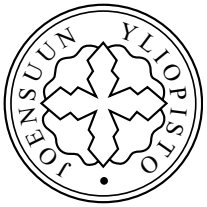

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Philip Bonanno

Learning Through Collaborative Gaming: A Process-oriented Pedagogy

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LEARNING THROUGH COLLABORATIVE GAMING: A Process-oriented Pedagogy

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ABSTRACT

Deriving inspiration from Connectionist and Constructionist epistemologies, a process-oriented methodology is developed for analysing and managing collaborative game-based learning. This identifies categories of interactions and the major factors that influence them during collaborative gaming. Interactions are categorised at the experiential and metacognitive levels along three dimensions (domain, technology/game and community) and across three pedagogical levels (acquisition, participatory and contributory) characterising novice, experienced and expert learners. The ultimate aim is to develop a process-oriented pedagogical model for using digital games in learning contexts.

Using this framework preliminary investigations and observations led to the identification of four major research questions: (1) What are the major gaming tendencies and patterns of the student sample? (2) What is the influence of individual characteristics on interactions during collaborative gaming? (3) What is the influence of group characteristics on interactions during collaborative gaming? (4) What is the influence of game features on interactions during collaborative gaming? These major research questions were sub-divided into a number of empirical research questions for more accurate analysis.

The complexity of interacting variables in collaborative gaming demanded multiple methods for capturing the different dimensions and levels of interactions generated by task and person-oriented processes. Data about the first research question focussing on gaming patterns (time, gaming device, preferred game genre and titles, motivation

for gaming) was gathered through a questionnaire. Theme focussed investigations were devised to investigate the other three major research questions in which the dependent variable was the collaborative gaming condition, more specifically the type, frequency and directionality of interactions that occur in group-based gaming. The independent variables were identified through preliminary investigations and observations. *Individual factors* comprise Personality dimensions (Paper 3), Gender-related neuro-cognitive propensities (Paper 2, 3 &6), Attitude to gaming (Paper 5 & 6) and Gaming competence (Paper 5, 6 & 7). *Group-based characteristics* (Paper 6) include Group Roles, Friendship level, Composition by gaming competence and Composition by gender. *Game features* (Paper 8) comprise 'Personal appeal' arising from Genre (which demands specific neurocognitive skills), perceived usefulness, perceived competence facilitation and perceived need satisfaction. It also involves 'Design' features that determine the degree of autonomy (user control) and interactiveness (sharability). Various experimental groups were set up using different combinations of these variables. These experimental sessions were recorded on video and subsequently analysed using appropriate observation and computational protocols. The data was corroborated through informal semi-structured interviews.

A range of results was obtained from the different methods used. The surveys showed that females prefer Puzzle and Fighting games compared to males who prefer First Person shooters, Role Playing Games, Sport and Strategy games. Gender influences also attitude to gaming with males scoring higher on the affective component, perceived control, perceived usefulness, behavioural component and on general attitude to gaming. A positive relationship between attitude to gaming and individual gaming competence was also recorded.

Analysis of interaction patterns using the video recordings gave interesting results. Personality dimensions exhibit characteristic interaction profiles involving different types, frequency and directionality of interactions. Extroverts initiate and receive more task and person-oriented interactions while adopting 'supporter' roles. Introverts show fewer interactions and tend to adopt 'spectator' roles.

The investigations carried out to explore the influence of group characteristics on interactions in collaborative gaming established that mixed composition regarding gender, gaming competence or friend-

ship level has a debilitating effect on collaborative gaming restraining the frequency and directionality of task and person-oriented interactions. Groups with established leader showed a wider repertoire of interactions that those without one. The most efficiently interacting groups were those made up of three members.

Investigations about how game genre affects gamers' perception and how it responds to underlying gender-related neurocognitive propensities showed that games are perceived to promote different competencies along the domain, gaming and community dimensions. History games were perceived useful regarding the way they represent historical events. Tutorials, time-lines and documentaries were considered less useful. Game type also influences the socio-emotional climate that stimulates or inhibits task and person-oriented interactions and consequently affects needs satisfaction. Games that provide limited user control, have uninteresting storyline, have a poorly designed environment and employ repetitive gameplay are not appealing and thus create negative socio-emotional climates. Through this interactions approach games were classified according to their degree of sharability.

The results from the different investigations and the emerging trends are compiled and discussed in a pedagogical model for managing and evaluating collaborative game-based learning. Pedagogical interventions at the experiential and metacognitive levels are discussed along the identified dimensions and pedagogical levels. The implications of this model and pedagogy are discussed in relation to the design of serious games and to its use in other technology-intensive collaborative environments.

DEDICATION

To my wife Marisa
for her relentless support and encouragement

and

To my kids Samuel, Daniela and Jasmine
who inspired and challenged me in this game

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This work was realized through the continual inspiration and support of my tutor Professor Päivi Atjonen, Faculty of Education, University of Joensuu. Words are inadequate to express my deep sense of gratitude for her guidance, patience, friendship and above all for her professional outlook that instilled in me a deep sense of professionalism.

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Joensuu, 15th September, 2008.

Philip Bonanno

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PART I

THE DEVELOPMENTAL PROCESS OF THE INVESTIGATION

1 THE GAME ABOUT GAMES

"Just as biological evolution has led to the development of highly sound organisms, so the socio-cultural evolution has produced sound forms of knowledge: "Broader and more flexible than other psychological languages, and at the same time, in spite of its crudeness, sufficiently exact to permit analysis of a wide variety of commonly experienced human interaction ..." Heider (1958, 10).

This work is about promoting learning and knowledge building through one of the latest evolved socio-cultural artefact - digital games. It is based on the premise that effective learning experiences can be developed by merging gaming engagement with reflection about learning. Driven by an epistemology relevant to the knowledge society, a pedagogy for acquiring competence in different aspects of knowledge-ability is developed using games both as physical and conceptual artefacts (Bereiter 2002).

1.1 General rationale for games in pedagogical contexts

The use of games for learning must be considered as part of the wider challenges education is currently facing. The profound influence of digital technologies and globalisation in a knowledge society demands a reconceptualisation of how we learn, where we learn and what we learn. In this context the role of education is to develop new individual and social skills that are essentially different from the ones provided through traditional methods. This demands a commitment to adapt to a changing vision for education based rather upon more immersive learning experiences and social interactions (de Freitas 2008).

Yet formal Education may still be quite immune to this changing reality adhering to practices based mainly on content-oriented approaches that conflict directly with the needs and mood of the digital generation. Even where technology is used in the educational process it is often used as a vehicle for teacher-centred content-driven approaches leaving little space for development of autonomous learning through innovative technology-intensive learning and knowledge building experiences. The knowledge society demands a range of per-

sonal and social skills that promote collaboration, creativity, multidisciplinary, adaptivity, intercultural communication and collective problem solving. Among digital technologies, games can be seen as promising in providing technology-intensive experiences that may promote most of these desired personal traits and provide an innovative and powerful approach that responds to these learner needs.

Technological advancements coupled with the creative flair of game designers are giving games that are highly immersive and interactive. During the last decade highly sophisticated game categories emerged including single, multi-user and massive multiplayer on-line entertainment games, serious games, simulations and virtual worlds. Their versatility proposes paradigmatic changes in the educational process by opening the opportunities to merge formal with informal learning and removing the boundaries between learning, knowledge building, working and entertainment. They are also encouraging a shift from gamers as consumers to gamers as designers.

Serious games and virtual worlds provide immersive, three-dimensional spaces as new learning spaces (de Freitas 2008) that embed major principles of learning. At least many of the well-designed games address the needs of the younger digital generation (Prensky 2006) that conceptualise the world in a totally different way from previous generations showing affinity to technology-intensive, collaborative, entertaining and highly interactive multimedial experiences. Technology-based social interaction and networking are two fundamental elements of their needs profile and they satisfy these through participation in various on-line social networking environments and web-based communities. Also sharing learner-generated content is becoming a way of life for the digital 'natives' and the role of education is to take up these tools and help learners to become more skilful in these new ways of learning and knowledge building where gaming technologies converge with other digital technologies (Kiili 2005 a & b; de Freitas 2008).

