

ANÁLISIS SISTEMÁTICO DE LA LITERATURA:

Análisis del Aprendizaje Basado en Juegos Serios en las Prácticas de los Estudios de Ingeniería

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En primer lugar, para buscar artículos que se refieran a las “experiencias virtuales”, se han preseleccionado las siguientes palabras clave (por orden alfabético y sin poner límite a la fecha de publicación de los artículos): *alternate reality game*, *serious game*, *virtual simulation* y *virtual world*. En la Tabla 1 se muestra el número total de resultados encontrados para dichas combinaciones de palabras, siempre buscando artículos escritos en inglés, dado que los artículos no escritos en este idioma tienen una visibilidad más limitada.

Tabla 1 Número total de artículos publicados, para cada palabra clave

Palabra Clave	Total
<i>alternate reality game</i> (ARG)	1.770
<i>serious game</i> (SG)	23.804
<i>virtual simulation</i> (VS)	20.338
<i>virtual world</i> (VW)	160.490
Total general	206.402

Para seleccionar una de estas combinaciones como “palabra clave” de este estudio, se ha desglosado más detalladamente en el tiempo, tal y como se muestra en la Tabla 2, y así poder comprobar cómo ha ido evolucionando el uso de los diferentes términos. Estos datos se representan en la Figura 1, comprobándose cómo hay muchos autores que utilizan *virtual world*, pero en los últimos años, se va empleando cada vez menos mientras que la tendencia a utilizar *serious games* es al alza.

Tabla 2 Número de artículos, clasificados por Palabra Clave/Año de Publicación

Palabra Clave ⇒ ↓ Año de Publicación	ARG	SG	VS	VW	Total
1900-1999	4	1.310	1.330	12.600	15.244
2000-2004	13	612	2.418	22.620	25.663
2005-2009	368	3.922	5.590	45.310	55.190
2010	182	1.900	1.620	13.800	17.502
2011	230	2.440	1.980	14.400	19.050
2012	273	2.960	2.190	14.900	20.323
2013	275	3.730	2.050	15.200	21.255
2014	288	4.480	2.140	14.900	21.808
2015 (04/08/2015)	137	2.450	1.020	6.760	10.367
Total	1.770	23.804	20.338	160.490	206.402

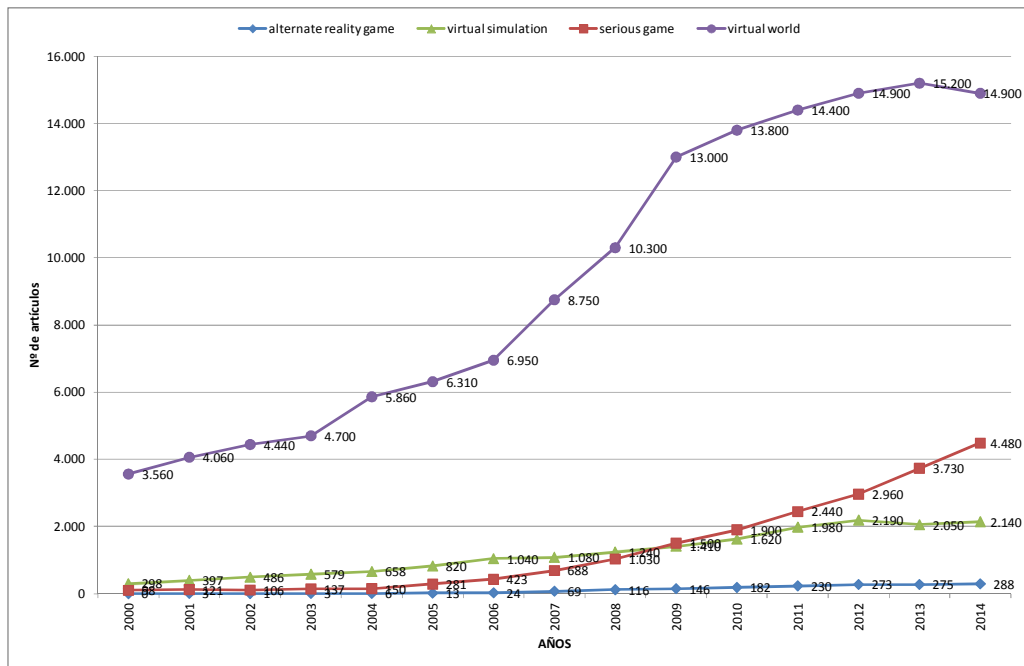


Figura 1 Número de artículos, por Año de Publicación/Palabra Clave (2000-2014)

