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Digital anthropology and educational eGames: learning through behavioural patterns in digital, game-based contexts

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UNIVERSITY OF WESTMINSTER

Digital Anthropology and educational eGames. Learning through behavioural patterns in digital, game-based contexts

A thesis submitted in partial fulfilment of the requirements of the University of Westminster for the degree of Doctor of Philosophy

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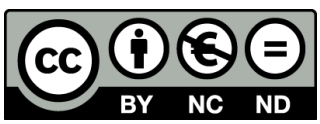

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To Ishinca. A metaphor of life and commitment

Anthropology is the science which tells us that people are the same the whole world over, except when they are different

Nancy Banks-Smith (British journalist, 1929-)

Abstract

The selected publications are focused on the relations between users, eGames and the educational context, and how they interact together, so that both learning and user performance are improved through feedback provision. A key part of this analysis is the identification of behavioural, anthropological patterns, so that users can be clustered based on their actions, and the steps taken in the system (e.g. social network, online community, or virtual campus). In doing so, we can analyse large data sets of information made by a broad user sample, which will provide more accurate statistical reports and readings.

Furthermore, this research is focused on how users can be clustered based on individual and group behaviour, so that a personalized support through feedback is provided, and the personal learning process is improved as well as the group interaction. We take inputs from every person and from the group they belong to, cluster the contributions, find behavioural patterns and provide personalized feedback to the individual and the group, based on personal and group findings. And we do all this in the context of educational games integrated in learning communities and learning management systems.

To carry out this research we design a set of research questions along the 10-year published work presented in this thesis. We ask if the users can be clustered together based on the inputs provided by them and their groups; if and how these data are useful to improve the learner performance and the group interaction; if and how feedback becomes a useful tool for such pedagogical goal; if and how eGames become a powerful context to deploy the pedagogical methodology and the various research methods and activities that make use of that feedback to encourage learning and interaction; if and how a game design and a learning design must be defined and implemented to achieve these objectives, and to facilitate the productive authoring and integration of eGames in pedagogical contexts and frameworks.

We conclude that educational games are a resourceful tool to provide a user experience towards a better personalized learning performance and an enhance group interaction along the way. To do so, eGames, while integrated in an educational context, must follow a specific set of user and technical requirements, so that the playful context supports the pedagogical model underneath. We also conclude that, while playing, users can be clustered based on their personal behaviour and interaction with others, thanks to the pattern identification. Based on this information, a set of recommendations are provided

to the user and the group in the form of personalized feedback, timely managed for an optimum impact on learning performance and group interaction level.

In this research, Digital Anthropology is introduced as a concept at a late stage to provide a backbone across various academic fields including: Social Science, Cognitive Science, Behavioural Science, Educational games and, of course, Technology-enhance learning. Although just recently described as an evolution of traditional anthropology, this approach to digital behaviour and social structure facilitates the understanding amongst fields and a comprehensive view towards a combined approach.

This research takes forward the already existing work and published research on users and eGames for learning, and turns the focus onto the next step — the clustering of users based on their behaviour and offering proper, personalized feedback to the user based on that clustering, rather than just on isolated inputs from every user. Indeed, this pattern recognition in the described context of eGames in educational contexts, and towards the presented aim of personalized counselling to the user and the group through feedback, is something that has not been accomplished before.

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Acknowledgements

This research is the result of a long-distance planning, which combines education, technology, communication, games and sociology into a new, adapted field called Digital Anthropology. For over 10 years, I have had the privilege of sharing designs, workshops, publications, keynotes, concerns and outcomes with a large number of top researchers, from every continent and over 100 countries. These relationships have contributed to a list of publications, from which I selected the ones provided in this dissertation. Indeed, this effort to create a sensitive and comprehensive compilation of research outcomes with a rational flow belongs to those people, to all of us.

I also thank Tom Corby, my supervisor, who has offered his support throughout this process at the University of Westminster, and who has been so kind as to make my project, his. I thank the University, as well, for looking beyond traditional ways of research, and for offering me this opportunity.

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Brussels, Belgium

Author’s declaration

I declare that all the material contained in this thesis is my own work.

1. Introduction and research context

Anthropology combines sociology, psychology, biology, education and the humanities in order to carry out deep analysis of human beings and social groups (Waitz, 1863; Cohen, 1978; Aarserth, 2001; Bernard, 2011). In any type of Society and cultural representation, games are a key part of this analysis (Schwartzman, 2012). Through play, children develop key features that will support them when they become adults, from hunting to counting, through solving problems and by learning other fundamental skills. In addition, for adults, games are the natural way to approach situations such as negotiations and meetings, in which everyone plays a role, and every individual has to find their place and a way of communication (Prensky, 2005, 2009). However, we cannot just refer to the original structures of ancient tribes in order to understand anthropology. Nowadays, the social unit consists of distributed contacts and cloud services which facilitate a 24/7 umbilical connection of the individual to the group (Trouillot, 2003; Scupin, 2015). With this background, eGames and gamification techniques look like a natural evolution for achieving real learning in a digital context, one that is based on interaction and social strategies with social networks, learning management systems, entertainment apps and digital tools that support and extend social contacts. In this setting, learning happens anytime, anywhere. This is the approach of Digital Anthropology (Horst & Miller, 2012, 2013), a new research field, in which groups are analysed as a combination of cultures and contexts.

In traditional anthropology, there are a number of features in which researchers focus their attention (Malinowski, 1929; Fried, 1975; Keesing, 1981): for example, social identity, the user's role in a group, social forms of expression (like chanting or dancing), the group's need for assembly and public justice, the development of personal and group skills for subsistence (like hunting or collecting fruits) and others. In digital tribes, we find similar features but within a particular manner of representation (Pfaffenberger, 1992; Guimarães Jr, 2005). Enabled by social networks and Internet apps, the individual and the groups can share and express themselves (i.e., via Facebook and Instagram); meet together for discussion (i.e., Google Hangouts and Skype); provide opinion, argue and call for justice (i.e., Twitter and WhatsApp); create music (e.g., Garage Band) and work (i.e., Outlook, Calendar and OpenOffice). Social roles within the group are also required for interaction (e.g., adopting the role of a follower or an alpha male). In short: Not so many differences and, indeed, many

similarities between these and other social structures that are usually the subjects of anthropological study.

In this context, games play a role in any tribe-group, as aforementioned: in achieving social status, developing social skills and personal competences and ascribing roles in group interaction (Piaget, 1962; Gros, 2010). The positive and negative sides of games have been discussed by Prensky, Gee and others (Prensky, 2003; Gee, 2003).

For example, the dark side of games might be used for promoting effective learning and interaction, including the ability to overlap tasks leading to skills in multitasking; the manipulation of social identification through colour, dress codes and strange jargon; encouraging social skills for empathy and creating internal relations inside a group and, finally, for cultural integration. Furthermore, the functional diversity based on the inclusion of over-gifted individuals, barely integrated into the group but possessing special features that make them unique becomes a one-in-a-million feature that makes them stand out. All of those examples present a number of 'bad habits' related to games, which can be turned upside down in order to support effective and useful learning and interaction. The main objective of this research analyses these similarities, and discover how to match the social behaviour of individuals and groups in educational digital games with the process of learning personal skills (Malaby, 2007, 2009). Furthermore, we examine those elicited specifically from recurrent patterns, which can be used for learning and the development of personal and social competences (Kline et al., 2003; Raessens, 2006). In doing so, we provide a new approach to the use of eGames, not just as a tool for learning, but as a vehicle for social and personal behaviour analysis, moving towards personalized support offered to every user and group, which is based on individual inputs and anthropological pattern identification.

The selected papers were published from 2006 to 2011 as a result of 10 years of research. During this period, the author focused on learning and instructional design, case studies and the practical implementation of eGames and user interaction, experiments about user clustering and user experience, and other topics that will be presented in the following pages. At the very end of this period, namely 2002-2011, Digital Anthropology emerged as a new approach to traditional Anthropology focused on digital contexts, with technological support, including social networks, multi-device deployment, information access and interaction through mobile devices, eLearning platforms, cloud services and other related means. Furthermore, Digital Anthropology provided a common

ground, an umbrella, to connect and improve the relation of the multiple fields involved in our work, becoming a natural container for the research already carried out. This combined, interlaced approach is required, since our research leans on a number of diverse, and yet complementary, academic fields, such as psychology, sociology, anthropology, games theory, learning, teaching, technology and others. In doing so, we are able to produce a comprehensive analysis based on a flexible, adaptive methodology, which is actually indispensable in addressing the main research focus, in full.

2. Research questions

Research questions lead to increased understanding of how learning occurs in game environments for users and groups when it is informed by an understanding of behavioural patterns. Our research is driven by the analysis, design and improvement of efficient learning process for the user and the group. This approach is supported in anthropology (Malaby, 2007, 2009), which plays a conducting role across the last stage of our research to inform its understanding of human behaviour, social units and dynamics, as an intrinsically interdisciplinary approach combining sociology, psychology, biology, education and the humanities (Waitz, 1863; Cohen, 1978; Aarserth, 2001; Bernard, 2011). Specific research questions (RQ), are extracted from the published papers and based on the bottom-line work, and include (*Table 1. List of research questions*):

Table 1. List of research questions

ID	Research questions extracted from papers
PP-01	RQ-1. Can users be clustered into groups based on behavioural patterns so that they can receive personalized, adapted feedback? RQ-2. Does feedback improve or damage the learning process and how? RQ-3. How does user information provide meaningful input towards a better learning performance through adapted, personalized feedback? RQ-4. Are users guided by similar behavioural patterns when they interact with peers in a game-based, digital context?
PP-02	RQ-5. How can commercial, traditional and non-educational games, played by non-academic users or students, be easily re-used and integrated in an educational context? RQ-6. How can these games support and improve the pedagogic goals?
PP-03	RQ-7. In the context of Game-based Learning, how does feedback interact with performance to illuminate results dependent on a user's behavior? RQ-8. Can feedback improve the student's performance when it is implemented in the context of eGames?
PP-04	RQ-9. How to employ units of learning in the authoring of eGames to boost user interaction and the learning process RQ-10. Can the levels of interaction and performance of a user in a group (and of the wider group) be improved? RQ-11. Which are the practical implications for game design and learning design from the authoring process?
PP-05	RQ-12. How to design eGames in an educational setting so that the user's information on behavior, performance and interactions is extracted for individual and group improvement?
PP-06	RQ-13. What is the current state-of-the-art on educational games in relation to eLearning environments?
PP-07	RQ-14. What are the practical issues faced in the design and implemention of a framework for eGames? RQ-15. How can eLearning systems be designed from game based scenarios, and how can these be integrated within games to encourage learning?
PP-08	RQ-16. How interface styles interact with the user's performance? RQ-17. Can too much feedback be counterproductive towards effective learning? RQ-18. Do the individuals in a group play a similar role in both externalized and internalized scenarios when they use a game-based learning resource? RQ-19. Can users be clustered in groups, following specific patterns, with the aim of providing personalized support based on individual and group objectives?
PP-09	RQ-20. Which are the user requirements and functional requirements to design educational games? RQ-21. What should design method be for eGames?

3. Research methods, research activities and methodology

The commentary in this section covers 10-years' worth of publications and is presented thematically rather than chronologically; during this time, research was pursued using a hybrid methodology combining experimental and practical approaches (Rodríguez et al., 1999; Kothari, 2004; Kumar & Phrommathed, 2005). The experimental methodology generated a number of case studies based on game and instructional designs in learning settings. We describe the best-case learning scenario to prove the original hypothesis, run the experiments in a controlled situation and interpret the qualitative and quantitative results and conclusions obtained from the process, in order to corroborate, refute or shape the original premise. Additionally, the practical approach designed and implemented a number of software prototypes, including integration with e-learning specifications, in the search for interoperability and replication. This hands-on approach focused on experiences with real users, who provided feedback on instructional design, game design, interface design and the educational paradigm. In doing so, we apply a hermeneutic, interpretative perspective to research, data and people, so that we can observe and interpret the users' behaviour and interaction, and contribute to an integrated analysis of the findings (Koch, 1999; Diekelmann, 2001).

From this methodological approach, a number of research methods and research activities were chosen, decided on, utilized, executed and validated, depending on the phase of the research, the pursued goals, the target users and other features. In Chapter 4. 'Rationale of the selected publications and links to the research questions', we match these methods (MT) and activities (AC) with the main research themes (TH), the research questions addressed (RQ) and their related publications (PP). The methods implemented are listed in the table below: (*Table 2. List of research methods and activities applied in the research*):

Table 2. List of research methods and activities applied in the research

MT-01. Desk/literature review
MT-02. Case study
AC-01. Software prototype development and implementation
AC-02. Game design
AC-03. Learning design

MT-01. Desk/literature review: This enabled a comprehensive understanding of existing research that placed our research in context and shaped the hypothesis, outcomes and conclusions. We employed a number of

authoritative databases, i.e., Web of Knowledge (renamed the Web of Science), Scopus, IEEE, ACM, Inspec, In-Recs and others iteratively throughout research to ensure we kept abreast of the field in a way that informed the novelty of the hypothesis, our outcomes and conclusions.

MT-02. Case study: For Gerring (2006) case study approaches are useful for both defined and experimental multi-disciplinary studies where methodological models are rare, and are applicable to both qualitative and quantitative research. Case studies can also be effectively scaled to include greater or lesser numbers. In our research, we used a case study as a practical, empirical approach, which was implemented with a select group of real users and which tested a tool in the context of a learning process and/or a technical deployment. This method provided a controlled, experimental context to match the research hypothesis with actual users. We used it in combination with game design and learning design methods in order to work with experimental and controlled groups that were tracked; it provided first-hand information about the individual user and the group's behaviour, and the interaction amongst them. The case studies were designed as a key part of the full research process, from the literature review to hands-on user experience. We used them to apply theoretical principles, and master designs (game design and learning design), to a contextual story with which the user could identify and interact freely.

