

# Open Research Online

---

The Open University's repository of research publications and other research outputs

## What can breakdowns and breakthroughs tell us about learning and involvement experienced during game-play?

### Conference or Workshop Item

How to cite:

Iacovides, Ioanna; Aczel, James; Scanlon, Eileen and Woods, William (2011). What can breakdowns and breakthroughs tell us about learning and involvement experienced during game-play? In: 5th European Conference on Games Based Learning, 20-21 Oct 2011, Athens, Greece.

For guidance on citations see [FAQs](#).

© 2011 The Authors

Version: Accepted Manuscript

Link(s) to article on publisher's website:

<http://www.academic-conferences.org/ecgbl/ecgbl2011/ecgbl11-proceedings.htm>

---

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online's data [policy](#) on reuse of materials please consult the policies page.

---

[oro.open.ac.uk](http://oro.open.ac.uk)

## **What can Breakdowns and Breakthroughs tell us about Learning and Involvement experienced during Game-play?**

Ioanna Iacovides, James Aczel, Eileen Scanlon, and Will Woods.

The Open University, Milton Keynes, UK

[i.iacovides@open.ac.uk](mailto:i.iacovides@open.ac.uk)

[j.c.aczel@open.ac.uk](mailto:j.c.aczel@open.ac.uk)

[e.scanlon@open.ac.uk](mailto:e.scanlon@open.ac.uk)

[w.i.s.woods@open.ac.uk](mailto:w.i.s.woods@open.ac.uk)

**Abstract:** Alongside the growing mainstream appeal of digital games, there has been an increasing amount of academic interest in how games can be used to support involving learning experiences within formal educational settings. While there has been particular emphasis on the potential of games within these contexts, there is still much to be understood about what happens during specific instances of game-play (Squire, 2008). For instance, it has been argued that research in the area would benefit from further exploration of both how and what people learn informally when they play games during their leisure time (Oliver & Carr, 2009). This paper aims to address some of these issues by reporting on research which explores how involvement and learning come together in and around instances of game-play. A multiple case study approach was adopted, which included game-play observation and a cued post-play interview. Eight cases were carried out in total, with participants being asked to come into the lab to play games on three different occasions and to keep a gaming diary over a three week period. This paper focuses on exploring the detailed processes that occur during game-play in order to consider how people learn through play. The preliminary findings of the analyses are presented through examples from the case studies which illustrate how these breakdowns and breakthroughs occurred with respect to: Action (e.g. problems with the controller, finding out a new attack), Understanding (e.g. not knowing what to do next, figuring out how to solve a puzzle) and Involvement (e.g. losing interest in the game, seeing evidence of progress). Consideration will also be given to how breakdowns and breakthroughs relate to each other and the influence they have on learning and involvement within this context.

**Keywords:** Informal learning, involvement, breakdowns, breakthroughs

### **1. Introduction**

As playing digital games has become an increasingly mainstream activity, there has been growing academic interest in the potential of games to support learning within formal educational environments (e.g. Gee, 2004; de Freitas, 2006), though there is some debate about whether games used within these contexts are any more effective than traditional forms of instruction (e.g. Egenfeldt-Nielsen et al., 2008). Part of the problem seems to be the difficulty of integrating learning content within game-play; it has been suggested this difficulty is due to the possibility that learning in games “involves a more complex understanding of learning, one that is not so easy to tie to specified learning outcomes” (de Freitas, 2006; p. 18). Further, some authors have highlighted a lack of research that addresses exactly how and what people learn through the games they play in their leisure time (Oliver & Carr, 2009) and argue that there is a need for further examination of the kinds of thinking in which people engage as they play these games (Squire, 2008). Frameworks have been established that help define different aspects of player involvement (see Boyle & Connolly, 2007 for a review) however little consideration has been paid to how these frameworks relate to learning within an informal context (Iacovides et al, 2011).

In this paper, we discuss some of the relevant literature before going on to describe a study that aimed to explore how learning and involvement come together in practice. A multi-method case study approach was adopted in order to undertake a detailed examination of the processes that occur in and around game-play. The results of a preliminary analysis are illustrated through examples of breakdowns and breakthroughs that occurred during instances of play. The paper concludes with a consideration of future work in this area.