The power of games comes from the underlying pedagogy that embeds learning within 'Play'. Playing a game is essentially an experience in self-learning that stands in stark contrast with teacher-driven instructional design approaches where learner adopts a consumer role (Papert 1998). Play is based on imagination, experimentation, exploration and role play accompanied by the need to stay aside creating a real and an imaginary private territory where one manages all activities, takes decisions, organise roles and tasks. Commercially available games

serve also as a virtual 'playground' where play is structured according to game rules and available tools where one can realise a play project experiencing the pleasure of building and destroying. But a lot of research evidence is needed to evaluate the possible advantages.

Through their multimedia nature games adapt to individual preferences and address the natural propensity of the digital generation of thinking in pictures and simulations (Gee 2007) emphasising visual rather than textual data (de Frietas 2008). At a more fundamental level they change the underlying epistemology from representation to simulation and enactment (Frasca 2003). Instead of descriptive accounts of expert knowledge and skill, epistemic games (Shaffer 2006) model expertise through authentic contextualisation and embodiment of human behaviour (Gee 2007). Pedagogically these visions look both interesting and challenging.

The complexity of the gaming experience led to a wide range of investigations about different aspects of games. Historically research about games evolved in parallel with the latest game design. With the rise of edutainment in the 80's, based on the behaviouristic drill-and-practice paradigm, research focused on extrinsic and intrinsic motivational aspects of gaming in an attempt to defining elements of game design that might be used to make learning environments more engaging (Bowman 1982; Bracey 1992; Driskell & Dwyer 1984; Malone 1981; Malone & Lepper 1987a, b). From a more cognitivist perspective, with the publication of Csikzentmihalyi and Larson's (1980) discussion of "flow," researchers investigated the power of video games to place users in "flow states", (Kiili 2005 a & b).

With the release of successful game genres like the line of "Sim" games, real time strategy games and simulations, the emphasis of research shifted to comparative studies about the effectiveness of games and conventional instruction (e.g. Randel, Morris, Wetzel & Whitehill 1992). The emergence of action and fighting games launched the (research) debate linking violent tendencies and aggression with playing games (Ellis 1990; Griffiths 1999; Anderson & Bushman 2001; Bensley & Van Eenwyk 2001). Throughout the 90's research focussed on the use of simulations and drill-and-practice games for learning in the military, schools, and industry (Thiagarajan 1998).

Within this context Gredler (1996) published her seminal work proposing a research paradigm for educational games and simulations claiming that very little empirical study has been done on how these

games are used and points to the fact that the existing research has failed to yield a useful research framework. At the same time Kafai and Resnick (1996) published their book about Constructionist approaches in using games for learning. Seymour Papert and Mitchel Resnick continued on this line of research, the former through the on-line environment and community at MaMamedia.com and the latter by providing researchers and practitioners with 'Scratch' – a game and simulation design toolkit.

With the introduction of powerful gaming consoles in the late 90's and at the turn of the century, the game industry was dominated by Fighting, "Shoot 'em up" and interactive fiction games. As a reaction researchers and game developers focused on writing games that capture the user with rich, interactive narrative and developing deep characters. The Games-to-Teach Project (2002) was launched as a research and development partnership between MIT and Microsoft with the specific objective to develop conceptual prototypes for the next generation of educational media for math, science and engineering education.

Research about games in the last few years focussed more on the intra-individual gaming experience specifically on issues of motivation in relation to needs satisfaction, user perception and identity. The emergence of Massive Multiplayer On-line Games generated a lot of interest and research about user experience (Yee 2006), experimentation with identity between real and virtual contexts (Mulcahy 1997; Griffen 2007) and learning in MMOGs (de Freitas 2006; Steinkuehler 2004, 2006, 2008). On-line virtual worlds became research contexts recruiting virtual subjects (Bainbridge 2007). Since the early 90's a number of investigations have taken a broad review approach (Berson 1996; Griffiths 1996, 1999; Emes 1997; Cesarone 1998; Dill & Dill 1998; McFarlane, Sparrowhawk & Heald 2002; Kirriemuir & McFarlane 2002, 2003, 2004; Mitchell & Savill-Smith 2004; Egenfeldt-Nielsen 2006; de Freitas 2008).

In this study the review of literature has been organised under three major categories. Research 'About games' reviews studies about normative aspects of games and their use focussing on gaming as a physical experience. Research 'With games' synthesises literature about pedagogical aspects of games and their use in educational contexts, considering interactions of learners with the world of ideas and conceptual artefacts. Research about the effects 'From games', elaborates on the intra-indi-

vidual gaming experience focussing on cognitive, affective and conative residues that give rise to beneficial and negative aspects of games.

The benefits of using games for learning are manifold. Apart from a number of physiological outcomes, games may enhance process intelligence involving perceptual analysis and quick decision taking. On the cognitive side, gaming can stimulates content related tasks such as creative writing or technology-enhanced design activities. The content of a game may lead to insights into the underlying domain model and stimulates explorations through negotiations, constructions and argumentation (Dillenbourg, Baker, Blaye & O'Malley 1996). Gaming also develops transferable skills like communication, teamwork, leadership and creativity (Prensky 2006; Kirriemuir & McFarlane 2004; Fitzgerald 2007; de Freitas 2008).

On the affective side, games develop self-efficacy by giving user a sense of control over the environment (Jones 2002). They offer experiences that are intrinsically motivating because they are based on personally meaningful goals whose attainment requires activity at a continuous optimal level of difficulty. The continual performance feedback provided by games boosts self-esteem by enhancing a sense of efficacy and empowerment over one's environment. Failure in games does not lead to irreversible long term effects, but stimulate gamer to work harder at developing the requested competence. Games have been also reported to reach under-served learners and learners with no previous interest in some domain. They could unlock a new enthusiasm for subject areas where traditionally few learners have participated (de Freitas 2006).

From a social perspective, the latest generation of games are promising in their power to evolve into a more collaborative experience addressing diverse user needs. Both contiguous and on-line multiplayer games are contexts where participants interact at the domain, gaming and community level in the process satisfying each others' needs for competence, relatedness, affiliation and self-actualisation. This may serve as a process for developing interpersonal and life-related skills that can give an enhanced feeling of social competence.

To enhance the educational value of the gaming experience, researchers recommend the provision of pedagogical scaffolding. Leemkuil (2006) proposes the use of the group in a gaming context as a pedagogical tool to enhance cooperation and collaboration through

debriefing and group discussions. Using a constructionist framework that promotes learning by designing, learning about systems and learning in communities, this investigation focuses on collaborative gaming involving different levels of individual and collective activities that promote learning and knowledge building through digital technologies along different dimensions. Collaborative gaming generates interactions along the domain determined by the theme of the game, interactions with the game both as a tool and as a medium and develops interpersonal and inter-group interactions. Thus collaborative gaming involves a complex system of interacting variables. It demands approaches that capture interactions at the experiential and metacognitive levels, along the domain, technology and community dimensions according to the level of competence of participants. The psychosocial processes operating in this context and the major factors influencing interactions in collaborative gaming have to be identified and possibly integrated in a pedagogical model. This will then serve as a tool to manage and evaluate collaborative game-based learning and offer advice for designing games that accommodate more to collaborative contexts.

1.2 The evolution of the research approach and context

Very much like a game, this investigation evolved through a series of levels each characterised by a decision making process and action proposals. My research game started at the undergraduate level writing of a dissertation about the development and evaluation of an instructional pack in Biology at secondary level. With the introduction of computers in the educational scenario, I shifted my research interests onto the role of computers as metacognitive tools. At Masters level I explored how learning differences and user's attitudes serve as critical factors in determining computer use. The focus was on how cognitive style influences the learning process and the implications this has for designing technology-enhanced learning environments.

This made me aware of the importance of metacognition in the learning process, both at the individual and social level, manifested as 'reflection-in-action' and 'reflection-on-action'. On a methodological level I became more convinced that learner's propensities could be better

identified and quantified through analysis of task execution rather than through self-reporting instruments. Artefacts such as written re-presentations and patterns of interactions involving approach or avoidance behaviours manifest more eloquently underlying learner cognitive, affective and social propensities than any other prescriptive methodology. This metacognitive reflection about individual propensities and motivations became a central theme in my research about learner engagement in technology-intensive collaborative learning environments.