AC-01. Software prototype development and implementation: In our research, we developed a number of prototypes of games and simulations in order to test the individual user and group's behaviour, interaction, performance and other features, leading towards effective learning through pattern recognition. This research activity provided a hands-on, practical setting, so that the individual users and the group could play, interact and test the game design and learning design in practice. In our context, the software prototype development complements the theoretical research, providing insights into user behaviour (with or without their explicit awareness) while using a tracking approach.

AC-02. Game design: Any game requires a conceptual phase in which the fundamentals are grounded, such as the storyboard, roles, rules, objectives, interactions, behaviour, group patterns, social skills and

others (Salen & Zimmerman, 2004). In fact, designing a game looks very much like designing a social experiment since, in addition to playability, the most important component is the interaction: between peers, between the user and the group, between the user and the system, between the various elements within the game, etc. (Kreimeier, 2002). In our research, we designed games for learning; however, we followed normative game design processes, meaning that the game must be engaging and playable, and produced to a high specification (Deterding, 2011). This research activity provided the users with a basic framework to explore, learn, interact and give feedback on their experiences within a game integrated in a learning context, process and itinerary. It was mainly devised using a case study method and/or a learning design activity. We used game design to examine the research hypothesis and the controlled variables of the experimental approach, providing a narrative framework through which the user interacts with the system and the other group members, while playing and providing inputs and feedback between the researcher and the research setting, in both ways.

AC-03. Learning design: Any learning scenario requires a design in order to elicit the best possible outcome (Conole, 2004). The design will describe users, learning goals, social goals, various types of interaction, the expected outcomes, criteria of success and other features (Koper, 2005). Usually, a learning design approach can overlap with and is similar to a pedagogic lesson or assignment design, in both their components and outcome-based approaches (Merlot, 2015). In our research, we combined game design and learning design, since the game is developed to support the learning process, for individuals and groups (Kafai, 1996; Gee, 2008). In addition, in most of the publications, the learning design becomes the actual rationale flowing across the prototype and/or the case study, which become mere tools that support the ultimate goals described in that learning design (Chien, 2002; Raymer, 2011). This research activity described the learning setting in which the user explores, experiments with and achieves certain competences and skills, in addition to group interaction. The instructional design behind the case study becomes the backbone of every practical experience. It was mainly used with game design, case study and software prototype methods, since it connects the hypothesis with the users' and the group's behaviour, giving an ultimate set of goals to the practical approach. The learning design facilitates the

learning processes, itinerary, variables and outcomes used throughout the research, from the game design through to the prototype and the case study. We used learning design to give an educational background and implementation to the research environment as a whole.

4. Rationale of the selected publications and links to the research questions

In the last 10 years, the candidate has produced various scientific results focused on eGames, learning and individual users' interaction with the media, the context and the group. This work has contributed perspectives and knowledge to the fields of Educational Technology, Games, Cognitive Science, Behavioural and Social Science (Malone, 1982; Brusilovsky, 1998; Prensky, 2001; Squire, 2003; Koper, 2005), and it provides a wide understanding of how games are socially and personally used for learning, based on the individual process as well on the group interaction amongst users. This research we suggest also contributes insights to the emerging field of Digital anthropology through its understanding of how these various fields intersect, as interrogations of social and technological formations with particular relevance to the way in which behaviour is traced and understood in digital learning environments.

Publications (PP) to be considered for this PhD proposal are listed below. Electronic copies of these papers are included in Annex III. A full list of related publications by the candidate, as Annex II, can be found at the end of this thesis. (*Table 3. List of publications to be considered for this PhD proposal*):

Table 3. List of publications to be considered for this PhD proposal

ID	Year	% author	Publication	Evidence of quality and fitness to the research proposal
PP-01	2009	90%	Burgos, D. & Nimwegen, C. v. (2009). Games-Based Learning. Destination Feedback and Adaptation: A Case Study of an Educational Planning Simulation. In T. M. Connolly, M. H. Stansfield & L. Boyle (Eds.), Games-Based Learning Advancements for Multi-Sensory Human Computer Interfaces. Hershey, USA: Information Science.	ISBN: 978-160566360-9 This book chapter concentrates on the interaction between users and the system, in the context of an educational setting, with end users who will play a simulation in order to retrieve their non-verbal communication, such as user-tracking information. Furthermore, the system is capable of identifying user patterns and user roles, in order to facilitate clustering and related actions.
PP-02	2007	85%	Burgos, D., Tattersall, C. & Koper, R. (2007). Re-Purposing Existing Generic Games and Simulations for E-Learning. Special Issue on Education and Pedagogy with Learning Objects and Learning Designs. Computers in Human Behavior, 23 (6), 2656–2667.	DOI: 10.1016/j.chb.2006.08.002 ISSN: 0747-5632 Impact Factor: 2.067 5-year Impact Factor: 2.489 Ranking (2012): Q1 This paper shows how commercial, traditional and non-educational games, played by non-academic users or students, can be easily reused in an educational context. The paper adopts the angle of a creator of learning resources who needs to connect with end users inside a social network of a virtual community, and who seeks to facilitate game play within an eGame.

PP-03	2007	80%	Burgos, D., Nimwegen, C. v., Oostendorp, H. v. & Koper, R. (2007). Game-Based Learning and the Role of Feedback. A Case Study. Advanced Technology for Learning. 4 (4), 188–193. Anaheim, CA, USA: ACTA Press.	DOI: 10.2316/Journal.208.2007.4.208-0918 This paper shows the relation between the user and the feedback provided by the system, in the context of an eGame. It shows how results depend on the user's behaviour.
PP-04	2007	80%	Burgos, D., Moreno-Ger, P., Sierra, J. L., Fernández-Manjón, B. & Kooper, R. (2007). Authoring Game-Based Adaptive Units of Learning with IMS Learning Design and <e-Adventure>. International Journal of Learning Technology, 3 (3), 252–268. Geneva, SWITZERLAND: Inderscience Publishers.	DOI: 10.1504/IJLT.2007.015444 This paper shows the authoring role of a user of eGames, when they create units of learning from scratch. It presents the methodology and practical outcomes, which point to a clear need for the simplification of the authoring process, so that user interaction can be strengthened.
PP-05	2008	80%	Burgos, D., Moreno-Ger, P., Sierra, J. L., Fernández-Manjón, B., Specht, M. & Koper, E. J. R. (2008). Building Adaptive Game-Based Learning Resources: The Marriage of IMS Learning Design and <e-Adventure>. Simulation & Gaming. Special Issue on eGames and Adaptive eLearning. A Practical Approach. 39 (3), 414–431. Thousand Oaks, CA, USA: SAGE Publications.	DOI: 10.1177/1046878108319595 This paper shows how to design and create game-based learning resources to integrate stand-alone games within digital frameworks, e.g., social networks, virtual campuses and intranets.
PP-06	2009	60%	Moreno, P., Burgos, D. & Torrente, J. (2009). Digital Games in eLearning Environments. Current Uses and Emerging Trends. Simulation & Gaming, 40th Anniversary, 40 (5), 669–687. Thousand Oaks, CA, USA: SAGE Publications.	DOI: 10.1177/1046878109340294 This paper gives a comprehensive review of the field of educational games, in the context of learning environments.
PP-07	2011	55%	Anido, L., Burgos, D., Caeiro, M., Torrente, J., Fernandez, M., Gonzalez, J., Manso, M., Ortega, M., Rodriguez, D. & Fernandez-Manjon, B. Gametel: An Approach to Multi-Format and Multi-Device Accessible Engineering Education. Proceedings of Frontiers in Education Conference, FIE 2011, Pages F1H-1-1-F1H-6. Rapid City, South Dakota (USA): IEEE Computer Society, October 12–15, 2011.	DOI: 10.1109/FIE.2011.6142745 This conference paper shows the practical experience of a framework focused on eGames, which is deployable in various formats and devices, including tablets and smartphones. This approach allows for complex information retrieval from a variety of users, which facilitates the identification of user interaction and group patterns.
PP-08	2006	50%	van Nimwegen, C., Burgos, D. D., van Oostendorp, H. & Schijf, H. (2006). The Paradox of the Assisted User: Guidance can be Counterproductive. In R. E. Grinter, T. Rodden, P. M. Aoki, E. Cutrell, R. Jeffries & G. M. Olson (Eds.), Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. CHI (p./pp. 917–926), New York, NY, USA: ACM. ISBN: 1-59593-372-7	DOI: 10.1145/1124772.1124908 This paper at the SIGCHI conference concentrates on the interaction between a user and the support provided by the system to carry out a specific task. It shows that too much assistance lowers the user's attention and performance. In the publication, the authors present the results of an experimental case with a random sample of users.
PP-09	2008	50%	Moreno-Ger, P., Burgos, D., Martínez-Ortiz, I., Sierra, J. L. & Fernández-Manjón, B. (2008). Educational Game Design for Online Education. Computers in Human Behavior. Special Issue on Electronic Games and Personalized eLearning Processes, 24 (6), 2530–2540.	DOI: 10.1016/j.chb.2008.03.012 ISSN: 0747-5632 Impact Factor: 2.067 5-year Impact Factor: 2.489 Ranking (2012): Q1 This paper shows the user requirements and functional requirements to design educational games. In addition, the authors propose a design method focused on user adaptation, group definition and assessment.

In addition to the selected papers and publications, the candidate was also one of the designers and scientific coordinators of the following European-funded projects focused on the research fields identified:

- GALA (Games and Learning Alliance: http://www.galanoe.eu, Framework Programme VII, 2009–2014). A network of excellence that gathered 30 partners across Europe, who were experts in games, learning and teaching. In 4 years, the network produced dozens of scientific papers, technical reports and a brand-new scientific journal, organized four major conferences in the field that registered over 1,000 participants and was the main focal point for game-based learning for the European Commission.

- EDUMOTION (Education on the move — mobile access to educational content: http://www.edumotion-project.eu/, Framework Programme VII, 2012–2014). This project developed a new methodology for using games for clustered groups of secondary students, based on a number of anthropological criteria (i.e., academic performance, social analysis, social identity, psychological development, level of social integration and others). The main outcome was the release of a game-app to analyse the users' behaviour and interaction while they played an indoor-outdoor challenge focused on a mission to be accomplished by the students who were clustered in groups.

- VERITAS (Virtual and augmented Environments and Realistic user Interactions To achieve embedded Accessibility designS: http://veritas-project.eu/, Framework Programme VII, 2009–2013). This project gathered over 30 expert partners from across Europe and developed a set of tools to design, implement and evaluate virtual environments for an immersive user experience, in order to achieve specific professional competences and skills. The project stressed the functional diversity of the outcomes, and was the basis for educational and social simulations in which the users interact with one another and with various objects in the augmented scenario.

Furthermore, we have clustered the publications thematically (**TH**), including a reference to the applied method (**MT**), the research activity (**AC**) and the research questions (**RQ**) addressed by each paper, for ease of reference along

with the commentary[1] (*Table 4. List of themes, publications, methods, activities and research questions, clustered thematically*):

Table 4. List of themes, publications, methods, activities and research questions, clustered thematically

Theme (TH)	Thematic focus	
TH-01 Game context and Learning scenario	This set of papers concentrates on two major issues. First, a) the context of games. The papers present what a game is, identify types of games, from traditional to video games; define anthropological features and the various formats and devices to play with; describe how to design a game and define the target user based on several criteria (i.e., user group, user performance, interaction between peers and with the system, and others). These criteria are key for designing effective and target-oriented games. Secondly, b) these articles depict the requirements of designing a learning scenario out of a game, including methodology, user analysis, assessment, group behaviour, social interaction and other features that, along with the previous paragraphs, provide an overall outlook of game design and learning design, combined.	
PP-02	Burgos, D., Tattersall, C. & Koper, R. (2007). Re-Purposing Existing Generic Games and Simulations for E-Learning. Special Issue on Education and Pedagogy with Learning Objects and Learning Designs. Computers in Human Behavior, 23 (6), 2656–2667.	Methods: MT-01. Desk/literature review MT-02. Case study AC-01. Software prototype AC-02. Game design AC-03. Learning design Research questions addressed: RQ-5, RQ-6
PP-06	Moreno, P., Burgos, D. & Torrente, J. (2009). Digital Games in eLearning Environments. Current Uses and Emerging Trends. Simulation & Gaming, 40th Anniversary, 40 (5), 669–687. Thousand Oaks, CA, USA: SAGE Publications.	Methods: MT-01. Desk/literature review Research questions addressed: RQ-13
PP-07	Anido, L., Burgos, D., Caeiro, M., Torrente, J., Fernandez, M., Gonzalez, J., Manso, M., Ortega, M., Rodriguez, D. & Fernandez-Manjon, B. Gametel: An Approach to Multi-Format and Multi-Device Accessible Engineering Education. Proceedings of Frontiers in Education Conference, FIE 2011, Pages F1H-1-1-F1H-6. Rapid City, South Dakota (USA): IEEE Computer Society, October 12–15, 2011.	Methods: MT-01. Desk/literature review AC-02. Game design Research questions addressed: RQ-14, RQ-15
PP-09	Moreno-Ger, P., Burgos, D., Martínez-Ortiz, I., Sierra, J. L. & Fernández-Manjón, B. (2008). Educational Game Design for Online Education. Computers in Human Behavior. Special Issue on Electronic Games and Personalized eLearning Processes, 24 (6), 2530–	Methods: MT-01. Desk/literature review AC-02. Game design AC-03. Learning design

[1] A one-page summary of this table, along with the research questions, is provided at the end of this document, as Annex I.

	2540.	Research questions addressed: RQ-20, RQ-21

Theme (TH)	Thematic focus
TH-02 Authoring and Adaptation	This thematic cluster shows the authoring process of educational games, with a special focus on the user experience and the adaptive ability to personalize this experience based on a number of inputs from the user, e.g., user performance, user behaviour, user interaction with peers and the system, personal goals, group goals, monitored counselling and others. In addition, this work discusses the how eGames and learning management systems (online platforms) can be deployed and implemented in the context of a learning scenario, as a necessarily integrated approach.