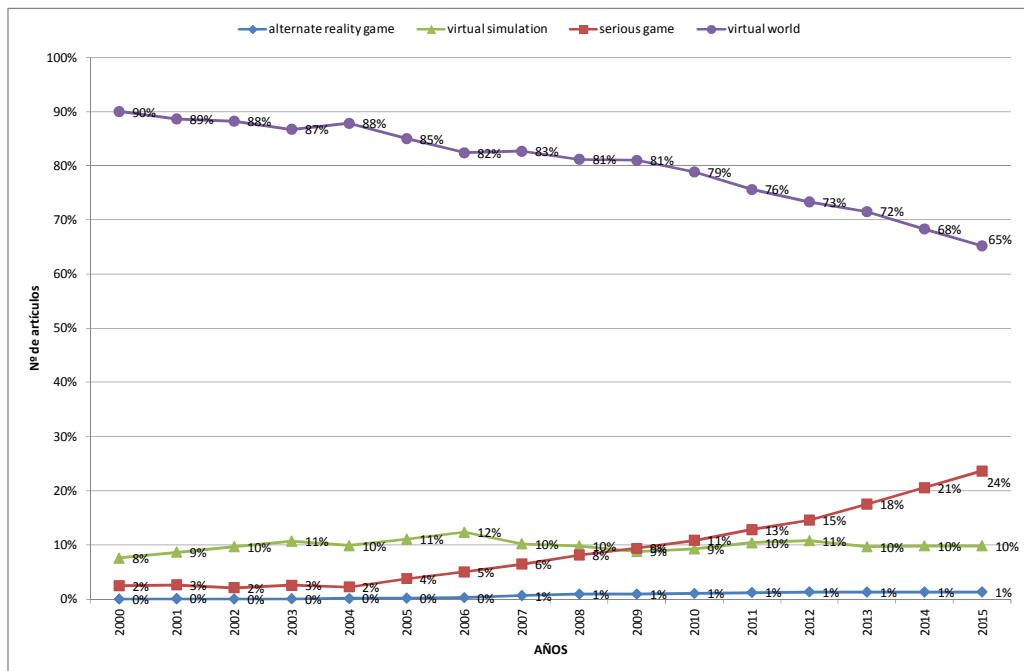


Figura 2 Porcentaje de artículos, por Año de Publicación/Palabra Clave

El análisis de este trabajo está enfocado a los estudios de ingeniería, por lo que los resultados obtenidos anteriormente se han filtrado con *engineering education*, obteniendo los datos que se muestran en la Tabla 3. En dicha tabla se aprecia que, en el ámbito de la educación en ingeniería, tanto para *alternate reality game*, como para *virtual simulation* y *virtual world* la tendencia es a la baja, mientras que para *serious game*, la tendencia en su uso es al alza, por lo que este estudio se va a centrar en las experiencias virtuales utilizando *serious game* (juegos serios), ver Figura 3.

Tabla 3 Número de artículos, Tabla 2, filtrado por *engineering education*

Palabra Clave⇒ ↓ Año de Publicación	ARG	SG	VS	VW	Total
1900-1999	0	21	23	175	219
2000-2004	2	10	74	399	485
2005-2009	8	223	183	1.320	1.734
2010	14	130	74	504	722
2011	11	219	96	705	1.031
2012	16	202	97	668	983
2013	18	269	110	577	974
2014	9	325	92	597	1.023
2015 (04/08/2015)	18	171	32	285	506
Total	96	1.570	781	5.230	7.677