I entered the third level of the research game with the specific objective of exploring the metacognitive dimension when learning with technology, going beyond their use for promoting domain knowledge and skills. This was reflected in the initial proposal I submitted for my PhD focussing on the use of 'The Computer as a Metacognitive tool 'considering that the real challenge lies in investigating how various digital technologies can be used to reflect on one's identity, one's learning propensities and their influence in promoting different forms of learning, knowledge building and social interaction. This research perspective was based on an underlying shift from an objectivist conception of knowledge and transmissionist methodologies, based on the 'mind as container' metaphor, to a connectionist epistemology promoting the 'rhizome or internet' metaphor of the mind. Thus learning is considered as the development of an elaborated and deep relationship with a particular domain and related 'community of practice'. The direct implication is that technology-intensive learning contexts, like collaborative gaming, should be considered from a process-oriented perspective integrating different dimensions and levels of interaction. Inspired by Bereiter's (2002) elaboration of Popper's three world model and the Constructionist Epistemology promoted by MIT scholars like Seymour Papert, Mitchell Resnick and Yasmine Kafai, a connectionist epistemology was thus adopted justifying the need for a process-oriented approach.

Bereiter extends the conceptualisation of knowledge and mind from the 'Situated Cognition' camp as a distributed network of ideas and relates this metaphor to Popper's (1972) three worlds model. These represent different aspects of the human experience – World 1 representing the physical world of practical action, World 2 representing the subjective or mental reality comprising one's idiosyncratic perceptions, thoughts, beliefs, attitudes and motivations, and finally the inter-individual World 3 of ideas that are entirely conceptual cre-

ations. These 'conceptual artefacts', such as a game or any other digital tool, are fallible but improvable, take on a life of their own, independent of their creators and they can be found to have characteristics, virtues and faults, implications and applications that their creators could not have foreseen. Bereiter extends this conceptualisation of Popper's World 3 of ideas to a 'workspace, as a sphere of activity' involving 'conceptual artefacts'. Games provide experiences across all three worlds: games as physical environments for interaction, gaming as an internal personal experience and games as conceptual artefacts serving as tools for knowledge building and sharing.

Such categorisation of human experience, especially the description of Popper's World 3 in terms of networks of conceptual artefacts, leads to a reconceptualisation of interactivity both as an intra-individual and social phenomena. The addition of World 3 makes the interactive scenario much more complex. 'There is the relation between theory and observation, between personal belief and observation, and between personal belief and theory. And there are the relations between different theories, different phenomena, and different people's readings of the same phenomena' (Bereiter 2002, 91). In this context, learning, understanding, knowledgeability, knowledge building, education and work manifest themselves as different modes of interaction within these three worlds. For example, the distinguishing factor between knowledge in an industrial society and that of a knowledge society is the shift for doing increasing amounts of work on conceptual objects rather than on the physical ones. Knowledge work is work that creates or adds value to conceptual artefacts.

Consequently education in the knowledge society is characterised as a process of enculturation into the world of conceptual artefacts, besides its complementary traditional role comprising interactions between world 1 and world 2. Learning accompanies all conscious activity directed toward World 2 through which one's state of mind is altered to achieve a gain in personal knowledge or competence (mental improvement). As a discourse aimed at World 2 dealing with the contents of individual minds, learning is manifested as a natural process of interaction when executing tasks (learning by doing) such as using a new tool, incidental learning, learning by failing, case-base learning, learning by reflection (Schank & Cleary 1995) or as an incidental outcome of knowledge building involving conceptual artefacts. Though it

might be interspersed with direct learning activity, knowledge building manifests itself as thinking of alternatives, thinking of criticism, proposing experimental tests, deriving one object from another, proposing a problem, proposing a solution or criticizing the solution.

Education as a process of enculturation into World 3 implies developing an understanding as an intense and elaborate relationship capable of supporting intelligent action with a particular conceptual artefact or a discipline, considered as a network of conceptual artefacts. Conceptual artefacts in turn become part of the environment serving as tools for the construction of new conceptual artefacts, leading to the emergence of progressive scientific disciplines.

But enculturation has also the social dimension, the integration of the learner into the community of practice. It means joining the ranks of those who are familiar with, understand, create, and work with the conceptual artefacts of their culture. Thus instead of considering understanding as the acquisition of mental constructs, it is conceived as a process of establishing evolving interaction patterns as a precondition of intelligent action and educating one's feelings to become an increasingly reliable guide. Understanding and mastery may then be treated as characteristics of such relationships, and the advancement of knowledge as the creating and improvement of conceptual artefacts (Bereiter 2002, 114). In practical terms understanding a particular domain involves different forms of knowledgeability and various levels of interaction with the domain and related community.

While traditional models based on the 'mind as container' metaphor emphasise declarative, procedural and conditional forms of knowledge, Constructionist models integrate all the three levels of the learning experience, addressing the external physical experience while interacting with the environment (physical tools and community) as a pre-requisite to other higher forms of learning and knowledge construction. Through the design approach, the competence and expertise in dealing with conceptual artefacts is developed. As a result of the interaction with World 1 and 3, the inner subjective experience is continually transformed and adapted for facilitating further its mediatory role between the two other worlds. Consequently the shift from the 'container' to the 'internet' metaphor of the mind and the adoption of Constructionist models of learning implies a shift from acquisition to participatory and contributory forms of learning.

Evolving from this connectionist frame-of-mind, the first paper published in this study (Part II, Paper 1: 'Metacognition within a Constructionist Model for Learning') explores the intimate interaction between epistemology, pedagogy and technology and how this determines the modality of interaction with the inner and outer world of individuals using particular digital technologies. It reviews literature about the role of metacognition in a Constructionist pedagogy, highlighting the role of reflection in the use of learning technologies in a knowledge society considering the three connectionist perspectives. Quoting different sources, metacognition is defined and discussed in detail in terms of metacognitive knowledge, skills and beliefs, which are then applied to the three aspects of a constructionist methodology: 'Learning by Design', 'Learning in Communities' and 'Learning about systems'.

The section about 'learning by designing' discusses the role of artefacts developed during inquiry-based learning and knowledge construction. In their role as inscription devices or 'objects to think with' for personal development, artefacts are an expression of the intra-personal processes (World 2 experience). As conscription devices, artefacts serve as 'objects to think with' in collaborative contexts serving both as physical objects mediating direct action (World 1 experience) and as attentional and conversational foci for knowledge building (World 3 experience). Artefacts can also serve as boundary objects to co-ordinate work across groups, time and space, and thus engage widely differing discursive and material practices (serving both World 1 and 3 aspects).

Metacognition is also explored in relation to 'Learning in Communities' elaborating on learning *From* others through apprenticeship, learning *With* others by participating in the social process of knowledge construction, and 'Mediating' others' learning as the highest level of learning within a community of practice involving the use of specialised tools and expertise. The influence of individual propensities in communication and learning arising from personality factors (approach or withdrawal tendencies) and information processing (verbal versus visual) are explored in relation to the collaborative process.

Learning about systems demands reflection on how to organise and impart domain knowledge and skills through a systems approach. At a deeper level this is concerned with the use of digital technologies as 'tool' systems for knowledge generation, elaboration, storage and dissemination. These systems should be adaptive to learner's cognitive

and affective needs capable of generating interactive patterns based on evolving user-tool interaction. Attitude to computers is one affective component that teachers and students have to reflect upon. At the highest level computers promote reflection on human learning, thinking processes and identity as a multiple distributed system.

This paper concludes highlighting recommendations from research about the importance of adopting an interactions-oriented approach within a constructionist framework using technology as metacognitive tools that use domain knowledge and skills as a platform for developing higher order transferable personal and social skills. This epistemological and pedagogical framework was used to organise this investigation about the use of games for learning in collaborative contexts considering games as artefacts capable of mediating experiences in the 3 Popperian worlds:

- As *physical objects* they mediate interactions with the real world through simulations or re-presentations of authentic scenarios. Eg. Simulators, Managerial and Real time Strategy games.
- As a *process* (gaming as a tool) triggering 'mental states' that mediate between world 1 and 3, and representing the inner world of individual experiences comprising idiosyncratic, internalised constructions based on personal cognitive, affective and conative propensities.
- As *conceptual artefact* promoting understanding through knowledge building thus providing users the opportunity to manipulate (create, test, discuss, modify) and develop individualised versions of the artefact.