PP-04	Burgos, D., Moreno-Ger, P., Sierra, J. L., Fernández-Manjón, B. & Kooper, R. (2007). Authoring Game-Based Adaptive Units of Learning with IMS Learning Design and <e-Adventure>. International Journal of Learning Technology, 3 (3), 252–268. Geneva, SWITZERLAND: Inderscience Publishers.	Methods: MT-01. Desk/literature research AC-01. Software prototype AC-02. Game design Research questions addressed: RQ-09, RQ-10, RQ-11
PP-05	Burgos, D., Moreno-Ger, P., Sierra, J. L., Fernández-Manjón, B., Specht, M. & Koper, E. J. R. (2008). Building Adaptive Game-Based Learning Resources: The Marriage of IMS Learning Design and <e-Adventure>. Simulation & Gaming. Special Issue on eGames and Adaptive eLearning. A Practical Approach. 39 (3), 414–431. Thousand Oaks, CA, USA: SAGE Publications.	Methods: MT-01. Desk/literature research AC-01. Software prototype AC-02. Game design Research questions addressed: RQ-12

Theme (TH)	Thematic focus
TH-03 Feedback and Interaction	The following three papers address user interaction and the required feedback to that user, in order to provide assistance for actual learning. The papers argue for recognition of a difference between a supportive comment, which can lead to the task's achievement, and useful feedback, which will shorten the learning curve and improve the cognitive load of the user. We discuss how the user is tracked and monitored, so that their behaviour is analysed to feed the system and provide personalized feedback. This research reveals how user interaction and responsiveness is encouraged via well-designed gaming strategies that encourage pleasurable engagement, through the challenges designed into the game as a series of steps towards a designated set of outcomes or achievements.

PP-01	Burgos, D. & Nimwegen, C. v. (2009). Games-Based Learning. Destination Feedback and Adaptation: A Case Study of an Educational Planning Simulation. In T. M. Connolly, M. H. Stansfield & L. Boyle (Eds.), Games-Based Learning Advancements for Multi-Sensory Human Computer Interfaces. Hershey, USA: Information Science.	Methods: MT-01. Desk/literature review MT-02. Case study AC-01. Software prototype AC-02. Game design AC-03. Learning design Research questions addressed:

		RQ-01, RQ-02, RQ-03, RQ-04
PP-03	Burgos, D., Nimwegen, C. v., Oostendorp, H. v. & Koper, R. (2007). Game-Based Learning and the Role of Feedback. A Case Study. Advanced Technology for Learning. 4 (4), 188–193. Anaheim, CA, USA: ACTA Press	Methods: MT-01. Desk/literature review MT-02. Case study AC-01. Software prototype AC-02. Game design AC-03. Learning design
		Research questions addressed: RQ-07, RQ-08
PP-08	van Nimwegen, C., Burgos, D. D., van Oostendorp, H. & Schijf, H. (2006). The Paradox of the Assisted User: Guidance can be Counterproductive. In R. E. Grinter, T. Rodden, P. M. Aoki, E. Cutrell, R. Jeffries & G. M. Olson (Eds.), Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. CHI (p./pp. 917–926), New York, NY, USA: ACM. ISBN: 1-59593-372-7	Methods: MT-01. Desk/literature review MT-02. Case study AC-01. Software prototype AC-02. Game design AC-03. Learning design
		Research questions addressed: RQ-16, RQ-17, RQ-18, RQ-19

5. Commentary

5.1 . Introduction to the commentary

In this commentary, we show the relevance of eGames in eLearning **(TH-01)** and their relation to behavioural patterns **(TH-01)**. These are identified as anthropological patterns at the very end of the research period, which encouraged us to include anthropology as a cross-field comprehensive view of that research, looking behind. We also introduce the need for appropriate user interaction in order to derive better performance, and in designing a personalized learning experience **(TH-02)**. Furthermore, we also state that feedback based on behavioural and anthropological patterns depends on both the group context and on the individual's position within that group **(TH-03)**, rather than just on individual themselves. We also stress that this needs to be supported by a practical approach to game and learning design that integrates both concepts within the same learning context **(TH-02, TH-01)**. This cross-thematic approach, which combines a number of scientific subjects under the umbrella of digital anthropology **(TH-02, TH-03, TH-01)**, is required to improve the level of interaction and performance of a user within a group, and of the group within an online community.

The following section presents the research rationale as an integrated commentary spanning the selected papers, which are presented thematically. They are clustered by themes (**TH**), as presented above in *Table 4*. In the grey boxes, we highlight the main approach to every thematic cluster (**TH**), we list the related papers (**PP**) the methods (**MT**) and the research activities (**AC**) that we used, along with the research questions (**RQ**) addressed and the main findings.

5.2 . Research outlook

5.2.1. Theme TH-01 (Game context and Learning scenario)

There is a growing interest in the introduction of computer and videogames in educational environments. This interest correlates with a long tradition of anthropological research into games and play (Piaget, 1962; Raessens, 2006; Lammes, 2007). It is also presented as a key component of modern digital anthropology, which is very much focused on the interaction between users, and between users and digital devices and applications (Coleman, 2010; Cardullo, 2014). Games have become one of the biggest entertainment industries, rivalling cinema and surpassing literature (ESA, 2005). This is mostly because

modern games are attractive, engaging and immersive, which, it has been argued, is due to their ability to allow user interaction and immersion in a game space. Additionally, the research about the nature of fun and motivation in videogames highlights a number of elements, such as short feedback cycles, high interactivity or embodiment that can have a significant impact in educational environments (Malone, 1982; Garris et al., 2002; Malone & Lepper, 1987). The pedagogical benefits of game-based approaches have been studied thoroughly in the literature (Betz, 1996; Gee, 2003), as have some of their shortcomings. Typical problems include social rejection, excessively high development costs and poor results, when the resulting products include very precise and detailed content but fail completely when it comes to providing entertainment (thus, losing the appeal of videogames and associated pedagogical benefits) (Mitchell & Savill-Smith, 2004; Squire, 2005).

In **Theme TH-01 (Game context and Learning scenario),** we address the increased interest in games through publications **PP-06** and **PP-09**, in which we survey the field of research, providing a comprehensive analysis of commonalties and what can be learnt and taken forward by new research. Indeed, in both papers, we conduct a thorough **literature review (MT-01)**, which is common to every publication of this compilation, but which is deeper and more comprehensive in these two papers. Furthermore, both publications address **RQ-13** (about the state of the art)**, RQ-20** and **RQ-21** — about the user and functional requirements to create a method design for eGames. In addition, **Theme TH-01 (Game context and Learning scenario)** supports a practical approach based on findings, through publications **PP-02** and **PP-07**, which explore the design of a game using a learning scenario to examine how a learner engages with goals (**RQ-5**), in addition to how a learning design and a game design should be to encourate learning (**RQ-14** and **RQ-15**. Another concern is how the design of game using this approach improves the individual user and the group's experience towards educational goals (**RQ-06**).

Highlights of Theme TH-01. We show which functional and user requirements are needed in order to design educational games. In addition to the thorough literature review, we also draft a design method for eGames, which stresses adaptation to the individual along with group interaction and, finally, the cross-assessment of every action to be analysed.

5.2.2. Theme TH-02 (Authoring and Adaptation)

Educational videogames are complex software artefacts executed in the computer of the student, which have a significant visual component (Pink, 2006, 2007; Kullmer, 2008). We take a visual approach to modern digital anthropology, which moves from face-to-face contexts to virtual environments in order to explain social, cultural and behavioural findings (Kline, 2003; Boellstorff, 2012). These factors are very interesting from the perspective of adaptive and personalized learning, because the videogame can behave differently every time it is adapted to user inputs and the user's level of prior expertise (Westecott, 2008: Adcock & Van Eck, 2012). Indeed, the possibility of choosing different levels of difficulty has been ever-present in videogames, with the majority becoming increasingly difficult as the user progresses, in conjunction with the possibility for the user to customize the difficulty of the game in response to their skill level. The objective is to keep the player in the zone, where he or she is forced to perform at the limit of his or her competence but without exceeding it.

The key idea is that videogames and adaptation are synergic fields and that we should use this knowledge as leverage when creating adaptive contents and courses, via the so-called learning management systems (LMS) (García-Barcena & García-Crespo, 2007; Srinivasan, et al., 2008). These LMS portals facilitate and monitor the learning experiences of large groups of students. Even though these environments are sometimes targeted at a very specific group of users, it is also common to find systems targeted at broad audiences that have different learning styles, differences in their previous background and different learning objectives.

For this reason, there is a lot of research in providing adaptive learning experiences (Brusilovsky, 1998; Paramythis & Loidl-Reisinger, 2004) in which the adaptation optimizes the focus of the content and the flow (by fitting the game to different levels of previous content or different objectives), and the overall learning experience (by fitting the game to different learning styles) for the user and the group, as a social action (Seifert, 2011; Westman, 2015).

In **Theme TH-02 (Authoring and Adaptation)**, in publications **PP-04** and **PP-05**, we address how personalized learning improves the learner experience based on a number of inputs (i.e., goals, assessment, coaching and others) (**RQ-9** and **RQ-11**). In addition, we explore the authoring process of educational resources (e.g., units of learning), as an individual and a group task of learning by doing (**RQ-11** and **RQ-12**). We use practical research activities: **AC-01**

(Software prototype development and implementation) and **AC-02 (Game design)**, in addition to the cross-case method **MT-01 (Literature review)**, so that we tested the theoretical findings and model with actual users. In doing so, we address the user interaction within an educational game (**RQ-9**), the similarity of behavioural patterns found in different individuals, as well as how to improve the user (and group) performance and the interaction itself (**RQ-10**).

Highlights of Theme TH-02. We conclude that a multi-input, multi-resource approach to designing and implementing eGames will provide a more personalized user experience. In doing so, we take a number of variables, such as user objectives, user performance, user interaction, group interaction, peer assessment and others, and combine them into a balanced formula that provides the correct feedback to every user. In addition, we design a way to create Game-based learning resources, so that the personalized approach can be taken from the very beginning as a way to shape user engagement as an integrated flow of experience.

5.2.3. Theme TH-03 (Feedback and Interaction)

In computer applications, there are numerous means of providing feedback to a user (visual, auditory or force feedback, to name a few). For Mason and Bruning (1999), feedback is defined as any message generated in response to a learner's action. It implies that there is an interactive flow between the learner and the system, deriving from information collected or generated through interactivity (Evans et al., 2004). Furthermore, this information flow is viewed as a series of frequent and multiple inputs, due to their existing in a complex learning environment that operates on multiple levels (Gherardi, 2006). This feedback is usually presented in a graphic manner, as a means to enhance the message and its impact (Cohen, 2005; Pink, 2011; Rode, 2011; Drazin, 2013).

Arguments provided by Prensky (2001) concerning the importance of feedback in learning and games contexts endorse its use in supporting game-based learning, as a way to provide useful and immediate information to the learner about his or her performance. Baer et al. (2005) underline the notion that immediate and contextual feedback improves learning and reduces uncertainty. Kirriemuir (2002) highlights the fact that instant feedback invites and allows for exploration and experimentation, and that it stimulates curiosity. Kiili (2005) and Chen et al. (1999) write that games should provide instant and appropriate feedback in order to improve the user's performance.

Moreover, in eGames, feedback improves learning and helps the learner to make decisions about their strategy by encouraging learner motivation. However, too much feedback can be problematic, leading to weakened learner engagement with the presented problem due to information overload, and resulting in lower performance.

In **Theme TH-03 (Feedback and Interaction),** we research how user interaction and group interaction are benefitted by accurate and timely feedback that is personalized and geared towards the learning process. We measure the quantity of feedback, determining how much feedback is supportive, and how too much might be counterproductive. Publications **PP-01**, **PP-03** and **PP-08** follow the same strategy, with a strong learning scenario supported by a **Game design (AC-02)** and a **Learning design (AC-03)**. This theoretical approach is implemented and tested, along with a **Case study (MT-02),** with actual users who run a **Software prototype (AC-01)**, which is a game designed and developed to act as the front-face or interface for those final users. A **Literature review (MT-01)** is also provided in support of this part of the research. This theme comprehensively addresses research questions **RQ-01, RQ-03**, **RQ-04, RQ-18 and RQ-19** by focusing on the identification of user and group behaviours through analysis of behavioural patterns. **RQ-02, RQ-07** and **RQ-08** are addressed by concentrating on how the practical application of specific steps can be used to improve interaction and learning performance based on rigorous analysis of feedback through eGames, including how much feedback is required (**RQ-17**), and how the interface style and the need for cognition (NFC) engages all the process (**RQ-16**)

Highlights of Theme TH-03. In short, we conclude that timely feedback improves both user and group experience in learning contexts, as long as it is properly measured and applied. We stress the significance of a thorough analysis of the user profile and the learning setting, to creating a proper match between user expectations and the designed learning goals, through the provision of personalized and sensitive feedback.

5.3 . Commentary on Theme 1: Game context and Learning scenario

5.3.1. Electronic educational games and simulations

Educational electronic games and simulations (or, more simply, eGames) are designed to engage a user using fundamental concepts derived from normative game environments, including immersive spaces, goal-based interaction

scenarios and attractive visual contexts. Through eGames, a learner can play and learn at the same time, while aiming at both learning objectives and playable goals. EGames have become an important topic in the recent, and not so recent, history of education, being widely researched over the last 40 years (Huizinga, 1971; Caillois, 1958); some of that work is based on anthropological approaches (Schweighauser, 2009). With the first appearance of computers in schools in the mid-1980s, gaming was supported by computer applications that sought integration between pedagogical principles and computer science facilities (Molnar, 1990, 1997; Impagliazzo, 2004). In the mid-90s, the Internet provided new perspectives, including collaborative, worldwide, extended multi-player sessions; instant messaging; instant updating of settings and multi-language support. The array of features is still growing, and is attractive to regular users, but also for learners and teachers (Bruckman, 1993; Prensky, 2001).