### **2. Learning and player involvement**

Several theories have been proposed to explain why people find games enjoyable. One of the earliest models comes from Malone and colleagues, who proposed a theory of “intrinsic motivation”. This was

derived from experimental manipulations of drill and practice games which suggested that games are rewarding in and of themselves, due to a combination of challenge, fantasy and curiosity (Malone, 1981). Later work carried out by Malone & Lepper (1987) also added the element of control and further interpersonal motivators (recognition, competition and cooperation). However, it has been suggested that, despite the later inclusion these interpersonal motivators, there is too narrow a focus on the structure of the game itself, without sufficient attention being paid to the social dynamics that occur in and around the context within which the game is played (Egenfeldt-Neilsen et al., 2008). In their review of different theories of enjoyment in games, Boyle & Connolly (2007) also argue there is a need for further research to consider how player enjoyment relates to learning and whether the two are even compatible.

One model that does suggest how involvement and learning might relate to each other is the Digital Game Experience Model (DGEM; Calleja, 2007). Calleja uses the terms “macro involvement” to refer to “motivational attractors to games that influence sustained engagement through the long-term” and “micro involvement” to refer to “the moment by moment instance of the game-play instance” (p. 237). Based on a study of massively multiplayer online games, the DGEM discusses the player experience with reference to six “frames”; where “each frame represents a modality of meaning through which the role-playing experience is interpreted and performed” (p. 237). Game-play can thus be described with reference to how the tactical, performative, affective, shared, narrative and spatial frames come together. Each of the frames describes experiences that range on a continuum from conscious attention to internalized knowledge, which will eventually lead to “incorporation” as the player internalises each of the frames. This is described as “the subjective experience of inhabiting a virtual environment facilitated by the potential to act meaningfully within it while being present to others” (p. 257). Incorporation seems similar to flow (Csikszentmihalyi, 1990) in the sense that it describes the experience of deep involvement in an activity but combined with the sensation of spatial and social presence. The description of how a player internalises the different frames is especially interesting from a learning perspective as, unlike most other models of the game-play, it potentially gives researchers a way of understanding how deeper levels of involvement actually depend on successfully internalising the relevant frames i.e. the process seems to depend on a certain amount of learning occurring in the first place (Iacovides, 2009). The model also has the potential to distinguish between activities that occur on both a micro and macro scale thus allowing for a discussion of specific game-play episodes and about how activities outside game-play (e.g. discussing a game with friends) might affect longer term motivations.

With respect to how people might learn from games that they play during their leisure time, Gee (2004) provides an account based on his own observations and semiotic analysis. He argues that when people play games they are actively engaged in the process of learning a new literacy. This literacy includes multi-modal texts and graphical representations. Through gaming, players learn to participate in “semiotic domains” made up of words, pictures, and anything else that is used to communicate meaning. These domains are associated with specific “affinity groups” of players who contribute knowledge, skills, tools and resources to the domain. Gee (2004) uses the term “critical learning” to refer to the learning experienced when players start to consider “the domain at a ‘meta’ level as a complex system of interrelated parts” (p. 23). He also argues that critical learning involves not just a change in practice “but in identity” (p. 190). This critical learning seems to occur from the adoption and experimentation of different identities, as well as from being able to reflect upon the relationship between old and new ones.

However, Oliver & Carr (2009) point out that while Gee gives us some idea of the general relevance of games to learning, there is still a lack of “detailed accounts of what is actually learnt when people play” (p. 444). This is something echoed by Squire (2008) when he suggests that there is a need for more “rigorous research into what players do with games (particularly those that don’t claim explicit status as educational), and a better understanding of the thinking that is involved in playing them.” (p.1). It can be argued that the area would benefit from further empirical research to substantiate Gee’s semiotic analysis. In particular, it is not clear whether everyone who plays games engages with them in the same sort of way and so there is a need for studies to examine the different ways in which involvement and learning actually do come together during game-play.

In examining the kinds of thinking and learning that occur during play the concept of breakdowns may be useful. For instance, Pelletier and Oliver (2006) used a small scale case-study approach to examine the process of how people learn to play. Using an approach based on Activity Theory (Kutti,

1996) they decided to decompose activities into actions and operations and to take note of any “contradictions” (i.e. breakdowns, problems) that occurred. This allowed them to discuss the strategies players developed but focusing purely on the game-play meant they had to make certain inferences about what players were trying to do. As a result, it is difficult to know the extent to which the inferences they made actually governed how players behaved within the game

Barr (2007) also considered breakdowns when he used a collective case study approach to examine the relationship between the game-play interface and the values players expressed during play. Activity Theory was used to analyse instances of game play, in terms of contradictions and breakdowns, whereas grounded theory was used to uncover different values. While Barr acknowledges that Pelletier and Oliver (2006) provide a clear and useful example of how to use Activity Theory within games studies, he also argues that they did not distinguish between contradictions and breakdowns. For Barr, breakdowns occur when the flow of an activity is interrupted (e.g. accidentally pressing the wrong button on the controller). While these can often be a normal part of game-play (when they are overcome quickly) repeated breakdowns within an activity are likely to indicate an underlying contradiction within the activity system (e.g. repeatedly pressing the wrong button can indicate poor design).

