone learning theory" (Duke, Harper, & Johnston, 2013, p. 10). Nevertheless, the idea that people who are interested in a specific problem or field of knowledge connect with each other online to study available knowledge, gain new insights, and possibly create new knowledge is certainly an intriguing vision and is one that is particularly apt for describing learning that takes place in the kind of MOOCs that Siemens was thinking about (connectivist or cMOOCs).

Most MOOCs however, are just that – Massive Open Online Courses, i.e. online courses with a very large number of registered students. Despite public enthusiasm for MOOCs, MOOC participants seem to have serious problems and dropout rates are huge. A recent study showed that only 4% of students attending Coursera MOOCs completed their courses (Armstrong, 2013). The very low retention rate of MOOC participants has also been of concern to other researchers (Koller, Ng, Do, & Chen, 2013; Yang, Sinha, Adamson, & Rose, 2013). One problem may be that many courses were created without taking into account the findings from research in the fields of learning and self-regulated learning (Bartolomé, & Steffens, 2015).

Rigorous empirical research on MOOCs is still somewhat scant (Haggard, 2013; Liyanagunawardena, Adams, & Williams, 2013; Gaseric, Kovanovic, Joksimovic, & Siemens, 2014; Jona, & Naidu, 2014). Although Karsenti (2013) reviewed some 100 studies on MOOCs, the results are not unequivocal. Student performances on MOOCs have been addressed in several studies (including Breslow, Pritchard, DeBoer, Stump, Ho, & Seaton, 2013; Liyanagunawardena, Adams, & Williams, 2013; Firmin, Schiorring, Whitmer, Willett, & Sujitparapitaya, 2013; Champaign et al., 2014) but rigorous studies investigating the effectiveness of MOOCs in addressing educational objectives are still needed (Hollands, & Tirthali, 2014). Instructional quality in many MOOCs is considered to be low (Margaryan, Bianco, & Littlejohn, 2015) and the concept of openness that was of central importance when Siemens and Downes developed their first cMOOCs is no longer a defining characteristic of MOOCs (Chiappe-Laverde, Hine, & Martínez-Silva, 2015). This is particularly unfortunate because perceived openness, along with perceived reputation, has been shown to be the best predictor of a student's intention to continue working on a MOOC (Alraimi, Zo, & Ciganeck, 2015).

It seems, however, that the original excitement about MOOCs is gradually fading (Zemsky, 2014; Kolowich, 2015). Nevertheless, we expect that MOOCs are here to stay. Most likely, they will be offered in parallel to regular university courses (without replacing them) and might be made components of programs leading to nano-degrees, i.e. degrees of a lower level than traditional bachelor or master degrees (Zapata-Ros, 2014). While Karsenti (2013) believes that MOOCs will have a transformative impact on universities, he also states that "It would also be

important to keep uppermost in our minds that neither technologies in general nor MOOCs in particular will foster successful university careers. Instead, it is the use that the students will make of them" (Karsenti, 2013, p. 34).

The use that students will make of MOOCs and of digital devices in general will very much depend on their attitudes towards these devices and on the affordances they perceive in them. In articulating a position on the implications of technology-enhanced learning environments for student learning, it is essential to be clear on the broader role of technology in the learning process. Numerous authors, most notably Selwyn (2010, 2012) have criticized educational technology research that adopts a technocentric or a technodeterminist stance. Technodeterminism assumes that integrating technology into the learning process is by its very nature positive or desirable, while technocentrism focuses too much on the objective capabilities of the technology and too little on the social and contextual aspects of the learning situation. In this paper we totally reject any notion of technodeterminism and have attempted to ensure a more critical approach. Nor do we accept the notion of technocentrism since we focus on encapsulating the broader social and contextual issues.

Underpinning our position on the relationship between technology and learning is the notion of affordances. Specifically, we see technology as affording particular learning tasks for particular learners in a particular context, and we see these learning tasks as then contributing to student learning. We are making two important points here. First, we reject any direct causal relationship between the use of particular technologies and particular learning outcomes. We see the learning outcomes as occurring through the learning activities and, although a particular technology can afford a particular learning activity, the provision of a specific technology never guarantees that the learning activity will occur for all learners and it is never the only way to afford a particular activity. Second, we see the learning affordances of a particular technology as being dependent on the prior experiences of the learner. As a result, they are different for different learners.

Given the definition of design research as a catalyst in the changing landscape of educational research, it behoves educational researchers to re-examine research methods and contexts that particularly relate to the current affordances of emerging digital technologies for education.