In order to achieve educational goals, several interactive learning techniques can be used in connection with games. Some examples are learning from mistakes, goal-oriented learning, role-playing and constructivist approaches. When playing games, one of the most commonly applied strategies is that of trial and error, in which the behaviour of a learner during play is characterized by the absence of a systematic strategy (Dempsey, 2002). At the same time, this strategy is a primary way to learn, and to keep the player motivated (Pivec, 2003). These learning techniques can be implemented in games, so that the game itself becomes fully integrated in the learning process, instead of remaining as an isolated, stand-alone resource (Gee, 2005). In doing so, any generic game can be an educational one if it is fully integrated within a learning process (Burgos et al., 2006). Furthermore, teachers are able to make good use of generic games, educational games and simulations in their daily teaching activities (Cobb, 2001; Squire, 2005; Jenkins, 2003; Eskelinen, 2001). However, a better development of an integrated model is needed in order to achieve learning goals, and to take full advantage of the potential of games in education (Williamson, 2005).

EGames are attractive, addictive, fashionable and elicit emotional reactions in players, such as wonder, the feeling of power or even aggression (Squire, 2002). These features provide entry points via game-based techniques for learners to attain educational goals, with educational goals and gaming processes being mutually supportive in this process. In addition, eGames can also support rather accurate education regarding episodes in history (Sega, 2005), real-life systems (Microsoft, 2006), complex popular events (E.Interactive, 2004) or board games (Microsoft, 2006), to mention a few examples. With eGames, the users can also access content (OUP, 2004), research human relationships (E.Arts, 2005),

improve personal and social skills (Auralog, 2005) and work on strategies (Seifert, 2011; E.Arts, 2004; Turtle, 1995; Piaget, 1962; Vygotsky, 1978).

5.3.2. Learning from the user behaviour via their cognitive style

Assistance from a user interface during problem-solving is often thought to make interactions easier, through the display of relevant contextual information that supports memory recall and a process called 'externalization' (e.g., feedback aids such as greyed-out menu items). By externalizing information, display-based behaviour is provoked; this, however, does not necessarily instigate planning, understanding and knowledge acquisition. Furthermore, a reaction from the user is expected, but this is not necessarily a learning process. When certain task-information is less directly available, it needs to be internalized and stored in memory, thus provoking plan-based behaviour that may lead to better performance and knowledge, thanks to the user's cognitive style — in this case, a "need for cognition" (NFC). Moreover, high-NFC subjects generally plan more, leading to better performance. Indeed, results show that interface style influences problem-solving behaviour, but not for NFC-based tasks. On the contrary, internalization resulted in more thorough behaviour, better solution routes and fewer reconsidered actions.

In software development, Usability is acknowledged as a key goal and concept. A recurring issue in devising guidelines is the importance of minimizing "user memory load" (Nielsen, 1995), also known as computational offloading, as well as relieving users' working memories so that they can devote maximum cognitive resources to the task at hand (Scaife & Rogers, 1996). A way to implement this is to make parts of the interface context-sensitive, e.g., by hiding or disabling functions that are not applicable, such as the greyed-out menu items in Microsoft Office. This act is called the externalization of information onto the interface. When no such features are provided, a user has to internalize the information and store it in his or her memory. Although research has showed that supporting the user in this way can make tasks easier to perform, it may also have some negative consequences for task performance and knowledge acquisition. The knowledge gained using an externalization-based interface may be volatile and difficult to transfer to other situations. This is not always crucial (e.g., in the case of a trivial task one seldom undertakes) but it can be undesirable when learning or gaining insight are themselves the point of the task.

Research by O'Hara and Payne (1999) supports this point of view, by stating that too strong a reliance on external information leads to negative effects

regarding planning and the transference of skills. They draw a distinction between plan-based and display-based approaches to problems. In plan-based approaches, long-term memory is used to inform strategies. Display-based approaches, on the other hand, make little use of learned knowledge but rely on contextual interface information. Plan-based activity leads to a shorter solution route, as steps are planned with little redundancy, while a display-based strategy involves more steps because more searching and data retrieval is required.

Findings in Theme TH-01: This sub-section presents a combined approach to **Theme TH-01 (Game context and Learning scenario)**, based on findings in papers **PP-06** and **PP-09**, which carry out an extensive **Literature review (MT-01)** in order to answer research questions **RQ-13, RQ-20** and **RQ-21**. These papers focus the research context on games, user and group interaction and learning, allowing for the identification of behavioural and anthropological patterns when using games for learning. In addition, this subsection concerns **Theme TH-01 (Game context and Learning scenario)**, through publications **PP-02** and **PP-07**. The papers follow a practical approach with the implementation of a **Case study (MT-02)**, a **Software prototype (AC-01)**, two **Game designs (AC-02)** and a **Learning design (AC-03)**. This research presents how user behaviour drives through Pedagogic goals based on a number of inputs facilitated by eGames integrated as learning resources in educational contexts (**RQ-5** and **RQ-6**).

RQ-14 and **RQ-15** are reflected on this Theme TH-01since they explore the analysis and definition of practical guidelines to implement eGames based on the identification of user patters and roles. Furthermore, these publications seek to improve user interaction based on those inputs, while following specific behavioural patterns. Thanks to this clustering exercise, the user and the social group might then receive personalized support. Our research concludes that users can be clustered into groups based on those patterns.

5.4 . Commentary on Theme 2: Authoring and Adaptation. Personalized learning from adaptive and adaptable interaction based on user behaviour

Recent research has addressed the definitions of adaptivity and adaptability, both focused on personalized learning (Ahmad et al., 2004; Cristea, 2005; Adcock & Van Eck, 2012). In short, adaptivity is the ability to modify eLearning lessons using different parameters and a set of pre-defined rules. In contrast,

adaptability is the possibility for learners to personalize an e-learning lesson by themselves. These two approaches go from the machine-centred (adaptivity) to the user-centred (adaptability). However, we contend that there are a vast number of stages in between, with both some adaptivity and some adaptability (Burgos et al., 2006). In practice, it is quite difficult to isolate one from the other due to their close relationship (Klann, 2003). Furthermore, all of the in-between stages are also instances of personalized learning, as they enable the dynamic adaptation of several features within a course, lesson plan or unit of learning. As a result, we view the concepts not as two opposite corners from which to consider personalized learning, but as describing a wide range of approaches that take the best from each style. Hereafter, we use the word adaptation to cover the various approaches.

From the user interface through to the e-learning resources and learning process, there are many aspects to take into consideration for effective adaptation. From the early 1980s, where computer-based training was used to fully control the flow of a learning process (Tennyson, 1980, 1981), to the concept of adaptive guidance, which provides rich information and a diagnosis to help the learner make effective decisions about his or her own learning (Bell & Zozlowski, 2002), there has been a wide collection of approaches to adaptation in e-learning. Examples are incorporating the tutor as a key factor in the adaptation process (van Rosmalen et al., 2006), or building a blended system strongly supported by AI agents (Wasson, 1997). All are based on the proposal of adapting personalized learning to the context of each student in order to stimulate their learning process and to encourage their involvement (Kinshuk et al., 2002). These approaches also hold that the best learning performance comes from personalized instruction (Towle & Halm, 2005). This does not necessarily imply that a user or student should keep full control over their training, because this would mean that 1) the student knows what is best for them within a learning script; 2) the student is aware of, understands and controls all the contributions so that they can take charge of the process and 3) the student is able to carry out the right decision when all of this information is collected (Snow, 1980).

We define adaptation in e-learning as a method of creating a learning experience for the student, but also for the tutor, based on the configuration of a set of elements in a specific period aiming to enhance the performance of pre-defined criteria. These criteria could be, i.e., educational, economic, time-based or user satisfaction-based. Elements to modify or adapt could be based on content, time, order, assessment, interface and so on. In this context, learning from the user's

behaviour while they interact with content, learning flow, interface (usability-adaptability) and peers, provides a perfect playground for improving their performance and outcomes.

Findings in Theme TH-02: This subsection refers to **Theme TH-02 (Authoring and Adaptation)**. It concludes that, in order to provide the learner with personalized counselling, a number of inputs are required; for instance, user performance, user behaviour, user interaction with peers and the system, personal goals, group goals, monitored coaching and others. Publications **PP-04** and **PP-05** follow the same methodological approach. They both carry out a **Game design (AC-02)** and develop a **Software prototype (AC-01)**, in addition to a **Literature review (MT-01)**. They focus on the identification of roles from user behaviour, so that users can be clustered into behavioural patterns and they can increase their learning performance and their interaction level (**RQ-09** and **RQ-10**). Indeed, they inform readers how to improve practically the level of interaction and performance of the user and the group, towards a better learning experience and engagement, fully integrated into an educational setting (**RQ-11** and **RQ-12**). Our research shows that many features of adaptivity and adaptability can be personalized based on the user and the group's behaviour and inputs, so that every user receives guidance (e.g., feedback) not just on an individual basis but also on a role basis. Indeed, that personalized support does not mean individualized support, alone; it is also given to the user profile that defines every cluster or group. In fact, such role identification is the result of the anthropological pattern identification that allows for the clustering of users in groups in order to implement that improvement.

5.5 . Commentary on Theme 3: Feedback and Interaction. User feedback and interaction for learning with eGames

5.5.1. What is feedback?

In context of human computer interaction (HCI), feedback can manifest itself in different ways. In the bulk of studied task environments, however, the term mostly refers to some sort of information presented to the user after something has been done. This can be an indication that a certain action has been carried out (or not), providing qualitative feedback about performance and a user's behaviour, amongst other things. Feedback is key to finding behavioural patterns and using them to provide a personalized recommendation for learning, so that the user can improve their performance and/or outcomes. The widespread adoption of consistent graphical user interfaces (GUI), or guidelines, in the early

1990s promoted forms of feedback that keep users informed about events that are appropriate to the context of interaction (A.Computer, 1992). When a user initiates an action, there should always be an indication that the application has received the user's input and is operating on it, since users want to know that a command is being carried out. A few years after GUIs and WYSIWIG interfaces became common; however, Gentner and Nielsen (1996) wrote an influential article intended not to discard Macintosh interface guidelines but to explore alternative approaches to computer interfaces. One of the issues, here, was to consider introducing some flexibility into the feedback and dialogue provided by the system. They wondered whether, rather than always providing the user with feedback on activities, the computer should be more flexible in the amount of feedback it provides. Initially, the computer could provide detailed feedback to familiarize the user with operations and instil confidence in them. Later, the feedback could be scaled back over time and restricted to unusual circumstances or times when the user requests more information. Jansen et al. (2005) also support the use and benefits of cautious visual feedback in learning processes, in order to acquire a better performance more focused on the task, and for four main purposes: monitoring and adaptation, social awareness, group processing and engagement and the mediation of development.

Through appropriate feedback, the learner is able to receive some information concerning the way they act and learn. This enables them to assess their own progress regarding goals and actions (Stoecker, 1991; Prensky, 2001; Garries et al., 2002), and they are able to make a choice about the next action to take or even about the strategy to follow (Hong et al., 2009). In the following sections, we provide a deeper analysis of the various ways of giving feedback and their relation to eGames.

5.5.2. Types of feedback

There are several ways to provide feedback that can be based on the learner's behaviour, performance, history or the learning goals (Prensky, 2001). Furthermore, feedback is driven fully by the learner's activity; their data are collected as inputs, which, after analysis by the system, are returned back to the learner as outputs (Evans, 2004; Weber, 2003). Mory (1996) describes two main types of feedback based on behavioural patterns: instructive and informative. In short, instructive feedback is related to the knowledge domain and informative feedback is related to the context in which learning occurs. The former refers to a corrective intervention in the learning process; the latter is focused on self-regulation. In addition, there are four main types of indicators in informative

feedback: 1) those related to performance, 2) those related to process, 3) those related to social interactions and 4) those related to environmental interactions. Performance feedback is the type used most frequently in eGames, but not uniquely so.

5.5.3. Feedback based on behavioural, anthropological patterns and eGames

Feedback derived from behavioural and anthropological patterns has proved to be critical for learning (Mory, 1996; Raessens, 2006), as it provides support for the educational process and motivation (Garries, 2002; Annett, 1969) and because feedback is also an important feature of games (Prensky, 2001). However, the effect of feedback in educational games and simulations is not a common research topic. Garries et al. (2002) define a cycle in games that involves several loops of repeated judgment, behaviour and interaction, and they point out that feedback is a critical component for regulating the learner's motivation. Csikszentmihalyi (1990) stresses the importance of feedback in his classic definition of flow theory. Kernan and Lord (1990) state that specific feedback based on commitment to goals increased the effort, performance and motivation of the learner. People expect some reaction to their actions and efforts, and they become disappointed when they do not receive it, resulting in a decrease of their motivation and performance (Beck & Wade, 2004).

However, not all authors agree on the positive effects of feedback. In their literature review on computer and video games for learning, Mitchell and Savill-Smith (2004) state that the same feedback mechanism could be perceived in different ways. They refer to a study by Halttunen and Sormunen (2000) that used an educational game to support the learning of information retrieval. After an evaluation, the effectiveness of the feedback that users received from the system was generally seen to significantly promote learning. Feedback concerning the performance of one's own query, and the chance to reformulate the query and to evaluate further the effect of changes on performance, was seen as a highly motivating form of learning advancement. However, there were also students reporting that their attention was thereby fixed on performance, and that they tried to improve their results mechanically, without analysis of or reflection on their preceding queries and results. Here, the feedback tempted researchers to pay attention to the performance measures achieved, rather than to analyse the search task's situation and strategy.

Educational games (and simulations, even more so) are usually played in an unpredictable way by the player or players. This behaviour can provide some

values based on performance, through which a final analysis can be returned to the learner, although this feedback might be too complex or not specific enough to be useful, easy to understand or to apply (Fowlkes et al., 1998). In addition, once some feedback is provided, its use by the learner is uncertain, entailing a reduction of performance (Kluger & Denisi, 1996).