Another example of this approach comes from Ryan and Siegel (2009) who drew upon the earlier work of Marsh, Wright and Smith (2001) by making a distinction between a breakdown in interaction and a breakdown in illusion. Ryan and Siegel argue that breakdowns occur “when actions we take to accomplish something no longer seems [sic] to work” (p.1) before going on to claim interaction breakdowns are part of normal game-play, but unlike illusion breakdowns, they do not disrupt the experience of flow. Further, Ryan and Siegel also seem to suggest that all interaction breakdowns result in learning, which may not necessarily be the case.

In recent work, Sharples (2009) takes a somewhat different approach, using critical incident analysis to identify breakdowns and breakthroughs for gathering mobile technology design requirements within an educational context. In this instance, breakdowns are “observable critical incidents where a learner is struggling with the technology, asking for help, or appears to be labouring under a clear misunderstanding” while breakthroughs are “observable critical incidents which appear to be initiating productive, new forms of learning or important conceptual change” (p. 10).

It seems the area of game-based learning would benefit from a further examination of exactly how and what people learn through game-play, especially in terms of to how this relates to their experience of involvement (Iacovides et al., 2011). The following section outlines a study that was carried out in order to consider these issues in relation to the concepts of breakdowns and breakthroughs, with the aim of furthering our understanding of how involvement and learning come together in practice.

### **3. Methods**

This paper reports on the preliminary results of a study which aimed to look at how involvement and learning relate to each other by addressing the following questions:

1. How can we identify breakdowns that occur during play?
  - a. How do players attempt to resolve these breakdowns?
  - b. What role do breakthroughs play in this process?
2. What does examining breakdowns and breakthroughs tell us about how involvement and learning come together in practice?

Initially, Sharples (2009) definitions were adopted for identifying breakdowns and breakthroughs. The definitions were further developed during the initial analysis (Section 4) to more accurately capture the breakdowns and breakthroughs that occur within the context of game-play.

A multiple-case study design was adopted (Yin, 2009). Eight case studies were conducted, in which each case involved a single participant who came into the lab on three different occasions and kept a gaming diary over three weeks; except for one case that consisted of two participants. The lab was set up as a comfortable living room environment. Participants (age 23-59; 5 male, 4 female) were recruited from a previous email interview study. Methods included observation of game-play and a post-play cued interview (similar to Iacovides, 2009). Physiological measures (chosen on the basis of

Mandryk & Atkins, 2007) were collected during play, while participants were also asked to keep a gaming diary over a three week period, but this data was not included in the initial analysis reported here.

The first session included a preliminary interview, a questionnaire and an introduction to the general procedure. In the second session, the participant was asked to bring in a game they were currently playing so they could be observed playing in the lab. In the third session, the investigator chose a game for the participants that would not be the sort of game they usually played. For both these sessions, the participant played for up to an hour, during which time video recordings were made of the player, their game-play and their physiological reactions. The investigator observed the session from a separate room. The player and the investigator then reviewed the game-play recording together during the post-play interview. Throughout the three week period, participants were also asked to keep a semi-structured diary of their game-playing activities outside the lab. A final interview was carried out at the end of the study in order to discuss the diary activities (Elliot, 1997).

The post-play interviews were first transcribed before using INTERACT (Mangold International GmbH) to code the multiple data streams (i.e. the player, game-play and physiological recordings). While initial breakdowns and breakthroughs were identified from the transcripts, INTERACT was used to develop a coding scheme to identify these within the data recordings. Critical episodes and themes were then identified via discussion amongst the researchers. The analysis of the full data set, including the physiological recordings, diary entries and final interviews is still being carried out. This section reports on preliminary analyses of the single-player case studies, with an emphasis on the participants' micro level involvement observed during the gaming sessions in the lab. The focus in this paper is on considering theoretical conjectures that have arisen from the initial analyses and can subsequently be used to consider research questions 1 and 2.