1.3 Research tasks and the outline of thesis

The major aim of this investigation is to determine how the group condition can be used as a pedagogical tool for promoting learning and reflection through the use of digital games. Designing, managing and evaluating collaborative gaming contexts is a complex activity involving a range of mutually interacting variables. This investigation thus attempts to identify the factors that influence the various dimensions and levels of interactions in collaborative gaming and to integrate these into a coherent pedagogical model for analysing technology-intensive collaborative learning environments.

To gain insight about entry conditions for collaborative gaming, normative aspects of gaming had to be determined as these serve as good indicators of possible interactions in a group. Thus the first research question explores the major gaming tendencies and patterns of the student sample. In the group condition collaboration is in itself neither efficient nor inefficient but works under some conditions (Dillenbourg *et al.* 1996), thus this investigation attempts to determine the conditions under which collaboration seems to be efficient. For this purpose one has to vary these conditions systematically, considering interactions in an experimental group as the dependent variable and individual, group and task characteristics as the independent variables. Each of these independent variables comprises a number of subsidiary components that influence interactions in collaborative gaming.

Consequently the other three major research questions explore the influence of individual characteristics, group characteristics and game features on interactions during collaborative gaming. To implement the recommended process-oriented approach for analyzing such environments, a model (Section 2.6) has been developed that categorizes Task and Person-Oriented Interactions along three dimensions and across three pedagogical levels. This model also integrates three categories of factors (individual, group and task/game features) outlined in the research questions and identified by research as exerting major influences on interactions in collaborative groups. Hence the broad objective of the investigation is to use this model to identify the optimal conditions for effective collaborative game-based learning.

A number of instruments had to be developed for capturing the frequency and directionality of different categories of interactions in the various experimental conditions created by varying group composition and games used. The instruments will be used to develop interactions profiles for participants, groups and gaming sessions. Using different games with the same experimental group will give interaction profiles revealing the effect of game on the group. Conversely, using the same game with different experimental groups will disclose the pattern of interactions arising from group-based factors. These will be analysed according to the different experimental conditions to find out the influence of individual, group and game features on interactions.

The results will be used to develop a pedagogical model that can guide the design, management and evaluation of collaborative game-based learning, considering the gaming experience from a connection-

ist perspective involving experiential learning, metacognitive reflection and knowledge building. Another objective is to explore how this pedagogical model can be used both in designing games that are more adapted to collaborative contexts and to develop engaging experiences in other technology-intensive collaborative learning environment.

The decision to adopt the 'Publications format' for this thesis implied describing and discussing both the developmental process and products. Figure 1 outlines both the structure and process of this investigation. Part I of this document describes the conceptual and methodological evolution of this study. The major stages of this process were captured in papers focusing on separate key themes of the investigation. These papers are compiled in Part II of this document after being published in journals or conferences proceedings relevant to the theme of the investigation.

After the introductory discussion in Chapter 1 about the rational and evolution of the research approach and context, Chapter 2 elaborates on the theoretical framework of this investigation. The main motivations for using digital games are discussed section 2.1 using the Popperian framework. This is followed by a critical review of games and gaming (section 2.2) considering both beneficial and negative effects. Section 2.3 reviews the literature about games under three major categories. Research 'About' games reviews studies about normative aspects of games and their use, including results from the preliminary survey (reported in Paper 2) about key normative aspects of games and gaming of a sample of college students. Research 'With' games (2.4) focuses on pedagogical aspects of games and their use, or restrains to their use, in educational contexts. Research about the effects 'From' games (2.5) elaborates on learning outcomes, including beneficial and negative aspects. Literature was also reviewed regarding the proposed process-oriented methodology, about collaborative learning together with the individual and psycho-social processes underlying solitary and collaborative gaming.

The insight obtained through the reviewing of literature created the need to develop pilot investigations using small groups of students playing collaboratively identified games. Gaming sessions were recorded on video. Analyzing systematically these video recorded sessions and considering recommendations from literature, a process-oriented pedagogical model capturing interactions along the domain, technology (game) and social dimensions was developed to serve as a

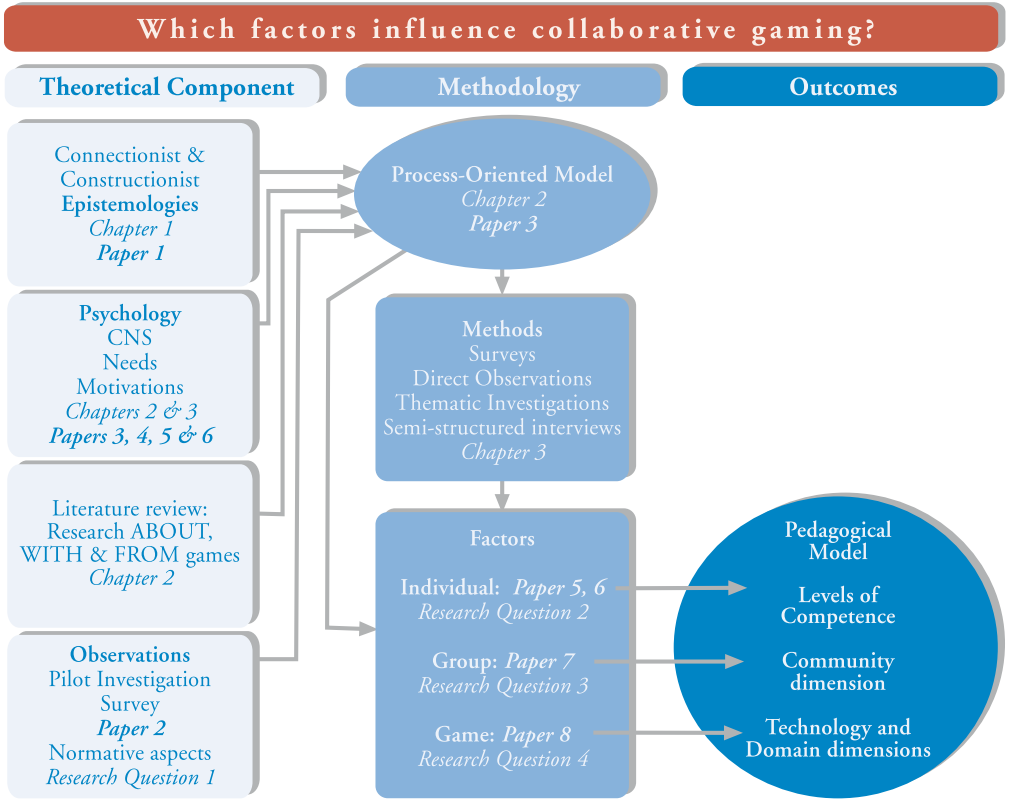


Figure 1: *Outline of the structure and process of this investigation*

framework for the main research investigation. This pedagogical model and related methodology are discussed in the Paper 3 and summarised in chapter 2, section 2.6.

At this stage the focus of the research activity shifted to identify the main factors determining interactions in collaborative gaming. Merging insights gained through literature review with those obtained from experimental settings, it became evident that individual, group and game characteristics influenced the gaming experience. The strong influence of gender on gaming was very evident and this was immediately explored in Paper 4 'Gender-based Neurocognitive Propensities influencing Gameplay: An Interactions-oriented approach'. This synthesises the literature from a Cognitive Neuroscience perspective linking it to relevant data from the survey about gaming patterns of college students. Through further research and experimental observations the various categories of interactions and the main factors influencing collaborative gaming were established. This enabled the formulation of the main research questions (section 2.7) that will guide the theme focused investigations.