5.5.4. Destination feedback and eGames

There are still other types of feedback. An example is what Apple's Human Interface Guidelines (A.Computer, 1992) refer to as 'destination feedback', which means that according to how a user manipulates an interface (an example would be dragging an icon to a specific destination) the application provides feedback indicating whether it will accept that item. Destination feedback should not occur simply because your application is drag-aware; rather, it should depend on the destination's ability to accept the type of data contained in the dragged item. This type of feedback informs the user of the possible actions that can be taken. In a certain way, the user is led by the hand because their choices are constrained. Everyday examples in which this principle is applied are software installation wizards, extended help options and greyed-out menu items. Feedback by the greying-out of items is one example of what is referred to as 'externalizing information'. The externalization of information makes it readily available within the interface and it is not necessary for users to remember that information. In other words, only recognition, and not recall, is needed for task performance, and this relieves the burden on working memory (Zhang, 1994, 1997). In the opposite situation, when no such features are provided, users have to internalize the information themselves and store this information in their memories. Zhang used various problem-solving tasks, such as material showing that externalizing information can be useful for cognitive tasks; the more information is externalized, the easier it is for users to solve the problem.

It is easy to see how the concept of destination feedback can be of interest in game-based learning. Providing guidance or assistance in complex situations and trying to relieve the working memory of students so that they can devote attention to the development of proper strategies is interesting in this context. However, one can also question the assumed positive effects that this kind of feedback might have. Perhaps learning with a feedback-based interface is more volatile, and it is difficult to transfer it to other situations. This is undesirable when learning or gaining insight itself is the aim of the exercise. We wondered whether having this kind of destination feedback (which is extremely common across a wide range of applications) might lead users to behave less proactively

and to do less "thinking before they act". This is an undesirable scenario when the goal is to learn by gaining insight and reflecting on tasks.

Research by O'Hara and Payne (1999) support that a strong dependency from external information might lead to a counter-effect on planning. A display-based strategy involves more steps, because of an increased need for searching and less need for planning, while a Plan-based activity is usually shorter since those steps are foreseen. In addition, Svendsen (1991), who used the Towers of Hanoi problem as an example, showed that the use of a high-cost interface yielded improved understanding of problems.

Findings in Theme TH-03: In this subsection, we address **Theme TH-03 (Feedback and Interaction)** through publications **PP-01**, **PP-03** and **PP-08**. The papers build on a thorough **Literature review (MT-01)** on these topics, along with a practical approach based on **Case studies (MT-02)** and the development of a **Software prototype (AC-01)**. These practical approaches respond to a specific **Game design (AC-02)** and a **Learning design (AC-03)**, which format a user interaction (and, thus, a learning scenario) between the systems and within a designed game environment. These methodologies support research questions **RQ-01, RQ-02**, **RQ-03** and **RQ-02**, which are focused on finding similar behavioural patterns in users and groups, which can be clustered and replicated (**RQ-1**, **RQ-4** and **RQ-19**). The research concludes that users behave similarly when they receive similar forms of support feedback (**RQ-4**), and that feedback is a powerful tool to improve learning and interaction when it is used properly (**RQ-2**, **RQ-3** and **RQ-7**), for instance, through eGames (**RQ-8**). It also shows that giving a user too much feedback in a learning process might be counterproductive (**RQ-17**), since they would lean too much on the educational counselling provided, thus diminishing their mental effort to make progress. In addition, this research suggests a way to improve the level of interaction and performance by both the individual user and groups, thanks to the provision of limited feedback based on the real activity of that user or group, that is provided at specific points of the learning process and not continuously, with a combination of externalized and internalized interfaces (**RQ-16** and **RQ-18**)

6. Conclusions & lessons learnt

This research shows how user interaction and inputs are vital for providing a personalized learning experience in the context of educational games. Furthermore, our research shows that users can be clustered together, since they follow similar patterns when playing and learning, based on these behavioural inputs and according to the game design and learning design. Indeed, they cluster together based on behavioural patterns, they interact with each other inside these groups and they can be provided with personalized support that is produced from both individual and group analysis.

In addition, this research shows others how to author, design and integrate games into online platforms, so that they can provide support for the aforementioned theoretical model, based on a thorough analysis of user and functional requirements. Through case studies and software prototypes, we show the practical specifics of successful implementation that can be used and replicated in learning contexts. Therefore, our research does not just offer a theoretical approach, but is supported by evidence.

Lastly, we prove that personalized feedback improves learning performance and user interaction, providing that this feedback is limited to specific moments, which can be scheduled according to user behaviour and pattern analysis. Too much feedback can be counterproductive and can inhibit the learning process. However, an appropriate amount of support in the form of feedback, which is delivered in a timely manner, would boost user performance and interaction.

These three main outcomes bring new understanding of how learning happens in games, based on individual behaviour and group pattern analysis, from the initial design to the final practical implementation, thus contributing new knowledge to this field.

Furthermore, users of digital eLearning platforms can be clustered together within social units. Through this approach, an analysis of anthropological patterns of behaviour may lead to better support and guidance thanks to specific tailored and personalized inputs, in the form of adaptive feedback that is based not just on those individual inputs but on the features of the identified group patterns.

Electronic educational games and simulations (eGames) are powerful platforms of learning. They build the appropriate pedagogic contexts to help a player learn more effectively through different activities, and lead to a better learning experience. They provide content, extend social networks and improve users' personal skills. We argue that eGames can offer a very effective learning

experience when they are used together with other resources, and are not treated as an external, non-related resource. Commercial games or bespoke educational games support learning when they are used in the right context and provide adequate information. In this context, feedback becomes a useful tool to improve the learning process of the user, supported by the interaction of the group.

This statement is reflected in the list of research questions, extracted from the selection of published papers:

ID	Year	Publication	Research questions from papers	Evidence of quality and fitness to the research proposal and questions
PP-01	2009	Burgos, D. & Nimwegen, C. v. (2009). Games-Based Learning. Destination Feedback and Adaptation: A Case Study of an Educational Planning Simulation. In T. M. Connolly, M. H. Stansfield & L. Boyle (Eds.), Games-Based Learning Advancements for Multi-Sensory Human Computer Interfaces. Hershey, USA: Information Science.	RQ-1. Can users be clustered into groups based on behavioural patterns so that they can receive personalized, adapted feedback? RQ-2. Does feedback improve or damage the learning process and how? RQ-3. How does user information provide meaningful input towards a better learning performance through adapted, personalized feedback? RQ-4. Are users guided by similar behavioural patterns when they interact with peers in a game-based, digital context?	ISBN: 978-160566360-9 This book chapter concentrates on the interaction between users and the system, in the context of an educational setting, with end users who will play a simulation in order to retrieve their non-verbal communication, such as user-tracking information. Furthermore, the system is capable of identifying user patterns and user roles, in order to facilitate clustering and related actions.
PP-02	2007	Burgos, D., Tattersall, C. & Koper, R. (2007). Re-Purposing Existing Generic Games and Simulations for E-Learning. Special Issue on Education and Pedagogy with Learning Objects and Learning Designs. Computers in Human Behavior, 23 (6), 2656–2667.	RQ-5. How can commercial, traditional and non-educational games, played by non-academic users or students, be easily re-used and integrated in an educational context? RQ-6. How can these games support and improve the pedagogic goals?	DOI: 10.1016/j.chb.2006.08.002 ISSN: 0747-5632 Impact Factor: 2.067 5-year Impact Factor: 2.489 Ranking (2012): Q1 This paper shows how commercial, traditional and non-educational games, played by non-academic users or students, can be easily reused in an educational context. The paper adopts the angle of a creator of learning resources who needs to connect with end users inside a social network of a virtual community, and who seeks to facilitate game play within an eGame.
PP-03	2007	Burgos, D., Nimwegen, C. v., Oostendorp, H. v. & Koper, R. (2007). Game-Based Learning and the Role of Feedback. A Case Study. Advanced Technology for Learning. 4 (4), 188–193. Anaheim, CA, USA: ACTA Press.	RQ-7. In the context of Game-based Learning, how does feedback interact with performance to illuminate results dependent on a user's behavior? RQ-8. Can feedback improve the student's performance when it is implemented in the context of eGames?	DOI: 10.2316/Journal.208.2007.4.208-0918 This paper shows the relation between the user and the feedback provided by the system, in the context of an eGame. It shows how results depend on the user's behaviour.
PP-04	2007	Burgos, D., Moreno-Ger, P., Sierra, J. L., Fernández-Manjón, B. & Kooper, R. (2007). Authoring Game-Based Adaptive Units of Learning with IMS Learning Design and <e-Adventure>. International Journal of Learning Technology, 3 (3), 252–268. Geneva, SWITZERLAND: Inderscience Publishers.	RQ-9. How to employ units of learning in the authoring of eGames to boost user interaction and the learning process RQ-10. Can the levels of interaction and performance of a user in a group (and of the wider group) be improved? RQ-11. Which are the practical implications for game design and learning design from the authoring process?	DOI: 10.1504/IJLT.2007.015444 This paper shows the authoring role of a user of eGames, when they create units of learning from scratch. It presents the methodology and practical outcomes, which point to a clear need for the simplification of the authoring process, so that user interaction can be strengthened.

PP-05	2008	Burgos, D., Moreno-Ger, P., Sierra, J. L., Fernández-Manjón, B., Specht, M. & Koper, E. J. R. (2008). Building Adaptive Game-Based Learning Resources: The Marriage of IMS Learning Design and <e-Adventure>. Simulation & Gaming. Special Issue on eGames and Adaptive eLearning. A Practical Approach. 39 (3), 414–431. Thousand Oaks, CA, USA: SAGE Publications.	RQ-12. How to design eGames in an educational setting so that the user's information on behavior, performance and interactions is extracted for individual and group improvement?	DOI: 10.1177/1046878108319595 This paper shows how to design and create game-based learning resources to integrate stand-alone games within digital frameworks, e.g., social networks, virtual campuses and intranets.
PP-06	2009	Moreno, P., Burgos, D. & Torrente, J. (2009). Digital Games in eLearning Environments. Current Uses and Emerging Trends. Simulation & Gaming, 40th Anniversary, 40 (5), 669–687. Thousand Oaks, CA, USA: SAGE Publications.	RQ-13. What is the current state-of-the-art on educational games in relation to eLearning environments?	DOI: 10.1177/1046878109340294 This paper gives a comprehensive review of the field of educational games, in the context of learning environments.
PP-07	2011	Anido, L., Burgos, D., Caeiro, M., Torrente, J., Fernandez, M., Gonzalez, J., Manso, M., Ortega, M., Rodriguez, D. & Fernandez-Manjon, B. Gametel: An Approach to Multi-Format and Multi-Device Accessible Engineering Education. Proceedings of Frontiers in Education Conference, FIE 2011, Pages F1H-1-1-F1H-6. Rapid City, South Dakota (USA): IEEE Computer Society, October 12–15, 2011.	RQ-14. What are the practical issues faced in the design and implemention of a framework for eGames? RQ-15. How can eLearning systems be designed from game based scenarios, and how can these be integrated within games to encourage learning?	DOI: 10.1109/FIE.2011.6142745 This conference paper shows the practical experience of a framework focused on eGames, which is deployable in various formats and devices, including tablets and smartphones. This approach allows for complex information retrieval from a variety of users, which facilitates the identification of user interaction and group patterns.
PP-08	2006	van Nimwegen, C., Burgos, D. D., van Oostendorp, H. & Schijf, H. (2006). The Paradox of the Assisted User: Guidance can be Counterproductive. In R. E. Grinter, T. Rodden, P. M. Aoki, E. Cutrell, R. Jeffries & G. M. Olson (Eds.), Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. CHI (p./pp. 917–926), New York, NY, USA: ACM. ISBN: 1-59593-372-7	RQ-16. How interface styles interact with the user's performance? RQ-17. Can too much feedback be counterproductive towards effective learning? RQ-18. Do the individuals in a group play a similar role in both externalized and internalized scenarios when they use a game-based learning resource? RQ-19. Can users be clustered in groups, following specific patterns, with the aim of providing personalized support based on individual and group objectives?	DOI: 10.1145/1124772.1124908 This paper at the SIGCHI conference concentrates on the interaction between a user and the support provided by the system to carry out a specific task. It shows that too much assistance lowers the user's attention and performance. In the publication, the authors present the results of an experimental case with a random sample of users.
PP-09	2008	Moreno-Ger, P., Burgos, D., Martínez-Ortiz, I., Sierra, J. L. & Fernández-Manjón, B. (2008). Educational Game Design for Online Education. Computers in Human Behavior. Special Issue on Electronic Games and Personalized eLearning Processes, 24 (6), 2530–2540.	RQ-20. Which are the user requirements and functional requirements to design educational games? RQ-21. What should design method be for eGames?	DOI: 10.1016/j.chb.2008.03.012 ISSN: 0747-5632 Impact Factor: 2.067 5-year Impact Factor: 2.489 Ranking (2012): Q1 This paper shows the user requirements and functional requirements to design educational games. In addition, the authors propose a design method focused on user adaptation, group definition and assessment.

The publications grouped under **Theme TH-01 (Game context and Learning scenario)** provide a comprehensive review of games and learning.

As a result of a thorough revision of the state of the art in eGames (RQ-13), **PP-06** and **PP-09** state that similar behavioural patterns guide the user's interaction in an educational game. This similarity allows for the conception of user clustering as a basis for offering personalized support to the user group, and not just to the individual. These papers also show the user and functional requirements, and a design method, specifically drawn for eGames (RQ-20 and RQ-21). In addition, **PP-02** and **PP-07** show practical ways to raise the pedagogical goals of both individual users and the group as a whole, thanks to the strategy defined based on those previous findings (**RQ-6**). Furthermore, since every user plays according to a certain behavioural pattern (as we can find through the analysis or commercial games –**RQ-5**-), the active support given to this user can be parameterized, replicated and applied to every single user within the same group, so that the learning resource (the eGame, in this case) can be re-used and integrated in various educational contexts (**RQ-5**). They also depict the requirements for designing a learning scenario within a game (**RQ-14** and **RQ-15**), including methodology, user analysis, assessment, group behaviour, social interaction and other features that, along with the other findings of this research, provide an overall outlook of game design and learning design, combined.

We acknowledge that there are great advantages to learning from the well-established games industry. It has proven able to produce products that can chain users to their game consoles. One seldom sees such determination and engagement as when watching gamers playing games; they undertake tremendous efforts to reach their goals. There is general agreement that it might be fruitful for education if learners displayed a similar level of engagement and intrinsic motivation.