#### 4. Preliminary analyses

The different definitions of breakdowns used within the literature meant that identifying them within the data proved quite a challenging task, though it soon became clear that they could occur on three different, though inter-related, levels. This section outlines some initial observations about how breakdowns and breakthrough occur with respect to player actions, understanding and involvement experienced during play. Conceptualising game-play in these terms was helpful in starting to address research questions 1 and 2.

With respect to **player actions**, a breakdown can be said to occur when the player is unable to execute an action within the game successfully. This may be due to pressing the wrong button, getting the timing of the action wrong, or in-game events; such as being hit by a projectile e.g. Amy (F, 28) being hit by a red shell in *Mario Kart*. In terms of **player understanding**, the most obvious example of a breakdown is when the player is unsure about what they are supposed to be doing, or where they are supposed to go. For instance, Nick (M, 29) when playing *Endless Ocean 2* was initially confused about whether a red circle on the map indicated where he was supposed to go next or where he had just come from. With respect to **player involvement**, boredom and frustration seem to be key indicators that a player is no longer engaged within the game. For example, Matt (M, 24) was visibly bored with the tutorial he had to go through in *Sam & Max: Save the World* because he was being given information (about the Wiimote controls) that he already knew.

Though breakthroughs are conceptualised by Sharples (2009) as relating to understanding (since they involve conceptual change), they could also be defined as occurring when a player successfully carries out a set of **actions** e.g. when Linda (F, 59) had trouble with a specific jump in *Lego Indiana Jones 2*, attempting it several times before managing to go from one platform to the next. Similarly, instances where a player is seen to become more involved within a game could also be described as breakthroughs relating to **involvement** i.e. when a player experiences the sensation of flow or incorporation. An example of this comes from Alex (M, 41) talking about how he successfully avoided the ghosts chasing him in *Super Mario Galaxy 2*: "So now you're in that nice kind of, you know, run, jump, don't know what's coming, just kind of react". With respect to **understanding**, breakthroughs can be said to occur whenever a player develops a new strategy or figures out how to solve a problem within the game. For example, Amy (F, 28) realising that her goal was to collect and guide a certain number of Loco Rocco characters to a gate, in order to proceed to the next area in *Loco Rocco: Cocoreccho*. Arguably, a breakthrough is easier to identify after an identified breakdown has

occurred, since the breakthrough can be seen as a resolution of the breakdown, although theoretically there is no reason to assume they can only occur in this instance.

The following episode provides an illustration of how action, understanding and involvement seem to come together within game-play. During the first boss fight in the Xbox 360 game *Kameo: Elements of Power*, Katy (F, 23) puts together much of the knowledge she has gained so far through her experience within the game. Upon entering the new area, she realises (from her previous experiences of playing similar action-adventure games) that she is about to engage in a boss fight and almost immediately consults the in-game hint about how to beat the boss (in the form of a note on the ground). The provision of the note can be seen as an example of how the game helps to facilitate breakthroughs in understanding. The hint tells Katy that the boss is susceptible to punches (though she doesn't read all of it), so she immediately switches to the character who is able to perform an uppercut attack. However, while the uppercut stuns the boss, subsequent punches fail to inflict any lasting damage. Katy can be said to experience a breakdown in terms of both action and understanding, since she missed out on some of the information provided and so punching him more than once "actually doesn't do anything anymore". She attempts to avoid the boss for as long as possible and starts switching between characters and using different attacks until she finds an effective combination in the form of using an uppercut and throwing ice bolts. It seems that she had to experience multiple action breakdowns until she found a strategy that worked, thus realising how she was supposed to defeat the boss. During this time, and though she occasionally pressed the wrong button, she seemed very focused on the task; so much so that "all the little indicators in the corner of my screen go away". Arguably, managing to figure out a successful attack and to progress within the game added to her experience of involvement. The fact that she responded to beating the boss with "Gotcha!" and admitted to wondering "what's going to happen next?" during the post-play interview, indicated her willingness to continue playing the game.

Katy's session with *Kameo* illustrates how understanding is mediated by player actions, but also by information provided by the game. Her experience suggests that breakdowns in action and understanding are not necessarily detrimental to game-play, and that they might actually contribute to learning since they are part of how the player progresses within the game. Further, it seems to suggest that player involvement can be increased as a result of overcoming these breakdowns and experiencing progress.