Designing learning and conducting design research in learning with new forms of ubiquitous, seamless and sensor-based technologies adds another layer of complexity to the research process. For example, the technological affordances and pedagogical considerations of mobile learning technologies blur the lines between formal and informal education regarding who facilitates learning, what learning is facilitated, and where learning is facilitated (e.g. is it user-generated and socially shared and are the technologies location-aware?). They also promote the powerful potential of leveraging simultaneous, in-situ, real-world and virtual data (e.g. augmented reality applications provide digital layering of real world information in real time) and illustrate exactly how these new technological "mixed reality" capabilities may impact applicable design processes and educational research methods for design research (Bannan, Cook, & Pachler, in press).

## Conclusions

The three topics that we have discussed in this paper –connectivism and MOOCs, digital devices and their affordances, and design research– have only recently entered the discussion on technology-enhanced learning. They constitute three different strands developed in three different discourses that seem to have been hardly aware of each other.



Interestingly, it is the first of these topics that has received by far the greatest amount of public attention in the last few years. *The New York Times* even named 2012 “The year of the MOOC” (Pappano, 2012). From an educational point of view, this is quite surprising. It is difficult to see why online courses that are open to masses of students should have any advantage over traditional online courses in helping students learn. We would not expect students to learn better from hard cover books than from paperback editions, although students might prefer paperback editions because they are cheaper and weigh less. It is also true that we are still lacking empirical evidence on the impact of MOOCs on student learning. Nonetheless, we believe that MOOCs are here to stay and deserve a critical examination. Also, Siemens’ ideas on connectivism, which gave rise to the development of cMOOCs, have opened up a new perspective on technology-enhanced learning (Yeager, Hurley-Dasgupta, & Bliss, 2013).

As Li (2014) pointed out, in thinking about technology-enhanced learning we will have to take into account the relationships between the learner, the learning context and the technology. Referring to Archer’s morphogenetic approach (Archer, 1995), she suggests that the development of an online course (she even refers to a MOOC in her example) may include several morphogenetic cycles, beginning with the structural conditions of the learning context including the external context (political, social, and cultural), a delivery platform, and instructional design (designed learning outcomes, learning materials, and teaching and learning activities). Students with different characteristics (motivation, prior knowledge, and digital literacy) enter this learning context, interpret it from their point of view, and interact with its technology as well as with their peers and tutors. Their interaction may result in changes in the learning context which then give rise to another morphogenetic cycle (Li, 2014, p. 16).

Li’s (2014) background is realist social theory and in her contribution she focuses on the social interaction that takes place in a learning environment and the extent to which this is influenced by its structure. There are some interesting parallels between her line of reasoning and ours. We also believe that the affordances of digital devices influence students’ learning. However, we believe that it is the perceived affordances that matter while Li argues that affordances are a more objective aspect of the structural conditions of the learning context. There is another interesting parallel between Li’s presentation of the morphogenetic approach and our presentation of design research. As stated by Sandoval (2013), one of the important aspects of design research is that it occurs through iterated cycles of design, enactment and analysis.

Although the three topics we have discussed in our paper –connectivism and MOOCs, digital devices and their affordances, and design research– are different strands that were developed in three different discourses that seem to have hardly been aware of each other, we believe that they are related in both practice and theory. We believe that design theory has the capacity to integrate these three topics by describing the learner as an agent in a technology-enhanced learning ecology.

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## About the authors

*Karl Steffens*

[Karl.Steffens@uni-koeln.de](mailto:Karl.Steffens@uni-koeln.de)

ORCID ID: <http://orcid.org/0000-0002-5566-9065>

Lecturer and senior researcher at the University of Cologne (UoC), Germany

Karl Steffens is psychologist and senior researcher at the University of Cologne in Germany. He obtained his PhD from the University of Bonn and has worked at the universities of Bonn, Cologne, Frankfurt, Erfurt, and Barcelona (Spain). At the University of Barcelona, he conducted research in the field of ICT for a year with a grant from the European Commission (Human Capital and Mobility Programme). In his teaching, he focuses on learning and instruction, technology-enhanced learning, motivation, emotion and personality development. He has coordinated and participated in numerous European research projects. His research activities have centered on intercultural communication and technology-enhanced learning, with a focus on self-regulated learning in technology-enhanced learning environments.

University of Cologne  
Institute of Didactics and Educational Research  
Albertus-Magnus-Platz  
50923 Cologne  
Germany

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*Brenda Bannan*

[bbannan@gmu.edu](mailto:bbannan@gmu.edu)

ORCID ID: <http://orcid.org/0000-0002-4685-7056>

Associate Professor at George Mason University (GMU), USA

Brenda Bannan, Ph.D. is an Associate Professor in the Learning Technology Design Research/Instructional Design and Technology Programs in the College of Education and Human Development at George Mason University in Fairfax, Virginia. Dr. Bannan's research interests involve the articulation of methods related to design research in the learning technologies field. She has authored numerous articles and book chapters in the areas of design research, design process, mobile learning, and augmented reality in several areas including learning/educational technologies, instructional design, special education, language learning, and science education. Her work investigates and links digital learning design, UX design process, design research and the development of innovative learning technology systems and solutions.