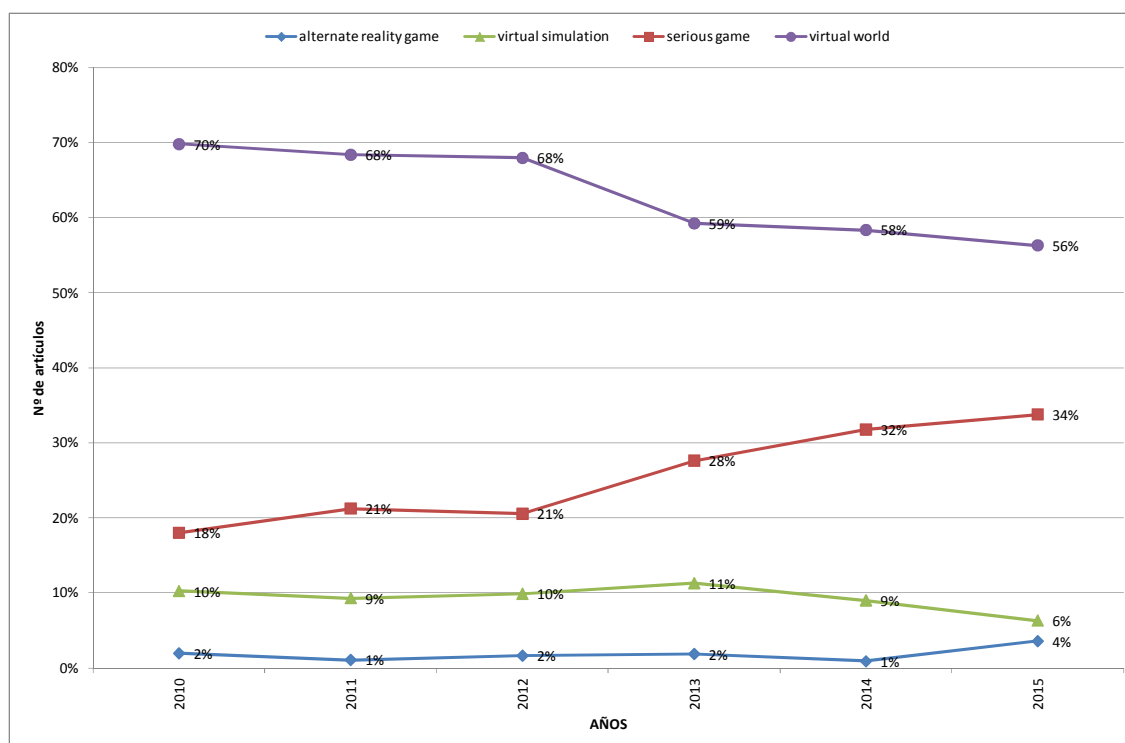


Figura 3 Porcentaje de artículos, Tabla 2, filtrado por *engineering education*

Las experiencias virtuales utilizando juegos serios pueden ser tanto a distancia (*e-Learning*) como mixtas (*b-Learning*). Se ha filtrado el conjunto de palabras clave anterior (*serious game & engineering education*) con estos dos terminologías. En la Tabla 4 se muestran el número de artículos encontrados tanto para *e-Learning* como para *b-Learning*. Observándola, se aprecia que no hay demasiado escrito sobre el *b-Learning* en las ingenierías utilizando videojuegos serios, aunque la tendencia es al alza tal y como se muestra en la Figura 4. Este tipo de aprendizaje mixto se ha empezado a utilizar en la última década, y está aumentando en los últimos años

Tabla 4 Número de artículos, filtrado por *serious game & engineering education*

Palabra Clave ⇒ ↓ Año de Publicación	e-Learning	b-Learning	Total
1900-1999	4	0	4
2000-2004	6	4	10
2005-2009	124	28	152
2010	79	16	95
2011	155	29	184
2012	104	38	142
2013	150	42	192
2014	184	85	269
2015 (04/08/2015)	102	51	153
Total	908	293	1.201