In a different example, Alex (M, 41) illustrates how important the sensation of agency is to the experience of involvement. Whilst playing *Flower* on the PS3, where the player controls a flower petal on a breeze and has to collect other petals from flowers within a 3D environment, Alex entered a new area where the wind speed noticeably picked up and he had to travel through a canyon. He soon became confused however. Previously, he had worked out that he needed to collect petals from the glowing flowers within the game world in order to open up new areas. In this section, the wind speed seemed to pick up and randomly change direction so that he started to miss flowers, where "all of a sudden we're too high, and then woop, you can't get any of those?". He mistakenly thought the game "was going to penalise me if I didn't get through" by making him go round the section again (in fact he was progressing into a similar looking section) and this breakdown in action was further compounded by a breakdown on the level of understanding, as he became unsure whether he was even controlling the petal stream anymore. This in turn reduced his enjoyment as "I didn't really know what I did, I missed things on the sort of jumps three times, and the only time I got them I had no control over it" so while it might have been a "pretty experience", "as a game that's not very satisfying"; suggesting he experienced a breakdown in involvement.

Alex's session indicates that progress on its own isn't enough to keep the player involved; without feeling responsible for that progress, the experience becomes less enjoyable. Thus, a breakdown in involvement occurs when a player does not feel in control of their actions and when they do not understand what is going on within the game.

The preliminary analysis seems to suggest certain theoretical conjectures. The first is that learning results from breakdowns and breakthroughs that occur with respect to action and understanding. Breakthroughs in understanding can be seen as evidence of learning, which appear to depend on the outcomes of player actions and information provided by the game. The second is that involvement depends on progress (which result from players successfully carrying out actions to enact their strategies) and agency (where players feel in control and understand what they have to do). It seems

that overcoming breakdowns can lead to increased involvement, but a failure to do so is likely to reduce involvement. These conjectures can be validated by looking for counter examples. The analytic claims can then be refined through discerning the conditions under which they apply.

## 5. Conclusion

The previous section illustrates how examining game-play in terms of breakdowns and breakthroughs that occur with respect to action, understanding and involvement can be used to consider how learning and involvement come together in practice. Further exploration of the micro level data will be carried out by looking for examples to test the claims established from the preliminary findings. Particular attention will be paid to the idea that understanding is mediated by player actions within the game and by how the game delivers information to the player. In addition, the claim that understanding leads to progress and contributes to involvement will be addressed. The suggestion that agency is a key component of player involvement will also be explored. The main analysis will also include the physiological data, which will provide further insight into the player experience, and examining the diaries for further information about micro level involvement. A macro level data analysis is also planned, in order to consider the influence of factors occurring beyond the instance of game-play. The macro analysis aims to address further questions such as whether players' seem to learn anything beyond learning how to play a game and to explore the extent to which they interact with different gaming communities and resources.

The idea that breakdowns and breakthroughs can occur with respect to action, understanding and involvement within the context of game-play helps contribute to previous research. With respect to Pelletier and Oliver (2006), the different levels help to distinguish between exactly what sorts of problems occur during play. In addition, the example of Katy's boss fight does indicate that action and understanding breakdowns are not necessarily disruptive to flow – similar to what Barr (2007) and Ryan & Siegel (2009) suggest – but there are situations when they can contribute to a breakdown in involvement e.g. Alex's experience of the canyon in *Flower*. While involvement and illusion breakdowns appear quite similar, it can be argued that distinguishing between breakdowns in action and understanding (rather than labelling them interaction breakdowns) allows for a more nuanced appreciation of how different breakdowns relate to each other. In addition, adding the concept of breakthroughs to analysing game-play extends Sharples (2009) work and indicates that learning within the context of game-play occurs via breakthroughs in understanding. While Ryan and Siegel (2009) do seem to suggest that all interaction breakdowns lead to learning, the initial analysis indicates this only occurs if there is a subsequent breakthrough in understanding. Further analysis is required however to explore which breakdowns (if any) are a pre-requisite for learning.

Through an in-depth examination of the breakdowns and breakthroughs that occur during play, we are starting to build a richer understanding of how involvement and learning come together in practice. The case-study approach means that care needs to be taken when making comparisons and generalisations between sessions, though Yin (2009) argues generalisations to theory are appropriate. The preliminary analysis reported yielded certain theoretical conjectures, but further analysis is necessary before we can fully capture exactly what it is players get out of playing games within an informal context and how this relates to wider learning theories. The area of game-based learning will subsequently benefit from developing a more complex understanding of what learning through games entails and how this relates to player involvement.