Chapter 3 synthesises the adopted methodology starting with the elaboration of each major question into a number of subsidiary empirical research questions (3.1). Section 3.2 outlines the preliminary survey that explored the normative aspect of gaming in relation to the physical gaming experience. The following section (3.3) discusses the organisation of experimental setting and the procedure used in developing theme focussed investigations. Section 3.4 describes the investigations carried out about the intra-individual gaming experience integrating Paper 5 that gives an in-depth analysis of the attitude to gaming of college students and Paper 6 about the major individual characteristics (personality type, gender, attitude to gaming, gaming competence) that influence interactions in collaborative gaming. The influence of group composition is discussed in section 3.5 in relation to Paper 7 which elaborates on the 'Community' dimension of the proposed interactions-oriented model and establishes the major group characteristics influencing interactions. Section 3.6 outlines the last set of investigations about games as physical and conceptual artefacts reported in Paper 8. This paper elaborates on the methodology for investigating the 'deep' structure of games focussing on the influence of various game features on user perception and interactivity. The last

section (3.7) evaluates the instruments and procedures used in the theme focussed investigations, and discusses the reliability and validity of both the approach and underlying integrative model.

Chapter 4 compiles all the results from the different investigations and synthesises the main trends that impact pedagogy and game design. In Chapter 5, section 5.1, these are integrated in the original interactions model which is discussed in relation to the design and management of collaborative game-based learning. Section 5.2 proposes various pedagogical elements that should be integrated in the design of future group-oriented games or used in other technology-intensive collaborative learning environments. The investigation is evaluated in section 5.3 and implications for future research are elaborated in section 5.4.

2 GAMES FOR LEARNING AND KNOWLEDGE BUILDING

"The potential uses of games, simulations and virtual worlds are many and varied and it will be interesting to see how these are exploited within academic research and teaching circles over the next years. Will the emphasis upon collaborative learning lead to new teaching and learning models, will learners more generally become the 'authors' of their own learning materials? Will tutors become the choreographers of learning experiences through designing activities and scenarios, and through mentoring?" de Freitas (2008, 70).

The theoretical framework underpinning this investigation is based on a sound review of literature about the diverse aspects of games and gaming, together with that about collaborative learning. The first section of this chapter justifies the use of games for learning and knowledge building considering gaming as a multi-dimensional experience that is best described through Popper's three world model. The difficulties encountered in educational contexts to implement a game-based learning approach are then discussed followed by an analysis of research about the negative effects of gaming. The literature review about games is organised into three sections: research ABOUT games, research WITH games and research about the effects FROM games. The second part of this chapter synthesises research about collaborative learning contexts that was discussed in greater detail in the published papers included in Part II of this document.

2.1 The multi-dimensional gaming experience

This section organises the discussion about gaming around the Popperian model considering the educational benefits and shortcomings of using games for learning and knowledge building. The objective is to justify the use of games for this investigation while promoting the rationale behind the proposed game-based pedagogy.

2.1.1 Games as mediators of interactions with the physical world

Games are external concretisations of the larger natural 'Play' phenomenon that is an essential component in the developmental process of all higher animal groups. Leemkuil (2006) gives a chronological description of how play was manifested over the ages through different types of games that were used for pleasure, to train certain motor or mental skills and to transfer knowledge. Farné (2005) discusses extensively play from an anthropological perspective manifested as a lifelong gaming endeavour of becoming playful through play.

In fact for Farné our identity depends on the games we played in our childhood and how much time we played. Farné discusses two models of play. As a 'verb' or process, play is a "primary energy" to be used (exploited) at its best for children's growth and this requires careful evaluation, manipulation and transformation processes. Play is a fundamental experience in self-learning. Papert (1998) discusses how games are a pedagogy based on self-directed learning that stands in stark contrast with the teacher-driven instructional/curriculum design approach where learners adopt a consumer role. Designing games is one aspect of this play dimension.

Farné's second model considers play as a 'noun' (or object) and moves the opposite direction. It is a free space (and time) that children fill in with their play project where they can experience the pleasure of building and destroying. This serves as an environment offered by adults in which they intervene only in supportive ways using it like a device functional to the learning process, so as to improve its quality (Hakkarainen 1999). Commercially available digital games are a concrete example where a child enters into a virtual "playground' that makes it possible to find innumerable playing scenarios and whose boundaries cannot be objectively defined.

As a constructivist and constructionist learning process (Rabinowitz 1993; Papert 1980, 1993; Kafai & Resnick 1996; Ackerman & Archinto 2001), play is always accompanied by the need to stay aside, creating a private territory (both real and imaginary) which enables escape from all interferences by adults offering gamers the possibility to be by themselves and act accordingly, to organise an activity and to take decisions, to establish roles and tasks within a situation that must be shared to become real.

Play characterises the whole life of human beings many times involving a shift from play activity to a play-like activity. From a pedagogical point of view this means a shift from using play as a device for preparing materials and teaching activities aimed at facilitating and making attractive identified learning outcomes, to a situation when play becomes a category, a style, when certain learning processes are based on research and exploration. Such experiences are triggered by curiosity and cognitive adventure, which makes individuals understand the sense and the value of what they are learning, as a significant experience *per se*.

For Kirriemuir and McFarlane (2002) since playful learning emphasizes experiences such as experimentation, exploration, trial and error, imagination, role-play, and simulation of experience, it might be possible to develop environments for learning based on these activities. This reconceptualisation of children as bearers of expertise, as capable of acting in the role of expert, raises serious questions about how we currently structure learning experiences in schools. It represents the pedagogical shift from learning to knowledge building.

Digital games offer a promising interactive environment that realises this pedagogy. Squires (2002) considers them as 'the most fully realized educational technology produced to date' that accommodate splendidly the epistemology and innovative pedagogy of self-directed learning and working in a knowledge society. Shaffer (2006, 126) claims that Dewey's model of learning through active engagement in meaningful activity depends on the *medium* in which the activity takes place – that is on the tools and materials with which the student is working. 'Digital games make it possible for more people to learn about the world by participating in a wider range of meaningful activities than is possible with traditional materials alone,' (Shaffer 2006, 128) or using other digital technologies.

Playing game genres that have an educational orientation like Real Time Strategy (RTS) games, managerial or simulation games provides an experience that is fundamentally different from didactical approaches; didactical refers here to sequential, teacher-centred and behaviourist model of learning. They are based on an epistemological shift from 'representing' to 'simulating' reality (Frasca 2003) which demands a corresponding shift in underlying pedagogical models that mediate learning and understanding through direct action involving both 'reflection in action' and 'reflection on action'. Both classroom

and technology-intensive instruction are still profoundly didactical in nature, assuming a teacher-student relationship with emphasis on the acquisition of abstract decontextualised knowledge and skills. On the other hand games provide contexts where users employ their natural learning capabilities (Schank & Cleary 1995).

By merging the fundamental learning ingredients - fun, play, rules, goals, winning, competition and community aspects - games propose extremely motivating learning and socialising contexts where these natural modes of learning are nurtured, refined and shared with others (de Freitas 2008). Gee (1996, 2004, 2005 & 2007) discusses in great detail how games impact learning and concludes that games are powerful learning machines that integrate elegantly into their very design many theoretical islands, learning principles and findings from cutting-edge research in the Learning Sciences into a coherent (gaming) pedagogy.

Most games offer environments that combine auditory, visual and tactile stimulation capable of creating highly immersive experiences. In fact games present learning in the most natural 'format'. While teaching relies heavily on phonic, articulatory and iconic aspects of language, games offer imagery as their fundamental communication medium with language having reinforcing functions. Evolutionary language is a relatively recent development, whereas visual information has been used for memory processing for most of mammalian evolutionary history (Lieberman 2002). This dependency on visual information appears to have given visual imagery and visual thinking a privileged status in our cognitive processing, resulting in a basic tendency to translate verbal information into visual images.

Digital games exploit this neurocognitive dimension of our brains maximising the comprehensibility and retrieval of information. Gee (2007) maintains that information retrieval is not in the form of separate and disjointed memory reconstructions but more as simulations and re-enactments. 'For humans, effective thinking is more like running a simulation than it is about forming abstract generalisations cut off from experiential realities,' (Pg 25). 'Good video games can externalise good thinking and problem solving' (Pg 4). This explains why simulations and games are highly effective and efficient media for transferring World 1 into World 2 experiences. Through their multimodal appeal and their exploratory approach, games establish very elaborated memory residues that can be rapidly accessed and re-con-

structed enabling gamers to 're-live' the experience in a holistic and vivid way.