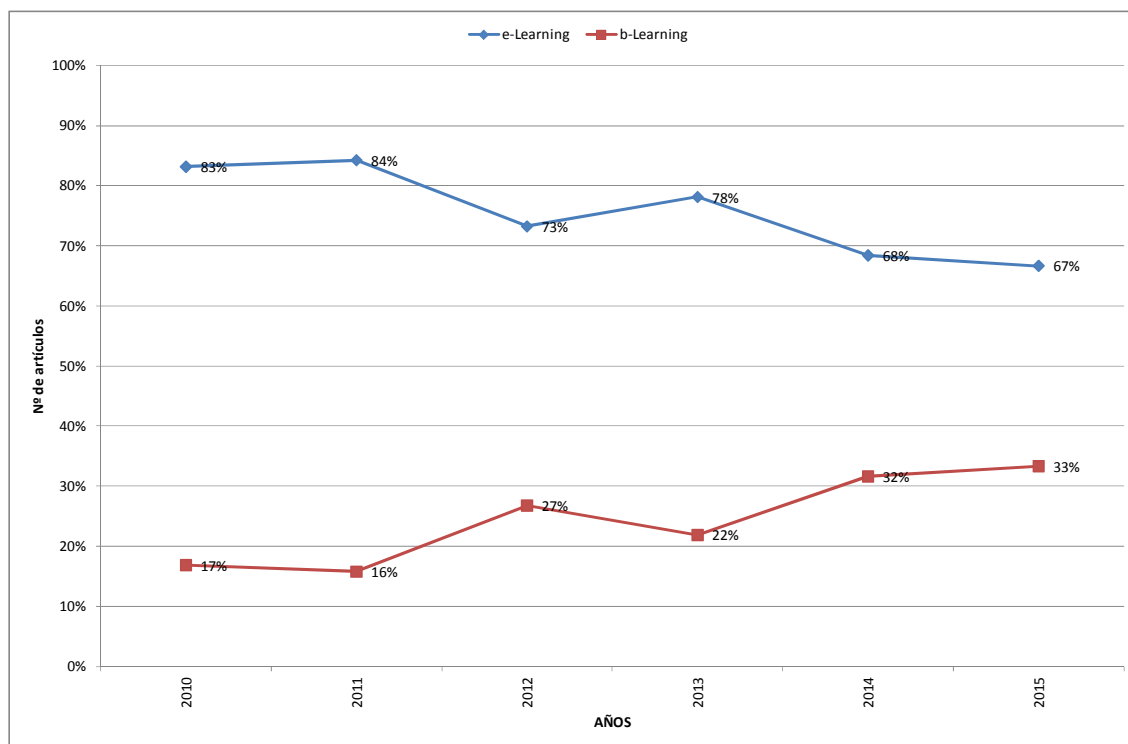


Figura 4 Porcentaje de artículos, filtrado por *serious game & engineering education*

Artículos seleccionados en este Análisis Sistemático de la Literatura

Los artículos finalmente seleccionados en esta SLR, listados en la Tabla 8, se han clasificado según los siguientes parámetros: tema central de estudio; enseñanza en la que se enmarca; y técnicas que se utilizan para implementar las prácticas.

En la Tabla 5, se muestra el número de artículos que están publicados diferenciado por cada tipo de publicación, según los temas principales establecidos anteriormente.

Tabla 5 Artículos SLR, clasificados por Tipo de publicación/Tema Principal

Tipo de Publicación ⇒ ↓Tema Principal	Congreso	Revista	Tesis	Total
<i>Active Learning Classroom</i>	1	2		3
<i>Serious Game</i>	7	10	3	20
<i>Virtual Laboratory</i>	6	5		11
<i>Virtual Reality</i>	1	4		5
<i>Simulation</i>	4	3	1	8
Total general	19	24	4	47

En la Figura 5 se aprecia que, de todos los artículos seleccionados, el tema principal del que se han encontrado más artículos es de juegos serios, publicados principalmente en revistas.