Division of Learning Technologies  
College of Education and Human Development  
George Mason University  
4400 University Blvd MS-5D6  
Fairfax, VA 22030  
USA

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Barney Dalgarno

[bdalgarno@csu.edu.au](mailto:bdalgarno@csu.edu.au)

ORCID ID: <http://orcid.org/0000-0002-6935-6844>

Professor; Co-Director of ulmage, Digital Learning Innovation Laboratory, Charles Sturt University (CSU), Australia

Barney Dalgarno is a Professor and the Director of ulmage, Charles Sturt University's Digital Learning Innovation Laboratory, a role in which he undertakes strategic leadership towards the adoption of innovative online learning practices across the university. As Associate Dean of Curriculum Learning and Teaching in the Faculty of Education, Professor Dalgarno has also led faculty and university wide initiatives in online learning, assessment, and transition and retention underpinned by technology and learning research over a number of years. Professor Dalgarno's research contributions have been in three broad areas: the relationship between learning technology and learning theory; learning in polysynchronous learning environments, including 3D virtual environments; and university teacher and student attitudes towards learning technologies and their use. He has obtained numerous grants and consultancies for research on learning and teaching, including five Australian Office of Learning and Teaching and Australian Research Council grants, and has produced over 70 refereed publications. Professor Dalgarno received the prestigious Ascilite Fellow Award in 2013 in recognition of his outstanding contribution on the exemplary use of and research into technologies for learning and teaching in tertiary education. He also received ALTC Citations in 2007 and 2011. He is a lead editor of the *Australasian Journal of Educational Technology*.

ulmage

Division of Student Learning

Charles Sturt University

Boorooma Street

Wagga Wagga NSW 2678

Australia

---

Antonio R. Bartolomé

[abartolomepina@gmail.com](mailto:abartolomepina@gmail.com)

ORCID ID: <http://orcid.org/0000-0002-8096-8278>

Specialist in Educational Technology and Professor at the University of Barcelona (UB), Spain

Antonio Bartolomé received his PhD from the University of Barcelona and is a specialist in Educational Technology. Since 1988, he has been working in multimedia design and development, first with laserdisc-based systems, then with CD-ROMs and the Web, and lately with video digital solutions.

His current work in the educational field is centered on blended learning solutions and new and innovative designs for virtual learning environments. Two main projects under his direction are Grimm about ICT for Spanish pre-school children and Mediakids, a 7th framework program under the Telematics-Socrates joint call.

He is the author of 20 books and one hundred articles. He has participated with papers or as a guest speaker at around 200 events since 1983.

Since 1990, he has also coordinated European projects in the Comett, Eurotecnet, Telematics, Socrates and eLearning programs as well as other national and local research projects.

Universitat de Barcelona

Edifici Llevant, despatx 005

Av. Vall Hebron, 171

08035 Barcelona

Spain



---

*Vanessa Esteve-González*

[vanessa.esteve@urv.cat](mailto:vanessa.esteve@urv.cat)

ORCID ID: <http://orcid.org/0000-0001-5909-1099>

Research assistant at Rovira i Virgili University (URV), Spain

Vanessa Esteve-González is a Computer Management Engineer and a PhD candidate in Educational Technology: E-Learning and Knowledge Management. She is member of the ARGET research group (Applied Research Group in Education and Technology) at the Rovira i Virgili University in Tarragona, Spain. She works as a research assistant in the Laboratory for Technology Applied to Education (LATE) at the same University, where she has participated in several national and international projects. Her research work concerns the use and implementation of simulations, MUVE's and emerging technologies as tools for enriching and extending the learning experience.

Departament de Pedagogia

Universitat Rovira i Virgili

Carretera de Valls, s/n

43007 Tarragona

Spain

---

*José María Cela-Ranilla*

[josemaria.cela@urv.cat](mailto:josemaria.cela@urv.cat)

ORCID ID: <http://orcid.org/0000-0001-9205-3860>

Associate professor at Rovira i Virgili University (URV), Spain

José María Cela-Ranilla is a research fellow at the Faculty of Educational Sciences and Psychology of the Rovira i Virgili University in Tarragona, Spain. He is a member of the Applied Research Group in Educational Technology (ARGET), which conducts research on the use of ICT in Education, where he has participated in several national and international projects. He is particularly interested in the application of Educational Research Methodology (EDR).

Departament de Pedagogia

Universitat Rovira i Virgili

Carretera de Valls, s/n

43007 Tarragona

Spain



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