One must put these positivistic commentaries in the right perspective complementing them with findings from empirical research and corroborating them through pedagogical practice. The distinction between using games for entertainment and their use for educational purposes should always be kept in perspective. This will be further discussed in the following sections and in the literature review. Section 2.4.1 focuses on the debate about the educational effects of games in different areas of the curriculum criticising assumptions about direct relationships between use of games and learning efficiency or educational benefits.

2.1.2 Games as an intra-individual experience

Games can serve as introspective tools to reflect about the personal experience of learning by comparing and contrasting established behavioural and thought patterns with innovative ones. Most important they promote reflection about the influence of individual traits on learning and how these tools address a range of user needs.

(a) Addressing the learning needs of the digital generation

Young learners living in a technology-permeated knowledge society, in which entertainment and play are an essential ethic, experience life in fundamentally different ways from previous generations (Prensky 2001; 2006). Digital tools, and the range of functionalities they mediate, are considered as indispensable components of their life style each satisfying some specific need. Entertainment, immediate access to information, a sense of connectedness, the sense of relatedness through extensive social networks, sharing information and knowledge are the identity norms of the digital generation.

This situation raises a number of questions regarding both the content and the process in formal education. Print-based media and instruction are becoming increasingly incompatible with the learning needs of the 'twitch' generation nurtured on digital games and media. Spending so many hours playing at 'twitch speed', students are bored by conventional media and likely to be attracted to courses that address their deeply imprinted interest in video games. Prensky

(2001) claims that immersion in the hi-tech environment is actually 're-wiring' the brain of young learners and redefines its mode of operation in fundamentally different ways from those of previous generations. These 'Digital Natives' are used to rapid, parallel information processing based on multi-tasking. They prefer a 'graphics *before* text' strategy when learning, rather than the opposite and prefer networked environments that offer random access. They thrive on instant gratification and frequent rewards and thus prefer games to "serious" work or work situations with strong elements of gaming. In contrast, the older "Digital Immigrants" (teachers and parents) are apprehensive to technology and tend to adopt book-based, sequential and secluded approaches to learning.

Deriving inspiration from Mead (1970) book about culture and generation gap, Selfe, Mareck and Gardiner (2007, 28) discuss extensively this cultural conflict elaborating on the concept of 'Intergenerational Disjuncture' comparing the three distinct cultural styles, each distinguished by the ways that the younger generation are prepared for adulthood. The 'post figurative' style, characterising pre-industrial societies in which change is largely imperceptible and the 'future repeats the past', considers education as the passing down of traditional values and knowledge through an adult-teacher. The second style, the 'co-figurative', characterise industrial societies where some form of disruption is experienced by society making the older not any more the experts. Therefore the young look to their contemporaries for guidance in making choices rather than relying on their elders for expertise and role models in a changing world.

The third cultural style is the 'pre-figurative' symptomatic of a fast changing (post-industrial) society that exists without models and without precedent. Change is so fast that neither parents, nor teachers or highly skilled and professional people can teach the young what they need to know about the world. Neither the elders nor the experts can provide models for the future. The authors emphasise the responsibility of adults in addressing the emerging needs of youths in a pre-figurative society claiming that the answers to their dilemmas are not the ones being offered in schools that are still embedded in a post-figurative framework. Papert (1998) has already anticipated the time when standard predetermined curricula will be replaced by learner designed ones. Gee (2007, 6) points to the inverted roles that has happened between himself and his son Sam confirming the reversed learning

trends where the younger first learn for themselves and then teach the adults. Games are an integral part of this digital pre-figurative social setup and thus should be an integral component of the educational process.

(b) Educational outcomes

Games promote different forms of learning that form an essential part of the individual experience. This section organises the discussion around three categories of beneficial outcomes of games, mainly physiological, cognitive and motivational.

Physiological outcomes

Research revealed a range of physiological positive effects from gaming including increased visual processing and acuity, refined eye-to-hand co-ordination and refined hand movements (Egenfeldt-Nielsen 2006). BBC Health News (2008) describes the therapeutic use of the Nintendo Wii gaming console, dubbed Wii-habilitation. Players can test their skills in tennis, boxing, and golf among others, a type of gameplay that is seen as an excellent means for improving strength, endurance and co-ordination in those who have sustained serious injuries. Various social groups are benefiting from this innovative approach including overweight children, stroke patients, war victims and the elderly. Specialised Wii-mediated exercises with victims suffering from brain injuries stimulate undamaged nerve cells to create new pathways for messages to the limbs helping the brain relearn this mechanism.

Cognitive outcomes

Research points to a range of positive cognitive benefits from gaming. McFarlane, Sparrowhawk and Heald (2002) contend that games provide a forum in which learning arises as a result of tasks stimulated by the content of the games, knowledge is developed through the content of the game, and skills are developed as a result of playing the game.

Regarding tasks stimulated by game content, the report mentions the role of games in creative writing where characters or scenarios from games promoted a high degree of engagement with the game and the perceived authenticity of the game's context provided jumping off points for other activities. These factors could also be used to

stimulate creative work in other areas such as art and design, technology and in some cases science. In addition teachers could use pupils' extensive games experience outside school as a starting point for work in school. Though games stimulate a lot of 'off game' creative work (designing characters, game environments, accessories, avatars etc.) which are then uploaded and promoted in 'affinity spaces', research in this area is very sparse.

The second learning outcome, that is, knowledge developed through the content of the game, opens a big debate from a research perspective. Squire (2004) points to the fact that very little knowledge is acquired through games and concludes that video games are interesting not for their content but for the way new explorations initiate negotiations, constructions, and journeys into knowledge. Brown *et al.* (1997) found that, though the game *Packy and Marlon*, aimed to promote self-care amongst diabetic children, improves a lot their motivation and self-care behaviours, it did *not* improve their knowledge on diabetes significantly.

Leemkuil (2006, 269) quotes Randel, Morris, Wetzel and Whitehill (1992) who examined 68 studies directly or indirectly on the difference between simulations or games and conventional instruction in student performance. Seven out of eight studies involving math found that the use of computer games is superior to traditional classroom instruction for improving math achievement. Subject matter areas where very specific content can be targeted and objectives precisely defined are more likely to show beneficial effects of gaming. Furthermore, they conclude that simulations/games show greater retention over time than conventional classroom instruction, and that in 12 of 14 studies, students reported more interest in simulation and game activities than in more conventional activities.

Leemkuil quotes two other studies having methodological robustness in contrast to Randel *et al.* (1992). Wolfe (1997) who reviewed only studies in which a computer based general management game was used to teach predefined strategic management learning outcomes, reports that in every study the particular gaming application that was used produced significant knowledge-level increases. When the business game approach was pitted against the case study approach, which is the major alternative teaching strategy in strategic management courses, the game approach was superior to cases in producing knowledge gains. In another study Klawe (1998) summarizes the results of

the Electronic Games for Education in Math and Science (EGEMS) project aimed at exploring the potential of specially designed electronic games to increase learning and appreciation of mathematics and science by children in grades 4-8. Klawe concluded that it is possible to design computer games that students aged 9 to 13 greatly enjoy playing and that are very effective in helping students understand mathematical concepts. Relatively small changes in design, however, can strongly influence the extent of the effectiveness.

The third learning outcome mentioned by McFarlane, Sparrowhawk and Heald (2002) considers skills arising as a result of playing the game. Playing games gives rise to a range of psychological benefits especially related to process intelligence. Green and Bavelier (2003) showed that action video game playing is capable of altering a range of visual skills and that the growth of these skills is not a result of self-selection (i.e. not because subjects with superior visual abilities tend to prefer playing video games). Subjects with little or no video gaming experience showed significant improvement on the benchmark tasks after playing just ten hours of a first person-shooter video game. Playing action games develops players' 'visual selective attention' manifested as the ability to concentrate on the most important things and filter out the rest (Prensky 2006; Green & Bavelier 2003).

Prensky (2006, 35) also claims that research points to a number of thinking skills enhanced by repeated exposure to computer games and other digital media. These include 'representational competence' - reading visual images as representations of three-dimensional space; 'multidimensional visual-spatial skills' - the ability to create mental maps and do mental paper folding; 'inductive discovery' - acting like a scientist by making observations, formulating hypotheses, and figuring out the rules governing the behaviour of a dynamic representation; 'attentional deployment' – the ability to focus on several things at the same time and being able to respond faster to unexpected stimuli. Prensky claims that while individually these individual cognitive skills may not be new, the emerging combination and intensity is a characteristic of the 'Digital Natives'.