In support of that argument, **Theme TH-02 (Authoring and Adaptation)**, a crucial part of this research, explores the requisites for providing proper support to the individual user and the group. Papers within the theme (**PP-04** and **PP-05**) follow the same methodological approach (**Literature review — MT-01, Software prototype — AC-01** and **Game design — AC-02**). They also answer research question **RQ-10** and **RQ-11**, about the similarity of roles following behavioural patterns and the practical way of implementing personalized support, based not just on individual inputs but on group analysis (**RQ-12**). They show specific requisites for both. Regarding user support, a number of user

inputs are required, e.g., user knowledge, user goals, user performance, user behaviour, self-assessment, user interaction with peers and the system, group goals, group behaviour, group assessment, tutor coaching, group counselling, tutor assessment and others (**RQ-9** and **RQ-10**). These publications show how to integrate personalized guidance into a learning management system, in order that this support becomes a useful and effective tool, leading to better user and group interaction, and better performance (**RQ-11**).

This support can be crystallized in the form of feedback: **Theme TH-03 (Feedback and Interaction**). In fact, feedback becomes a basic pillar of this delivered support. Appropriate and contextualized feedback helps the learner to achieve their educational and gaming goals. (**RQ-2**) Feedback in games is usually based on the user's behaviour and performance. According to how the user behaves, some related information is collected and processed, and some kind of report is given to the user (**RQ-4**). However, feedback can also take a different form. Destination feedback stresses the relevance of providing information about the next action to come, before it occurs (**RQ-3**). Feedback provision through eGames enhanced the user learning process and the group interaction (**RQ-8**). It results in a kind of feed-forward that also supports the player's decision; it is based on the player's actions but also guides the next movement. However, feedback does not always have a positive impact on learning (**RQ-7** and **RQ-17**). **Theme TH-03 (Feedback and Interaction)** provides a homogeneous methodological approach for considering this specific topic, carried out with actual users in online and face-to-face experiments. All the methodologies used in this research are applied to this topic, with a clear stress on the practical approach (**Game design — AC-02, Learning design — AC-03, Case study — MT-02,** and **Software prototype — AC-01**) based on a comprehensive **Literature review — MT-01**. The findings of these publications (**PP-01, PP-03 and PP-08**) present an extended background on feedback based on behavioural and anthropological patterns, personalized learning and eGames. The research shows that too much feedback can be counterproductive, as it provides too much information, making the player less engaged and less capable of developing a 'winning strategy'. These papers answer research questions **RQ-02** and **RQ-03**, as they provide empirical proof of the benefits of grouping users by similar behaviour in a way that gives personalized feedback to the whole group, and not to a single individual (**RQ-1**, **RQ-18** and **RQ-19**). However, this feedback is designed based on individual inputs, meaning that every single user contributes to the identification of similar patterns, which develops personalized feedback for every cluster, which, in turn, will benefit the

original individual user. In addition, **PP-08** contributes to addressing research question **RQ-04**, and shows how this clustering exercise, which leads to personalized support, being given to the individual user and the group, can be implemented practically, including interfaces styles based on externalized and internalized support (**RQ-16**). Furthermore, it shows that this support has to be wisely managed and delivered, in a timely manner and not in excess, in order to improve the individual user and the group's levels of interaction and performance.

Indeed, one might argue that the type of skill (or knowledge) acquired in playing popular games is probably often of a procedural nature. Besides engagement, what is needed is insight into how to provoke intense mental effort and deep, rather than shallow, processing in learners. To reach conclusions concerning the latter, cognitive principles that might apply should be empirically validated, because insight into these processes is crucial for understanding the ways in which rules are inferred and information is encoded in memory by learners. We consequently argue that one must be careful about providing interface cues that give away too much, and which must be designed in such a manner that observation of the ways in which learners think and act is optimally supported. Designers might consider making interactions less assisted in order to persuade learners into engaging in specific behaviour. When certain types of behaviour are the aim, with learning as the target, engagement resulting in deep processing on the learner's part is a prerequisite. In doing so, offering personalized guidance through the educational game is supported by the actions of identified clusters of users who act in a similar way, following behavioural and anthropological patterns that are based not only on the inputs from the learner, but on the analysis of those clusters. Moreover, we state that users are guided by similar behavioural patterns when they interact with peers in a game-based, digital context (**RQ-7**), which makes them play a similar role in both educational digital contexts and face-to-face scenarios when they use a game-based learning resource following anthropological patterns (**RQ-4** and **RQ-18**). Furthermore, these users can be clustered in groups, following those specific social and patterns (**RQ-1** and **RQ-19**), with the aim of providing personalized support in the form of feedback (**RQ-2**) based on individual and group objectives (**RQ-3**), so that the levels of interaction and performance of a user in a group (and of the wider group inside an educational community) can be improved (**RQ-2** and **RQ-8**).

In this context, there is a need for a comprehensive understanding of this research as a process orchestrated across various academic fields, from

sociology to psychology, through education and technology. Digital Anthropology has emerged recently as a field (2011) that integrates various disciplines towards a greater understanding of how digital environments affect and change human behaviour. Similarly, issues core to this research project include understanding how behavioural analysis in learning environments helps understanding user behaviour in other contexts, online and offline. This focus on intersection of behaviour, the social and technological domains means that research discussed here can be seen retrospectively to have value for Digital anthropology. Indeed, the proper analysis of users and groups in online educational settings might elicit some deeper understanding of personal and social offline behaviours based on number of scientific disciplines, like the ones aforementioned, To some extent, the use of this panoramic approach allows us design and understand in a better, bi-directional and nurturing way, how the learning process and the group interaction are enhanced, as supported by this thesis.

7. Present and future of this research

eGames have evolved since 2011 (Justesen et al., 2016). From the technological perspective, 3D engines allow for more accurate and faster rendering process, integration of social networks and collaborative sessions encourage social play, the combination of images and videos with computer-created designs produce enriched worlds with inventive and engaging characters and architectures. Furthermore, the use of augmented reality facilitates the integration of information resources into the real world, so that additional knowledge and interaction capacities are provided to the user, as an individual and as a group. In addition, although virtual reality is long-time present in experimental cases, it is just now about to reach a broader audience and education thanks to the emergence of cheaper consumer hardware. Last, the omnipresent mobile devices, namely tablets, smartphones and wearable smart gadgets retrieves precise user information allowing for a 24/7 connectivity to others and the World, but also to one-self, through the various apps and support services for self-tracking and self-improvement.

Thanks to all these technological novelties the user experience as a learner in a group is significantly improved (Romero-Zaldívar et al., 2012; Burgos, 2013). Interaction becomes a natural way of behaviour, a required step towards games about problem solving, team building or just knowledge competition. Clustering of users becomes the natural step to cope with the huge diversity of profiles and expectations, so that everyone is attended, but in a rational, do-able way which is at the same time personalized but not-individualised. Constant feedback is provided to the user and the group as a result of the analysis of tracking information from multiple sources, enabling a learning process more complex and efficient, and improving the learner performance derived from rich support and the group interaction.

In the coming years, we expect to see research develop on two fronts: 1) the scaling-up of the approaches and methods for large data case studies (e.g., Open Educational Resources like MOOCs), e.g. users behaviour will provide a massive amount of tracking information that will need to be analysed. As research discussed here shows, the clustering process can provide a) a larger number of different behavioural patterns; b) a larger number of instances of the same replicated patterns; c) a historic record against which to compare the results of the case study in motion and in which we might discover similarities in the evolution of the sample and d) a useful input for improving the learner performance. Although all these data are available now, they remain poorly

categorised and lack a proper service, model or software application towards an effective processing and useful implementation.

The second front 2) is educational: the combination of the users' feedback, both individuals and groups, with support from and to teachers. The teacher, professor, tutor or supervisor might find this analysis useful for facilitating a more effective teaching methodology. When the teacher defines the rules for clustering, the expected outcomes and the various forms of feedback for the individuals and groups, they can influence learner performance as another input of the learning process. We must design the learning experience as a team, a cell, which consists of students, teachers, tutors, parents (when applicable), administration staff and other stakeholders. Learning is personal, but a learning process supported by group interaction and personalized feedback enhances the chances for an outstanding performance.

In this context, Digital Anthropology becomes the perfect fit to cross-relate every single academic field in the equation (Guimarães, 2005; Boellstorff, 2012; Miller & Horst, 2012; Horst & Miller, 2013; Westman, 2015). Anthropology provides the common ground to work on new forms of social relations and structures, as a complement to that field work and analysis of social behaviour, now also focused on a digital context. From a historic perspective, since 1950 (Turing, 1948), computers changed productivity. Since 1996, Internet and the World Wide Web became popular. Since 2000, mobiles were widely used. Since 2002 (Johnstone, 2005), Open Educational Resources democratize access to educational material. Since 2003 (Koper et al., 2003; Dougiamas, 2004), Learning Management Systems and Learning Design improved learning processes and resources. Since 2005 (Acquisti & Gross, 2006; Huberman et al., 2008), social networks enhanced personal and group connectivity by billions. Since 2006 (Wolf, 2008), collaborative and immersive games with connected game stations changed the rules in the market. Since 2007 (Grossman, 2007), smartphones arrived as a new interface with a personal device. Since 2010 (Melhuish & Fallon, 2010), tablets were widely used as a complement to personal productivity and information access. Since 2012 (Siemens & Baker, 2012), learning analytics provide big data retrieval and categorisation for supporting the learning process. Since 2013 (Reuters, 2013), multi-device messenger systems allow for a 24/7, ubiquitous service amongst users. Since 2016 (Johnson et al., 2016), virtual reality and augmented reality will change our way to understand personal relations and social interaction, learning process and performance indicators. This is Evolution. And Anthropology is part of this Evolution thanks to the analysis, observation and cross-relation of people, data, methods, outcomes

and technology. Anthropology becomes a practical tool to enhance the observation and analysis of individuals and groups connected to a digital World, thanks to all the academic fields presented and used along our research, so that the new field called Digital Anthropology provides a comprehensive view and understanding of the individual and the group, also in educational contexts.

Research is to see what everybody else has seen, and to think what nobody else has thought.

Albert Szent-Gyorgyi (Hungarian scientist, 1893–1986)

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Annex I: List of themes, publications, methods, activities and research questions clustered thematically *(one-page summary)*

Theme (TH)	Thematic focus
TH-01 Game context and Learning scenario	This set of papers concentrates on two major issues. First, a) the context of games. The papers present what a game is, identify types of games, from traditional to video games; define anthropological features and the various formats and devices to play with; describe how to design a game and define the target user based on several criteria (i.e., user group, user performance, interaction between peers and with the system, and others). These criteria are key for designing effective and target-oriented games. Secondly, b) these articles depict the requirements of designing a learning scenario out of a game, including methodology, user analysis, assessment, group behaviour, social interaction and other features that, along with the previous paragraphs, provide an overall outlook of game design and learning design, combined.

PP-02	Burgos, D., Tattersall, C., & Koper, R. (2007). Re-purposing existing generic games and simulations for e-learning. Special issue on Education and pedagogy with Learning objects and Learning designs. Computers in Human Behavior, 23 (6), 2656-2667	Methods and activities: MT-01. Desk/literature review MT-02. Case study AC-01. Software prototype AC-02. Game design AC-03. Learning design Research questions addressed: RQ-5, RQ-6
PP-06	Moreno, P., Burgos, D., & Torrente, J. (2009). Digital games in eLearning environments. Current uses and emerging trends. Simulation & Gaming, 40th anniversary, 40 (5), 669-687. Thousand Oaks, CA, USA: SAGE Publications.	MT-01. Desk/literature review RQ-13
PP-07	Anido, L., Burgos, D., Caeiro, M., Torrente, J., Fernandez, M., Gonzalez, J., Manso, M., Ortega, M., Rodriguez, D., Fernandez-Manjon, B. Game·Tel: An approach to multi-format and multi-device accessible engineering education. Proceedings of Frontiers in Education Conference, FIE 2011, Pages F1H-1-1-F1H-6. Rapid City, South Dakota (USA): IEEE Computer Society, October 12-15, 2011	MT-01. Desk/literature review AC-02. Game design RQ-14, RQ-15
PP-09	Moreno-Ger, P., Burgos, D., Martínez-Ortiz, I., Sierra, J. L., & Fernández-Manjón, B. (2008). Educational Game Design for Online Education. Computers in Human Behavior. Special issue on Electronic Games and Personalized eLearning Processes, 24 (6), 2530-2540	MT-01. Desk/literature review AC-02. Game design AC-03. Learning design RQ-20, RQ-21

Theme (TH)	Thematic focus
TH-02 Authoring and Adaptation	This thematic cluster shows the authoring process of educational games, with a special focus on the user experience and the adaptive ability to personalize this experience based on a number of inputs from the user, e.g., user performance, user behaviour, user interaction with peers and the system, personal goals, group goals, monitored counselling and others. In addition, this work discusses the how eGames and learning management systems (online platforms) can be deployed and implemented in the context of a learning scenario, as a necessarily integrated approach.

PP-04	Burgos, D., Moreno-Ger, P., Sierra, J. L., Fernández-Manjón, B., & Kooper, R. (2007). Authoring Game-Based Adaptive Units of Learning with IMS Learning Design and <e-Adventure>. International Journal of Learning Technology, 3 (3), 252 - 268. Geneva, SWITZERLAND: Inderscience Publishers	Methods and activities: MT-01. Desk/literature research AC-01. Software prototype AC-02. Game design Research questions addressed: RQ-09, RQ-10, RQ-11
PP-05	Burgos, D., Moreno-Ger, P., Sierra, J. L., Fernández-Manjón, B., Specht, M., & Koper, E. J. R. (2008). Building Adaptive Game-Based Learning Resources: The Marriage of IMS Learning Design and <e-Adventure>. Simulation & Gaming. Special issue on eGames and Adaptive eLearning. A practical approach. 39 (3), 414-431. Thousand Oaks, CA, USA: SAGE Publications	MT-01. Desk/literature research AC-01. Software prototype AC-02. Game design RQ-12

Theme (TH)	Thematic focus
TH-03 Feedback and Interaction	The following three papers address user interaction and the required feedback to that user, in order to provide assistance for actual learning. The papers argue for recognition of a difference between a supportive comment, which can lead to the task's achievement, and useful feedback, which will shorten the learning curve and improve the cognitive load of the user. We discuss how the user is tracked and monitored, so that their behaviour is analysed to feed the system and provide personalized feedback. This research reveals how user interaction and responsiveness is encouraged via well-designed gaming strategies that encourage pleasurable engagement, through the challenges designed into the game as a series of steps towards a designated set of outcomes or achievements.