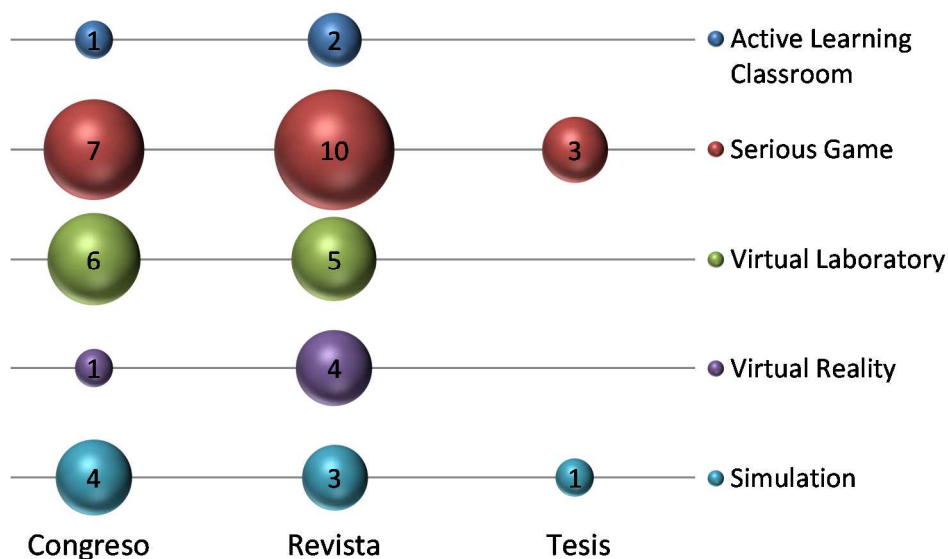


Figura 5 Número de artículos: Tema Principal – Tipo de Publicación

En la Tabla 6, se muestra una primera aproximación del número de artículos que están publicados, separado por cada tipo de publicación, según la Aplicación dentro de la Ingeniería, a la que va referenciado cada artículo.

Tabla 6 Artículos SLR, clasificados por Tipo de Publicación/Aplicación

Tipo de Publicación ⇒ ↓ Aplicación	Congreso	Revista	Tesis	Total
Civil Eng. & Construction	1	4	1	6
Software Engineering	2	2		4
Electrical & Electronic Eng.	7	4	1	12
Mechanical Engineering		3		3
Engineering	3	5	2	10
Others	6	6		12
Total general	19	24	4	47

Por último, en la Tabla 7 se han clasificado los artículos según la metodología que usa, con relación a la impartición de la docencia, en cada artículo.

Tabla 7 Artículos SLR, clasificados por Tipo de Publicación/Metodología

Tipo de Publicación ⇒ ↓ Metodología	Congreso	Revista	Tesis	Total
<i>b-Learning/e-Learning</i> (b-L)	8	6		14
<i>Collaborative Learning</i> (CL)	1	4	1	6
<i>Flipped Classroom</i> (FC)	1	2		3
<i>Game-Based Learning</i> (GBL)	8	10	2	20
<i>Problem-Based Learning</i> (PBL)	1	2	1	4
Total general	19	24	4	47

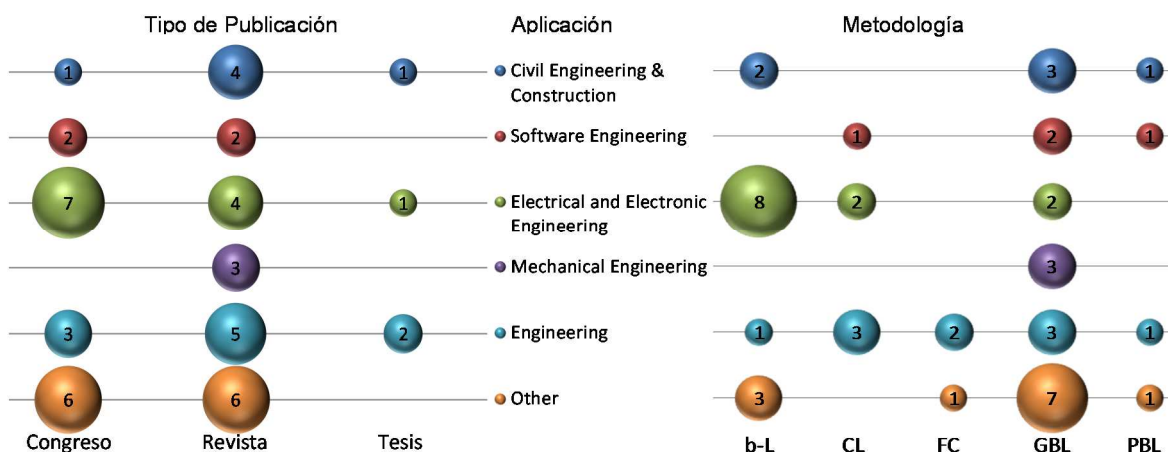


Figura 6 Número de artículos: Aplicación – Tipo de Publicación – Metodología

Tabla 8 Lista de artículos seleccionados en el Análisis Sistemático de la Literatura