On a more pedagogical orientation Kirriemuir and McFarlane (2004) reported that teachers and parents recognize that games play can support valuable skill development, such as strategic thinking, planning, communication, application of numbers, negotiating skills, group decision-making and data-handling. Jacobs and Dempsey

(1993) claim that games improve practical reasoning skills, develop higher levels of continuing motivation, and reduce training time and instructor load. Hogle (1996, 11) states that simulations and games may improve several types of cognitive learning strategies like organizational strategies (paying attention, self-evaluating, and self-monitoring), affective strategies (anxiety reduction and self-encouragement), memory strategies (grouping, imagery, and structured review), and compensatory strategies (guessing meaning intelligently). On a cautionary note Leemkuil (2006) concludes that several authors have questioned some claims because of a lack of sufficient empirical support considering that much of the work on the evaluation of games has been anecdotal, descriptive or judgmental.

Research also focused on transferable skills - the short and long term cognitive and affective residues that result from the gaming experience. The comparative aspect of this research compares and contrast gamers with non-gamers. Other investigations focus on the conditions required to develop specific skills.

On the basis of the survey done about game use in schools, Kirriemuir and McFarlane (2004) point to the different skills profile developed in gamers. Gamers' expectations of learning activities are changing radically shifting their preference for tasks that are fast, active and exploratory, with information supplied in multiple, parallel forms. They also point to the fact that traditional school-based learning may not be meeting these demands.

The skills profile of gamers is much more discussed and researched beyond the formal educational process. Prensky (2006) claims that computer and video gamers are better than non-gamers at 'situational awareness' manifested as taking prudent risks in business. Game players get good at taking information from many sources, pulling together data from many places into a coherent picture of the world and making good decisions quickly. Not only do game players learn thinking, collaboration and other skills, but they begin to acquire them at a very early age. Saunders (2007) claims that immersive world applications like games have the potential to support communication between learners, to support problem-based learning opportunity and to support exploratory learning experiences.

Beck and Mitchell (2004) elaborate on how gamers are more successful in business than non-gamers. Regarding personal skills video game-players are committed to professional excellence, put a high

premium on skill and adding value, have a strong sense of competence, love data, are comfortable taking measured risks, multi-task well, learn on the fly, think globally, see the world through the lens of competition and expect themselves to actually deliver. Their social skills include collaborative problem solving, have both highly developed teamwork skills and the desire to be part of a team, care about their organisation and yet don't count on fixed organisational structures. According to the authors these transferable professional skills are developed because gamers have amassed thousands of hours rapidly analyzing new situations, interacting with characters they don't really know and solving problems quickly and independently in a world that has also emphasized tangible results and given them constant, critical feedback. Fitzgerald (2007) discusses how gamers also tend to be more loyal to their companies and are likely to want to work with others more than non-gamers. de Freitas (2008) highlights communication, teamwork, leadership and creativity as the particular skills supported through gaming.

Research about the transfer of specific skills is quite controversial. Referring to a number of studies that connect problem-solving with video games, Egenfeldt-Nielsen (2006) argues that research about the development of problem-solving skills has received much attention over the years. He concludes that problem-solving might improve between video games, are predictive of better performance in a video game (Ko 1999) but it is hard to transfer the improvement to contexts other than video games. On the same vein Kirriemuir and McFarlane (2004) cautions about the perception that the exploratory approach, built in strategy or adventure games giving users a high degree of control, translates into the development of logical thinking and problem-solving skills. They argue that to date much of this research relies on inference from the structure of computer games and psychological theory rather than direct and sustained empirical evidence. It is still doubtful whether gamers are in fact able to move from intuitive problem solving in the game to an understanding of effective processes for identifying problems and generating hypotheses and solutions in other contexts.

Other research has identified that use of computer for gaming may play a significant role in developing effective use of computer-mediated information resources especially programming, problem-solving skills and enhanced self-directed problem-solving. Mackereth (1998)

suggests that familiarity with, and interest in, video games can influence children's confidence when using computers for more professional applications and that children unfamiliar with video games may not develop the skills necessary to relate with electronic media, such as dealing with dynamic visual change, parallel processing of multiple streams of information and the ability to experiment in free-form, ill-defined problem domains. Children's early interactions with computer games encourage them to develop a playful approach to computers (Downes 1998) which develops the expectation that 'trial and error works', and that linear progressive models for using computers (such as those characterized by worksheets or computer manuals) are often the least effective way of engaging with computer-based technologies (Facer *et al.* 2003). Massanari (1998) also records teachers' concern that gaming in schools may make it harder to engage children with the computer as a tool in more conventional learning tasks.

Motivational outcomes

Research focuses on two aspects of motivation in relation to games. One direction considers extrinsic motivation focussing on the influence of games' appeal on adoption and use by different social groups. This is discussed in section 2.3. The other research perspective focuses on the intrinsic motivational benefits of games comparing the gaming condition with other media or instructional contexts and also explores motivational benefits resulting from the gaming experience *per se*.

On the comparative side, Oyen and Bebko (1996, 187) studied the development of memory enhancing strategies in young children (7-9 years) by embedding a memory task in a computer game context and comparing it to a more formal "lesson" context. The researchers found that the game contexts stimulated much greater observed rehearsal and that rehearsers recalled more items than non-rehearsers in both contexts. But recall in the games was less than for the lessons. The authors assume that the game condition, while more enjoyable and interesting for children, was also more difficult. The added complexity and the distracting features inherent in the games may have combined to make the task more difficult, resulting in the decreased recall performance of the non-rehearsers.

Lieberman (2001) found that children playing a video game for 30 minutes expressed more enjoyment and learned the same as those

watching an educational video for 30 minutes. While TV conveys all information at once, the video game delivered a limited amount of information in 30 minutes compelling players to repeat game several times. The researcher concluded that though the game is less efficient on a time basis at imparting information, this compensates by enhancing motivation facilitating replay that leads to complete knowledge acquisition.

Colley (2003) confirms that boys obtain greater experience with computers at home than girls quoting Comber *et al.* (1997) and Shashaani (1994) and asserts that much of this experience is acquired with computer games, which boys play to a far greater extent than girls. These trends are confirmed by the Eurydice report (2005) providing evidence that across Europe the attitudes of boys vis-à-vis the use of ICT differs from that of girl (boys are more attracted to ICT and use it more freely) because of their longer exposure to ICT and games.

Brown *et al.* (1997) found that players using an educational video game for juvenile diabetes improved on self-efficacy, communication with parents about diabetes and self-care behaviours. This study is notable because it shows that a video game can have a direct impact on everyday self-health management. The researchers point to the motivational benefit of the game and to the lack of knowledge acquisition regarding diabetes. Quoting various sources, Egenfeldt-Nielsen (2006) refers to similar findings on the educational use of health games.

Regarding the intrinsic motivational benefits resulting from the gaming experience, there is a widespread agreement amongst researchers about the motivation pull of games (Ryan *et al.* 2006) and its link to learning. Leemkuil (2006) claims that the fast growth of the use of digital games has led to renewed attention to the role of game play in education and to scientific research that could be used to design games. People play games because they are intrinsically satisfying (Malone & Lepper 1987a & b) by providing optimal level of challenge, provoke sensual and intellectual curiosity, develop competencies and provide 'fun'. Gamers are challenged when they have to work towards personally meaningful goals whose attainment requires activity at a continuously optimal level of difficulty. In games tasks are hard but doable (Gee 2007). They provide continual performance feedback in different ways which boosts self-esteem by enhancing a sense of efficacy and power over one's environment. This in turn enhances the sense of control over the tool and the gaming task (Jones 2002).

Games empower users to produce a desired amount of a desired effect, give them insight into cause-and-effect relationships both within the game and more important between the virtual and real worlds. Games also enhance user's sense of control by providing choice – which tasks to do and how. This results in a cascading effect. An increase in performance promotes one's sense of competence which in turn boosts self esteem and *autonomy* which is considered as a sense of volition or willingness when doing a task (Deci & Ryan 1980; 2000). Ryan *et al.* (2006, 350), claim that "Perceived competence is among the most important satisfactions provided by games, as they represent arenas in which a person can feel accomplishment and control."