PP-01	Burgos, D., & Nimwegen, C. v. (2009). Games-based learning. Destination feedback and adaptation: a case study of an educational planning simulation. In T. M. Connolly, M. H. Stansfield & L. Boyle (Eds.), Games-based learning advancements for multi-sensory human computer interfaces. Hershey, USA: Information Science.	Methods and activities: MT-01. Desk/literature review MT-02. Case study AC-01. Software prototype AC-02. Game design AC-03. Learning design Research questions addressed: RQ-01, RQ-02, RQ-03, RQ-04
PP-03	Burgos, D., Nimwegen, C. v., Oostendorp, H. v., & Koper, R. (2007). Game-based learning and the role of feedback. A case study. Advanced Technology for Learning. 4 (4), 188-193. Anaheim, CA, USA: ACTA Press	MT-01. Desk/literature review MT-02. Case study AC-01. Software prototype AC-02. Game design AC-03. Learning design RQ-07, RQ-08
PP-08	van Nimwegen, C., Burgos, D. D., van Oostendorp, H. & Schijf, H. (2006). The paradox of the assisted user: guidance can be counterproductive. In R. E. Grinter, T. Rodden, P. M. Aoki, E. Cutrell, R. Jeffries & G. M. Olson (eds.), Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. CHI (p./pp. 917-926), New York, NY, USA: ACM. ISBN: 1-59593-372-7	MT-01. Desk/literature review MT-02. Case study AC-01. Software prototype AC-02. Game design AC-03. Learning design RQ-16, RQ-17, RQ-18, RQ-19

Annex II: Full list of related publications, by the candidate

Scientific, indexed papers by ISI Web of Knowledge (ISI-WoK), Journal Citation Report-JCR *(ordered by year and first author)*

Year	Publication
2013	Sánchez-González, P., Burgos, D. et al (2013). TELMA: technology-enhanced learning environment for minimally invasive surgery. Journal of Surgical Research, 182 (1), 21-29. o DOI: http://dx.doi.org/10.1016/j.jss.2012.07.047 o ISSN: 0022-4804 o Impact Factor: 2.018. 5-year Impact Factor: 2.123 o Ranking (2012): Q1
2012	Romero-Zaldivar, V., Pardo, A., Burgos, D., Delgado Kloos, C. (2012). Monitoring Student Progress Using Virtual Appliances: A Case Study. Computers & Education, 58 (4), 1058-1067 o DOI: 10.1016/j.compedu.2011.12.003 o ISSN: 0360-1315 o Impact Factor: 2.775. 5-year Impact Factor: 3.305 o Ranking (2012): Q1
2008	Burgos, D., Fernández Manjon, B., & Richards, G. (2008). Electronic games and personalized elearning processes. Computers in Human Behavior. Special issue on Electronic games and personalized elearning processes, 24 (6), 2475-2476 o DOI: http://dx.doi.org/10.1016/j.chb.2008.03.008 o ISSN: 0747-5632 o Impact Factor: 2.067. 5-year Impact Factor: 2.489 o Ranking (2012): Q1
2008	Moreno-Ger, P., Burgos, D., Martínez-Ortiz, I., Sierra, J. L., & Fernández-Manjón, B. (2008). Educational Game Design for Online Education. Computers in Human Behavior. Special issue on Electronic Games and Personalized eLearning Processes, 24 (6), 2530-2540 o DOI: 10.1016/j.chb.2008.03.012 o ISSN: 0747-5632 o Impact Factor: 2.067. 5-year Impact Factor: 2.489 o Ranking (2012): Q1
2007	Burgos, D., Tattersall, C., & Koper, R. (2007). How to represent adaptation in eLearning with IMS Learning Design. Interactive Learning Environments, 15 (2), 161-170 o DOI: 10.1080/10494820701343736 o ISSN: 1049-4820 o Impact Factor 1.302 o Ranking (2012): Q1
2007	Burgos, D., Tattersall, C., & Koper, R. (2007). Re-purposing existing generic games and simulations for e-learning. Special issue on Education and pedagogy with Learning objects and Learning designs. Computers in Human Behavior, 23 (6), 2656-2667

	○ DOI: 10.1016/j.chb.2006.08.002 ○ ISSN: 0747-5632 ○ Impact Factor: 2.067. 5-year Impact Factor: 2.489 ○ Ranking (2012): Q1
2007	Burgos, D., Tattersall, C., Dougiamas, M., Vogten, H., & Koper, R. (2007). A First Step Mapping IMS Learning Design and Moodle. Journal of Universal Computer Science, 13 (7), 924-931 ○ DOI: 10.3217/jucs-013-07-0924 ○ ISSN: 0948-695X ○ Impact Factor: 0.762. 5-year Impact Factor: 0.594 ○ Ranking (2012): Q2
2007	Hernández-Leo, D., Harrer, A., Dodero, J. M., Asensio-Pérez, J. I., & Burgos, D. (2007). A Framework for the Conceptualization of Approaches to "Create-by-Reuse" of Learning Design Solutions. Journal of Universal Computer Science, 13 (7), 991-1001 ○ DOI: 10.3217/jucs-013-07-0991 ○ ISSN: 0948-695X ○ Impact Factor: 0.762. 5-year Impact Factor: 0.594 ○ Ranking (2012): Q2
2005	Hummel, H., Burgos, D., Tattersall, C., Brouns, F., Kurvers, H., Koper, R. (2005) Encouraging contributions in Learning networks using incentive mechanisms. Journal of Computer Assisted Learning (JCAL), 21 (5), 355-365 ○ DOI: 10.1111/j.1365-2729.2005.00140.x ○ ISSN: 0266-4909 ○ Impact Factor: 1.632 ○ Ranking (2012): Q1
2005	Hummel, H., Tattersall, C., Burgos, D., Brouns, F., Kurvers, H., & Koper, R. (2005) Facilitating participation: From the EML website to the Learning Network for Learning Design. Interactive Learning Environments (ILE),13 (1-2), 55-69 ○ DOI: 10.1080/10494820500173474 ○ ISSN: 1049-4820 ○ Impact Factor 1.302 ○ Ranking (2012): Q1

Scientific, indexed papers, out of the Journal Citation Report list *(ordered by year and first author)*

Year	Publication
2013	Burgos, D. (2013). L.I.M.E. A recommendation model for informal and formal learning, engaged. International Journal of Interactive Multimedia and Artificial Intelligence - IJIMAI, 2, 79-86. DOI: 10.9781/ijimai.2013.2211
2013	de-la Fuente Valentín, L., Carrasco, A., Konya, K. & Burgos, D. (2013). Emerging Technologies Landscape on Education. A review. International Journal of Interactive Multimedia and Artificial Intelligence - IJIMAI, 2 (3), 55-70. DOI: 10.9781/ijimai.2013.238

2011	Anido, L., Burgos, D., Caeiro, M., Torrente, J., Fernandez, M., Gonzalez, J., Manso, M., Ortega, M., Rodriguez, D., Fernandez-Manjon, B. Game·Tel: An approach to multi-format and multi-device accessible engineering education. Proceedings of Frontiers in Education Conference, FIE 2011, Pages F1H-1-1-F1H-6. Rapid City, South Dakota (USA): IEEE Computer Society, October 12-15, 2011. DOI: 10.1109/FIE.2011.6142745
2011	Sánchez-González, P., Fernández, A., Oropesa, I., Noguera, J., Sánchez-Margallo, F. M., Burgos, D., & Gómez, E.J. (2011) "Herramienta de autoría de contenidos didácticos multimedia para entorno de formación colaborativo en Cirugía de Mínima Invasión ", Revista de Educación a Distancia (RED), vol. 28, pp. 1-9, Julio
2011	Sánchez-González, P., Oropesa, I., Romero, V., Fernández, A., Albacete, E., Asenjo, J., Noguera, J., Sánchez-Margallo, F. M., Burgos, D., & Gómez, E.J. (2011) "TELMA: technology enhanced learning environment for Minimally Invasive Surgery", Procedia-Computer Science Journal, vol. 3, pp. 316-321, , 2011
2011	Zaldivar, V. A. R., García, R. M. C., Burgos, D., Kloos, C. D. & Pardo, A. (2011). Automatic Discovery of Complementary Learning Resources. In C. D. Kloos, D. Gillet, R. M. C. García, F. Wild & M. Wolpers (eds.), Proceedings of the 6th European conference on Technology enhanced learning: towards ubiquitous learning, EC-TEL (p./pp. 327-340), Lectures in Computer Science: Springer. ISBN: 978-3-642-23984-7
2010	Barak, N., Burgos, D., Camilleri, A. F., de Vries, F., Specht, M. & Windrum, C. (2010). Modelling a Stakeholder Community via a Social Platform: The Case of TELeurope.eu. In M. Wolpers, P. A. Kirschner, M. Scheffel, S. N. Lindstaedt & V. Dimitrova (eds.), EC-TEL (p./pp. 396-401), Lectures in Computer Science: Springer. ISBN: 978-3-642-16019-6.
2010	Burgos, D. (2010). What is wrong with the IMS Learning Design specification? Constraints And Recommendations. In M. Atzmüller, D. Benz, A. Hotho & G. Stumme (eds.), Proceedings of LWA2010 - Workshop-Woche: Lernen, Wissen & Adaptivitaet, Kassel, Germany.
2010	Fernández Manjon, B., Burgos, D., & Richards, G. (2008). eGames and adaptive eLearning: A practical approach. Simulation & Gaming, 39, 316 - 318. Thousand Oaks, CA, USA: SAGE Publications.
2010	Romero, V. & Burgos., D. (2010). Meta-rules: Improving Adaptation in Recommendation Systems. In M. Atzmüller, D. Benz, A. Hotho & G. Stumme (eds.), Proceedings of LWA2010 - Workshop-Woche: Lernen, Wissen & Adaptivitaet, Kassel, Germany.
2010	Romero, V., & Burgos, D. (2010). Meta-Mender: A meta-rule based recommendation system for educational applications. Proceedings of the Workshop on Recommender Systems for Technology Enhanced Learning, RecsysTEL-2010. Barcelona, Spain, September, 29th, 2010
2010	Zaldivar, V. A. R. & Burgos, D. (2010). Meta-Mender: A meta-rule based recommendation system for educational applications. Procedia Computer Science, 1, 2877-2882.

2009	Burgos, D., & Nimwegen, C. v. (2009). Games-based learning. Destination feedback and adaptation: a case study of an educational planning simulation. In T. M. Connolly, M. H. Stansfield & L. Boyle (Eds.), Games-based learning advancements for multi-sensory human computer interfaces. Hershey, USA: Information Science.
2009	Burgos, D., Boticario, J. G., & Petrie, H. (2009). Lifelong learning and ICT in Europe. Learn, not labour. Science and Technology Review (August, 2009)
2009	Moreno, P., Burgos, D., & Torrente, J. (2009). Digital games in eLearning environments. Current uses and emerging trends. Simulation & Gaming, 40th anniversary, 40 (5), 669-687. Thousand Oaks, CA, USA: SAGE Publications. DOI: 10.1177/1046878109340294
2008	Botturi, L., Burgos, D., Caeiro, M., Derntl, M., Koper, R., Parrish, P., et al. (2008). Comparing Visual Instructional Design Languages: A Case Study. In L. Boturri & T. Stubbs (Eds.), Handbook of Visual Languages for Instructional Design: Theory and Practices.
2008	Burgos, D. & Tattersall, C. (2008). Modelling a case study in Astronomy with IMS Learning Design. Journal of Interactive Media in Education. Special Issue on Comparing Educational Modelling Languages on the "Planet Game" Case Study. Retrieved from http://www-jime.open.ac.uk/jime/article/view/2008-19 [November 3rd, 2013]
2008	Burgos, D., Hummel, H. G. K., Tattersall, C., Brouns, F., & Koper, R. (2008). Design guidelines for collaboration and participation with examples from the LN4LD (Learning Network for Learning Design). In L. Lockyer, S. Bennet, S. Agostinho & B. Harper (Eds.), Handbook of Research on Learning Design and Learning Objects: Issues, Applications and Technologies. Wollongong: Idea Group Inc.
2008	Burgos, D., Moreno-Ger, P., Sierra, J. L., Fernández-Manjón, B., Specht, M., & Koper, E. J. R. (2008). Building Adaptive Game-Based Learning Resources: The Marriage of IMS Learning Design and <e-Adventure>. Simulation & Gaming. Special issue on eGames and Adaptive eLearning. A practical approach. 39 (3), 414-431. Thousand Oaks, CA, USA: SAGE Publications. DOI: 10.1177/1046878108319595
2008	Dolog, P., Kravcik, M., Cristea, A., Burgos, D., Bra, P. D., Ceri, S., Devedzic, V., Houben, G.-J., Libbrecht, P., Matera, M., Melis, E., Nejdl, W., Specht, M., Stewart, C., Smits, D., Stash, N. & Tat, C. (2007). Authoring, Specification and Prototyping of Personalized Workplace Learning Solutions. International Journal of Learning Technology, 3 (3), 286-308. Geneva, SWITZERLAND: Inderscience Publishers. DOI: 10.1504/IJLT.2007.015447
2008	Miao, Y., Burgos, D., Griffiths, D., & Koper, R. (2008). Representation of Coordination Mechanisms in IMS-LD. In L. Lockyer, S. Bennet, S. Agostinho & B. Harper (Eds.), Handbook of Research on Learning Design and Learning Objects: Issues, Applications and Technologies. Wollongong: Idea Group Inc.
2008	Tattersall, C., Sodhi, T., Burgos, D., & Koper, R. (2008). Using the IMS Learning Design notation for the modelling and delivery of education. In L. Boturri & T. Stubbs (Eds.), Handbook of Visual Languages for Instructional Design: Theory and Practices.