## 6. Acknowledgements

This research is funded by the ESRC as part of a 1+3 studentship. We would like to thank all the participants for taking part in the project and Mangold International GmbH for the software, INTERACT™.

## References

- Barr, P. (2007). **Video Game Values: Play as Human Computer Interaction**. PhD thesis; Victoria University, Wellington, New Zealand.
- Boyle, E. and Connolly, T. (2008) *A Review of Theories of Player Enjoyment in Playing Computer Games*. In Proceedings of the 2nd European Conference on Games-Based Learning. Barcelona, Spain, 16-17 October, pp. 59-67.
- Calleja, G. (2007). *Digital Game Involvement: A Conceptual Model*. **Games and Culture**, 2, 236–260.
- Csikszentmihalyi, M. (1990). **Flow: The Psychology of Optimal Experience**. Harper & Row, New York.

- De Freitas, S. (2006). *Learning in Immersive Worlds: A Review of Game-Based Learning*. London: Joint Information Systems Committee. [http://www.jisc.ac.uk/media/documents/programmes/elearninginnovation/gamingreport\\_v3.pdf](http://www.jisc.ac.uk/media/documents/programmes/elearninginnovation/gamingreport_v3.pdf) (accessed 11/05/11).
- Egenfeldt-Nielsen, S., Smith, J. H., & Tosca, S. P. (2008). **Understanding Video Games: The Essential Introduction**. New York and London, Routledge.
- Elliott, H. (1997). *The Use of Diaries in Sociological Research on Health Experience*. **Sociological Research Online**, vol. 2, no. 2, <http://www.socresonline.org.uk/2/2/7.html> (accessed 11/05/11).
- Gee, J. P. (2004). **What Video Games Have to Teach Us About Learning and Literacy**. New York: Palgrave Macmillan.
- Kutti, K. (1996). *Activity theory as a potential framework for human computer interaction research*, in: B. A. Nardi (Ed.) **Context and consciousness: activity theory and human-computer interaction**, pp 17-44. Cambridge, MA, MIT Press.
- Malone, T. W. (1981) *Toward a theory of intrinsically motivating instruction*. **Cognitive Science: A Multidisciplinary Journal**, 5, 333-369.
- Malone, T. W., and Lepper, M. R. (1987) *Making learning fun: A taxonomy of intrinsic motivations for learning*. **Aptitude, Learning, and Instruction**, 3, 223-253.
- Mandryk, R. L., and Atkins, M.S. (2007). *A Fuzzy Physiological Approach for Continuously Modeling Emotion During Interaction with Play Environments*. **International Journal of Human-Computer Studies**, 6(4), 329-347.
- Oliver, M., and Carr, D. (2009). *Learning in virtual worlds: Using communities of practice to explain how people learn from play*. **British Journal of Educational Technology**, 40(3), 444-457.
- Pelletier, C. and Oliver, M. (2006). *Learning to play in digital games*. **Learning, media and technology**, 31, 329-342.
- Ryan, W., and Siegel, M. A. (2009). *Evaluating interactive entertainment using breakdown: Understanding embodied learning in video games*. In Proceedings of Digital Games Research Association. London, England. <http://www.digra.org/dl/db/09287.38300.pdf> (accessed 18/05/11).
- Sharples, M. (2009) *Methods for Evaluating Mobile Learning*. In G.N. Vavoula, N. Pachler, and A. Kukulska-Hulme (eds), **Researching Mobile Learning: Frameworks, Tools and Research Designs**. Oxford: Peter Lang Publishing Group, pp. 17-39. <http://www.lsri.nottingham.ac.uk/msh/Papers/Methods%20Evaluating%20Mobile%20Learning.pdf> (accessed 11/05/11).
- Squire, K. (2008). *Open-Ended Video Games: A Model for Developing Learning for the Interactive Age*, in **The Ecology of Games: Connecting Youth, Games, and Learning**, Salen, K. (Eds). Cambridge, MA: The MIT Press, pp. 167-198.
- Iacovides, I. (2009). *Exploring the Link between Player Involvement and Learning within Digital Games*. In Proceedings of the 23rd Conference on Human Computer Interaction, Cambridge, UK, pp.29-34.
- Iacovides I., Aczel J.C., Scanlon, E., Taylor, J. and Woods, W.I.S. (2011). *Motivation, engagement and Learning through Digital Games*. **Journal of Virtual and Personal Learning Environments**, 2(2), pp. 1-16.
- Yin, R.K. (2009). **Case Study Research: Design and Methods**. SAGE Publications, California, USA.