Ref.	Título	Tipo de Publicación	Año	Tema Principal	Aplicación	Metodología
[1]	Intelligent Performance Assessment of Students' Laboratory Work in a Virtual Electronic Laboratory Environment	Revista: IEEE Transactions on Learning Technologies	2013	Virtual Laboratory	Electrical & Electronic Eng.	b-Learning / e-Learning
[2]	Low-Cost Virtual Laboratory Workbench for Electronic Engineering	Revista: International Journal of Virtual and Personal Learning Environments	2010	Virtual Laboratory	Electrical & Electronic Eng.	b-Learning / e-Learning
[3]	Using a Serious Game Approach to Teach'Operator Precedence'to Introductory Programming Students	Congreso	2013	Serious Game	Software Engineering	GBL
[4]	It's not about seat time: Blending, flipping, and efficiency in active learning classrooms	Revista: Computers & Education	2014	Active Learning Classroom	Other	FC
[5]	Engaging Engineering Students with Gamification	Congreso	2013	Serious Game	Other	GBL
[6]	Gamification of a Software Engineering course and a detailed analysis of the factors that lead to it's failure	Congreso	2013	Serious Game	Software Engineering	GBL
[7]	Game-like language learning in 3-D virtual environments	Revista: Computers & Education	2013	Virtual Reality	Other	GBL
[8]	Educational Quiz Board Games for Adaptive E-Learning	Revista: World Academy of Science, Engineering and Technology	2010	Serious Game	Engineering	GBL
[9]	Using game analytics to measure student engagement/retention for engineering education	Congreso	2014	Virtual Reality	Engineering	GBL

Ref.	Título	Tipo de Publicación	Año	Tema Principal	Aplicación	Metodología
[10]	Teaching software engineering project management—a novel approach for software engineering programs	Revista: Modern Applied Science	2011	Serious Game	Software Engineering	Collaborative Learning
[11]	Genuine lab experiences for students in resource constrained environments: the RealLab with integrated intelligent assessment	Revista: International Journal of Online Engineering / Multidisciplinary Engineering Education Magazine	2008	Virtual Laboratory	Electrical & Electronic Eng.	b-Learning / e-Learning
[12]	Simulation, Emulation and Remote Experiments	Congreso	2007	Virtual Laboratory	Electrical & Electronic Eng.	b-Learning / e-Learning
[13]	Effectiveness of using a video game to teach a course in mechanical engineering	Revista: Computers & Education	2009	Serious Game	Mechanical Engineering	GBL
[14]	Video game-based education in mechanical engineering: A look at student engagement	Revista: International Journal of Engineering Education	2009	Serious Game	Mechanical Engineering	GBL
[15]	Exigencies for engaging undergraduates in rhetorical problem solving: insights from engineering managers and A3 report analyses	Tesis	2012	Serious Game	Engineering	PBL
[16]	The Value of Team-Based Mixed-Reality (TBMR) Games in Higher Education	Revista: International Journal of Game-Based Learning	2013	Serious Game	Other	GBL
[17]	Serious Sustainability Challenge Game to Promote Teaching and Learning of Building Sustainability	Revista: Journal of Computing in Civil Engineering	2013	Serious Game	Civil Eng. & Construction	GBL
[18]	Successful implementation of user-centered game based learning in higher education: An example from civil engineering	Revista: Computers & Education	2007	Serious Game	Civil Eng. & Construction	GBL
[19]	Blended learning labs practice: magnetic field measurement	Congreso	2011	Virtual Laboratory	Other	b-Learning / e-Learning