2008	Vignollet, L., Ferraris, C., Martel, C. & Burgos, D. (2008). A Transversal Analysis of Different Learning Design Approaches. Special Issue on Comparing Educational Modelling Languages on the "Planet Game" Case Study. Retrieved from http://www-jime.open.ac.uk/jime/article/view/2008-26 [November 3rd, 2013]
2008	Vignollet, L., Martel, C. & Burgos, D. (2008). Editorial. Special Issue: Comparing Educational Modelling Languages on the "Planet Game" Case Study. Journal of Interactive Media in Education, 2008. Retrieved from http://www-jime.open.ac.uk/jime/article/view/2008-16 [November 3rd, 2013]
2007	Burgos, D. (2007). Editorial. Special Issue: Adaptation and IMS Learning Design. Journal of Interactive Media in Education. Retrieved from http://www-jime.open.ac.uk/2007/01/ [November, 3rd, 2013]
2007	Burgos, D., Moreno-Ger, P., Sierra, J. L., Fernández-Manjón, B., & Kooper, R. (2007). Authoring Game-Based Adaptive Units of Learning with IMS Learning Design and <e-Adventure>. International Journal of Learning Technology, 3 (3), 252 - 268. Geneva, SWITZERLAND: Inderscience Publishers. DOI: 10.1504/IJLT.2007.015444
2007	Burgos, D., Nimwegen, C. v., Oostendorp, H. v., & Koper, R. (2007). Game-based learning and the role of feedback. A case study. Advanced Technology for Learning. 4 (4), 188-193. Anaheim, CA, USA: ACTA Press
2007	Burgos, D., Tattersall, C., & Koper, E. J. R. (2007). Representing adaptive and adaptable Units of Learning. How to model personalized eLearning in IMS Learning Design, 41-56. In B. Fernández Manjon, J. M. Sanchez Perez, J. A. Gómez Pulido, M. A. Vega Rodriguez & J. Bravo (Eds.), Computers and Education: E-learning - from theory to practice. Germany: Springer. DOI: 10.1007/978-1-4020-4914-9_4
2007	Dodero, J. M., Tattersall, C., Burgos, D. & Koper, R. (2007). Transformational Techniques for Model-Driven Authoring of Learning Designs. In H. Leung, F. W. B. Li, R. W. H. Lau & Q. Li (eds.), ICWL (p./pp. 230-241). Springer. ISBN: 978-3-540-78138-7
2007	Fisher, A., Barak, N., Burgos, D., & Ullmann, T. D. (2010). Engaging the community in multidisciplinary TEL research: A case-study on networking in Europe. Proceedings of the EDEN Conference. Valencia, Spain, June 9th-12th, 2010
2007	Leo, D. H., Burgos, D., Tattersall, C. & Koper, R. (2007). Representing Computer-Supported Collaborative Learning Macro-scripts using IMS Learning Design. In M. Wolpers, R. Klamma & E. Duval (eds.), EC-TEL (Posters) : CEUR-WS.org.
2007	Moreno-Ger, P., Burgos, D., Sierra, J. L. & Fernández-Manjón, B. (2007). A Game-Based Adaptive Unit of Learning with IMS Learning Design and <e-Adventure>. In E. Duval, R. Klamma & M. Wolpers (eds.), EC-TEL (p./pp. 247-261), Lectures in Computer Science: Springer. ISBN: 978-3-540-75194-6
2007	Specht, M., & Burgos, D. (2007). Modeling Adaptive Educational Methods with IMS Learning Design. Journal of Interactive Media in Education. Special Issue on Adaptation and IMS Learning Design. Retrieved from http://www-jime.open.ac.uk/jime/article/view/2007-8 16 [November 3rd, 2013]

2006	Burgos, D. & Specht, M. (2006). Adaptive e-Learning Methods and IMS Learning Design: An Integrated Approach. Proceedings of the Sixth IEEE International Conference on Advanced Learning Technologies, ICALT (p./pp. 1192-1193), Washington, DC, USA: IEEE Computer Society. DOI: 10.1109/ICALT.2006.1652688. ISBN: 0-7695-2632-2
2006	Burgos, D., Herder, E., & Olmedilla, D. (2006). TENCompetence: Construyendo la Red Europea para el Desarrollo Continuo de Competencias. Inteligencia Artificial, Revista Iberoamericana de Inteligencia Artificial (AEPIA), 11, 79-84.
2006	Cristea, A. I. & Burgos, D. (2006). Authoring Adaptive Hypermedia and IMS Learning Design: A Possible Understanding?. Proceedings of the Sixth IEEE International Conference on Advanced Learning Technologies, ICALT (p./pp. 1190-1191), Washington, DC, USA: IEEE Computer Society. DOI: 10.1109/ICALT.2006.1652687
2006	Hernández-Leo, D., Burgos, D., Tattersall, C., & Koper, R. (2007). Representing CSCL macro-scripts using IMS LD: lessons learned. Proceedings of ECTEL, Crete, Greece: ProLearn
2006	Hummel, H. G. K., Tattersall, C., Burgos, D., Brouns, F. & Koper, R. (2006). Fostering Participation in Learning Networks by Using Reward Systems and Face-to-Face Meetings. Proceedings of the Sixth IEEE International Conference on Advanced Learning Technologies, ICALT (p./pp. 534-536), Washington, DC, USA: IEEE Computer Society. DOI: 10.1109/ICALT.2006.1652494
2006	Hummel, H., Tattersall, C., Burgos, D., Brouns, F., Kurvers, H., Koper, R. (2006) Critical Facilities for Active Participation in Learning Networks. International Journal of Web-based Communities (IJWBC), 2 (1), 81-99. Geneva, SWITZERLAND: Inderscience Publishers. DOI: 10.1504/IJWBC.2006.008617
2006	Memmel, M., Ras, E., Weibelzahl, S., Burgos, D., Olmedilla, D. & Wolpers, M. (2006). Proceedings of the Joint International Workshop on Professional Learning, Competence Development and Knowledge Management - LOKMOL and L3NCD in conjunction with the First European Conference on Technology Enhanced Learning (EC-TEL'06) Springer LNCS
2006	van Nimwegen, C., Burgos, D. D., van Oostendorp, H. & Schijf, H. (2006). The paradox of the assisted user: guidance can be counterproductive. In R. E. Grinter, T. Rodden, P. M. Aoki, E. Cutrell, R. Jeffries & G. M. Olson (eds.), Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. CHI (p./pp. 917-926), New York, NY, USA: ACM. DOI: 10.1145/1124772.1124908. ISBN: 1-59593-372-7
2006	van Nimwegen, C., van Oostendorp, H., Burgos, D. & Koper, R. (2006). Does an interface with less assistance provoke more thoughtful behavior?. ICLS '06: Proceedings of the 7th international conference on Learning sciences (p./pp. 785-791), : International Society of the Learning Sciences. ISBN: 0805861742
2005	Berggren, A., Burgos, D., Fontana, J. M., Hinkelman, D., Hung, V., Hursh, A., Tielemans, G. (2005) Practical and Pedagogical Issues for Teacher Adoption of IMS Learning Design Standards in Moodle LMS. Journal of Interactive Media on Education, Special issue on Learning Design. Retrieved from http://jime.open.ac.uk/article/2005-2/263 [November, 3rd, 2013]

2005	Burgos, D., Koper, R. (2005) Virtual communities, research groups and projects on IMS Learning Design. State of the art, key factors and forthcoming challenges. E-Journal of Educational Research, Assessment and Evaluation. Revista ELectrónica de Investigación y EValuación Educativa, 11 (2). Retrieved from http://www.uv.es/RELIEVE/v11n2/RELIEVEv11n2_6.htm [November, 3rd, 2013]
2005	Koper, R., Burgos, D. (2005) Developing advanced units of Learning using IMS Learning Design level B. International Journal on Advanced Technology for Learning (IJATL), Special Session on "Designing Learning Activities: From Content-based to Context-based Learning Services", volume 2, issue 4, October 2005. DOI: 10.2316/Journal.208.2005.4.208-0868. ISSN: 1710-2251. Indexado por Inspec y Cambridge Scientific Abstracts

Annex III: Papers considered for this PhD proposal

ID	Year	% author	Publication	Evidence of quality and fitness to the research proposal
PP-01	2009	90%	Burgos, D. & Nimwegen, C. v. (2009). Games-Based Learning. Destination Feedback and Adaptation: A Case Study of an Educational Planning Simulation. In T. M. Connolly, M. H. Stansfield & L. Boyle (Eds.), Games-Based Learning Advancements for Multi-Sensory Human Computer Interfaces. Hershey, USA: Information Science.	ISBN: 978-160566360-9 This book chapter concentrates on the interaction between users and the system, in the context of an educational setting, with end users who will play a simulation in order to retrieve their non-verbal communication, such as user-tracking information. Furthermore, the system is capable of identifying user patterns and user roles, in order to facilitate clustering and related actions.
PP-02	2007	85%	Burgos, D., Tattersall, C. & Koper, R. (2007). Re-Purposing Existing Generic Games and Simulations for E-Learning. Special Issue on Education and Pedagogy with Learning Objects and Learning Designs. Computers in Human Behavior, 23 (6), 2656–2667.	DOI: 10.1016/j.chb.2006.08.002 ISSN: 0747-5632 Impact Factor: 2.067 5-year Impact Factor: 2.489 Ranking (2012): Q1 This paper shows how commercial, traditional and non-educational games, played by non-academic users or students, can be easily reused in an educational context. The paper adopts the angle of a creator of learning resources who needs to connect with end users inside a social network of a virtual community, and who seeks to facilitate game play within an eGame.
PP-03	2007	80%	Burgos, D., Nimwegen, C. v., Oostendorp, H. v. & Koper, R. (2007). Game-Based Learning and the Role of Feedback. A Case Study. Advanced Technology for Learning. 4 (4), 188–193. Anaheim, CA, USA: ACTA Press.	DOI: 10.2316/Journal.208.2007.4.208-0918 This paper shows the relation between the user and the feedback provided by the system, in the context of an eGame. It shows how results depend on the user's behaviour.
PP-04	2007	80%	Burgos, D., Moreno-Ger, P., Sierra, J. L., Fernández-Manjón, B. & Kooper, R. (2007). Authoring Game-Based Adaptive Units of Learning with IMS Learning Design and <e-Adventure>. International Journal of Learning Technology, 3 (3), 252–268. Geneva, SWITZERLAND: Inderscience Publishers.	DOI: 10.1504/IJLT.2007.015444 This paper shows the authoring role of a user of eGames, when they create units of learning from scratch. It presents the methodology and practical outcomes, which point to a clear need for the simplification of the authoring process, so that user interaction can be strengthened.

PP-05	2008	80%	Burgos, D., Moreno-Ger, P., Sierra, J. L., Fernández-Manjón, B., Specht, M. & Koper, E. J. R. (2008). Building Adaptive Game-Based Learning Resources: The Marriage of IMS Learning Design and <e-Adventure>. Simulation & Gaming. Special Issue on eGames and Adaptive eLearning. A Practical Approach. 39 (3), 414–431. Thousand Oaks, CA, USA: SAGE Publications.	DOI: 10.1177/1046878108319595 This paper shows how to design and create game-based learning resources to integrate stand-alone games within digital frameworks, e.g., social networks, virtual campuses and intranets.
PP-06	2009	60%	Moreno, P., Burgos, D. & Torrente, J. (2009). Digital Games in eLearning Environments. Current Uses and Emerging Trends. Simulation & Gaming, 40th Anniversary, 40 (5), 669–687. Thousand Oaks, CA, USA: SAGE Publications.	DOI: 10.1177/1046878109340294 This paper gives a comprehensive review of the field of educational games, in the context of learning environments.
PP-07	2011	55%	Anido, L., Burgos, D., Caeiro, M., Torrente, J., Fernandez, M., Gonzalez, J., Manso, M., Ortega, M., Rodriguez, D. & Fernandez-Manjon, B. Gametel: An Approach to Multi-Format and Multi-Device Accessible Engineering Education. Proceedings of Frontiers in Education Conference, FIE 2011, Pages F1H-1-1-F1H-6. Rapid City, South Dakota (USA): IEEE Computer Society, October 12–15, 2011.	DOI: 10.1109/FIE.2011.6142745 This conference paper shows the practical experience of a framework focused on eGames, which is deployable in various formats and devices, including tablets and smartphones. This approach allows for complex information retrieval from a variety of users, which facilitates the identification of user interaction and group patterns.
PP-08	2006	50%	van Nimwegen, C., Burgos, D. D., van Oostendorp, H. & Schijf, H. (2006). The Paradox of the Assisted User: Guidance can be Counterproductive. In R. E. Grinter, T. Rodden, P. M. Aoki, E. Cutrell, R. Jeffries & G. M. Olson (Eds.), Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. CHI (p./pp. 917–926), New York, NY, USA: ACM. ISBN: 1-59593-372-7	DOI: 10.1145/1124772.1124908 This paper at the SIGCHI conference concentrates on the interaction between a user and the support provided by the system to carry out a specific task. It shows that too much assistance lowers the user's attention and performance. In the publication, the authors present the results of an experimental case with a random sample of users.
PP-09	2008	50%	Moreno-Ger, P., Burgos, D., Martínez-Ortiz, I., Sierra, J. L. & Fernández-Manjón, B. (2008). Educational Game Design for Online Education. Computers in Human Behavior. Special Issue on Electronic Games and Personalized eLearning Processes, 24 (6), 2530–2540.	DOI: 10.1016/j.chb.2008.03.012 ISSN: 0747-5632 Impact Factor: 2.067 5-year Impact Factor: 2.489 Ranking (2012): Q1 This paper shows the user requirements and functional requirements to design educational games. In addition, the authors propose a design method focused on user adaptation, group definition and assessment.