Ref.	Título	Tipo de Publicación	Año	Tema Principal	Aplicación	Metodología
[20]	The use of a game-based project in engineering education: An examination of the academic learning, engagement and motivation of first-year engineering students	Tesis	2012	Serious Game	Engineering	Collaborative Learning
[21]	Learning and teaching styles in engineering education	Revista: Engineering Education	1988	Active learning Classroom	Engineering	Collaborative Learning
[22]	A framework for developing serious games to meet learner needs	Congreso	2006	Serious Game	Other	GBL
[23]	Tackling engineering education research challenges: Web 2.0 social software for personal learning	Revista: International Journal of Engineering Education	2010	Virtual Laboratory	Engineering	Collaborative Learning
[24]	A framework for Virtual Interactive Construction Education (VICE)	Revista: Automation in Construction	2011	Simulation	Civil Eng. & Construction	b-Learning / e-Learning
[25]	Requirements on learning analytics for facilitated and non facilitated games	Congreso	2014	Serious Game	Other	GBL
[26]	The use of game-based learning methods for teaching supply chain management subjects.	Revista: Journal of Advanced Distributed Learning Technology	2014	Serious Game	Mechanical Engineering	GBL
[27]	Impact of gaming application use in construction engineering education	Congreso	2010	Simulation	Civil Eng. & Construction	PBL
[28]	A plug and play pathway approach for operations management games development	Revista: Computers & Education	2010	Simulation	Other	PBL
[29]	Assessment of Application Technology of Natural User Interfaces in the Creation of a Virtual Chemical Laboratory	Revista: Journal of Science Education and Technology	2015	Simulation	Other	b-Learning / e-Learning

Ref.	Título	Tipo de Publicación	Año	Tema Principal	Aplicación	Metodología
[30]	Achieving broad access to satellite control research with zero robotics	Tesis	2013	Simulation	Electrical & Electronic Eng.	GBL
[31]	Laboratory instruction in engineering education	Revista: Global J. of Engng. Educ	2007	Virtual Laboratory	Electrical & Electronic Eng.	Collaborative Learning
[32]	Work in progress-How real is student engagement in using virtual laboratories	Congreso	2007	Virtual Laboratory	Engineering	b-Learning / e-Learning
[33]	A detailed investigation of the applicability and utility of simulation and gaming in the teaching of civil engineering students	Tesis	2010	Serious Game	Civil Eng. & Construction	GBL
[34]	Games for science and engineering education	Revista: Communications of the ACM	2007	Serious Game	Engineering	GBL
[35]	GETsoft/LabWeb-a virtual electrical engineering laboratory for first-year students	Revista: Workshop on using VR in education, Proceedings	2007	Virtual Laboratory	Electrical & Electronic Eng.	b-Learning / e-Learning
[36]	Envisioning engineering education and practice in the coming intelligence convergence era—a complex adaptive systems approach	Revista: Central European Journal of Engineering	2013	Virtual Reality	Engineering	FC
[37]	Control and Automation Engineering Education: combining physical, remote and virtual labs	Congreso	2012	Simulation	Electrical & Electronic Eng.	b-Learning / e-Learning
[38]	A Format of Serious Games for Higher Technology Education Topics: A Case Study in a Digital Electronic System Course	Congreso	2012	Serious Game	Electrical & Electronic Eng.	GBL
[39]	Creating Adaptive e-Learning Board Games for School Settings Using the ELG Environment.	Revista: Journal of Universal Computer Science	2008	Serious Game	Other	GBL

Ref.	Título	Tipo de Publicación	Año	Tema Principal	Aplicación	Metodología
[40]	3D and VR models in Civil Engineering education: Construction, rehabilitation and maintenance	Revista: Automation in Construction	2010	Virtual Reality	Civil Eng. & Construction	b-Learning / e-Learning
[41]	MareMonstrum: a Contribution to Empirical Research about How the Use of MUVES May Improve Students' Motivation.	Revista: Journal of Universal Computer Science	2013	Virtual Reality	Software Engineering	PBL
[42]	Real and Emulated Experiments for e-Learning and m-Learning Implemented by Virtual Instrumentation	Congreso	2007	Virtual Laboratory	Electrical & Electronic Eng.	b-Learning / e-Learning
[43]	Laboratory demonstrators' perceptions of the remote laboratory implementation of a fluid mechanics laboratory	Congreso	2010	Virtual Laboratory	Other	b-Learning / e-Learning
[44]	DIBE - Existing e-learning products	Congreso	2007	Simulation	Electrical & Electronic Eng.	b-Learning / e-Learning
[45]	Gameplay to introduce and reinforce requirements engineering practices	Congreso	2008	Serious Game	Other	GBL
[46]	Flipping the Work Design in an industrial engineering course	Congreso	2009	Active Learning Classroom	Engineering	FC
[47]	Infusing Technology Into Engineering Education	Congreso	2010	Simulation	Electrical & Electronic Eng.	Collaborative Learning

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