This accomplished sense of competence can then be used to compete. Games are motivating because they allow competition within a safe environment. Through various possibilities gamers experience satisfaction by comparing their performance with that of others. Failure in games does not lead to irreversible long term effects, but stimulate gamer to work harder at developing the requested competence. The task is hard but doable through increased effort and exercise. Gee (2007) considers this 'Performance before Competence' as an essential learning principle. When the requested level of competence is achieved, games recognise this through a number of built in feedback features.

From a social perspective, games are becoming more motivating because they are evolving into a more collaborative experience where gamers feel satisfaction by helping others achieve their goals. In both contiguous and on-line multiplayer games participants interact at the domain, gaming and community level in the process satisfying each others' need for competence, relatedness, affiliation and self-actualisation. Through this experience interpersonal and life-related skills are developed giving an enhanced feeling of social competence.

The fun factor is the strongest motivational element in games. Bartle (2004) emphasise that people play games because they are seeking 'fun'. This fun or pleasure principle arises because games offer pedagogically holistic experiences by integrating cognitive, affective and intuitive aspects of learning in line with Damasio (1994) emotional tagging theory. Gee (2007, 10) points out that pleasure is inseparable from deep learning and hard work.

At the affective level, games increase fun by stimulating curiosity and fantasy. Sensory curiosity results from abrupt changes occurring in the gaming environment involving music, evolving scenes, com-

mentaries or humour. Cognitive curiosity is stimulated by task-related interactions that cause cognitive disequilibrium as a result of optimal level of discrepancy between current level of knowledge or skills and a more advanced one, a situation that creates the most favourable enticing conditions for learning.

In addition to cognitive stimulation, games are attractive due to their emotional activation resulting from immersion which is associated with *presence,* (Lombard & Ditton 1997; Rigby 2004) or 'the sense that one is within the game world, as opposed to experiencing oneself as a person outside the game, manipulating controls or characters' (Ryan *et al.* 2006). A gamer enters a state where one ceases to be aware of the physical self, focuses intensely on task leading to a distorted sense of time and effortless action. Games create this immersive experience through stunning photo-realistic graphics, surround sound effects and animated characters that are part of a spectacular game environment. The experience in the game is made 'more real and authentic, both by creating a compelling story line and graphic environment, and by making controls as "intuitive" or user-friendly as possible' (Ryan *et al.* 2006, 350). They define 'intuitive' as the degree to which game controls make sense, are easily mastered, and do not interfere with one's sense of being in the game.

Immersion is enhanced by fantasy, the suspension of disbelief (Frasca 2003). Gamers playing the role of fictitious characters in fictitious past (medieval, *Dungeons and Dragons*), contemporary (*World of Warcraft*, *Second Life*) and futuristic (*Star Wars*, *Star Trek*, and other science-fiction) environments, suspend their real life unbelief regarding these characters and environments, and just for the gaming session behave and interact with them as if they really exist in the virtual world. This environment provides gamers with the optimal conditions for experimenting with various 'projective identities' (Gee 2007) that inspires reflection about the 'real identity'. Prensky (2001, 62) discusses how fantasy, as a characteristic of the digital generation, forms an integral component in technology-mediated social environments. Gee (2007, 32) discusses how good games promote fantasy by offering identities – either as an intriguing character to be inhabited or as an empty character to be modelled and for whom a life history is to be developed.

Lombard and Ditton (1997) related the experience of presence to Csikszentmihalyi's (1990) concept of *flow* that is associated with intrinsic motivation. *Flow* is described as the feeling of optimal experience

that is felt when "...instead of being buffeted by anonymous forces, we do feel in control of our own fate. ...we feel a sense of exhilaration, a deep sense of enjoyment" (Pg 3). Most often flow in learning occurs at times when outside forces do not dictate what is to be learned. In computer games, certain features like good graphics, nice music, visual effects, and interesting animations are aesthetically pleasing, but do not necessarily contribute to creating a good game based on enjoyment – the feeling of forward movement, or a sense of accomplishment. Kiili (2005a & b) discusses in detail this entire process referring to flow antecedents, flow experiences and flow consequences.

Researchers (Lombard & Ditton 1997; Gee 2007; Prensky 2006; Shaffer 2006) insist that what makes a game enjoyable is a good problem that is manifested appropriately. It does not matter if it is rendered realistically, but that it is rendered in a manner consistent with the problem. In fact many researchers object to the principle underpinning edutainment that attempts to merge learning with fun based solely on extrinsic motivation. Section 2.4.1 discusses this issue pointing to research criticizing the underlying 'Learning by Stealth' approach, claiming it is too simplistic both at conceptual and design levels, ethically unacceptable by tricking students into supposedly learning experiences and does not have valid beneficial effects.

Good games are enjoyable because they are based on a model specifically designed to promote insight into the domain simulating authentically all problem situations. Enjoyment comes from playing roles demanding expertise in the game environment thus behaving like a professional. In *Flight Simulators* one behaves like a professional pilot, in managerial games gamer 'plays god', in *Food Force* one has to carry out specialised missions typical of a humanitarian aid expert, while in *Full Spectrum Warrior* or in *Oblivion* gamer has to act the role of a professional soldier.

Besides extending the area of effectiveness within some domain of expertise, games serve also as tools for promoting insight and empowerment over the social environment by promoting social metacognition (Jost, Kruglanski & Nelson 1998).

(c) Games as tools for reflection about society

Games provide the most valid metaphor for representing how people construct reality through narrative and argumentation. Learning

should not differ from this social construction of reality (Berger & Luckman 1966) and should be based on the same strategy. Learners create accounts of the world as stories or as arguments using an agreed medium and symbolic system that help them arrive at valuable understandings (Jost *et al.* 1998). Well designed games simulate faithfully this process of reality construction by integrating and interchanging narrative with argumentation.

Important aspects of the game of life are re-presented and re-enacted when playing different genres of games, especially in collaborative contexts. Games provide the contexts where people practice and re-live the same dynamics that are experienced in reality giving the possibility of reflecting 'in' and 'on' action.

But games are also excellent tools for promoting individual and collective reflection about culture (Gee 2007). While accommodating to sub-cultures that determine learners' identities, at the same time, established cultural models are challenged (Wright 2004). Reflection brings about cultural accommodation by integrating the diverse identities established in the different communities to which one belongs and creates a core identity. Descriptors like the digital generation, the gaming sub-culture, the mobile driven young generation or the entertainment-oriented people, refer directly to a core identity or a conglomeration of various identities acquired through diverse social affiliations. These social 'typifications' (Berger & Luckman 1966) exert stronger influence on younger people than formal educational and training institutions, and thus are regarded by them as more relevant. Learning experiences should integrate and build upon these typifications and never create tensions by discriminating one from the other. If the learner experiences conflicts with these different identities, for example between the classroom and gaming contexts, then the most natural outcome would be to prioritise such experiences using affective criteria. The 'class is boring ... games are fun' mentality manifests this duality.

Good games also challenge established cultural models by creating both faithful and fictitious scenarios that can serve as powerful pedagogical tools for creating alternative models and value systems and thus promote comparative reflection. Games like *SIMS*, *World of Warcraft* and *Second Life* create 'sub-universes of meaning' where, through role-play, one can experiment and reflect about cultural models, theories and belief systems. For example, the game *SIMS* facilitates the assimilation of the American middle-class value system by creating an imag-

inary environment where gamers build a typical middle-class family, within a neighbourhood practising middle-class values and aspirations. Gee (2007) emphasises that content in video games either reinforces or challenges players' taken-for-granted perspectives of the world. He also claims that video games have an unmet potential to create complexity by letting people experience the world from different perspective. This is mainly done through acting as a given character in a particular virtual world simulating specific cultural models.

In the game *Under Ash* one challenges culture models built around the Israeli-Palestine conflict. Gamers separately act the role of Ahmed (a Palestinian boy throwing stones at Israeli soldiers), an Israeli settler and a neutral journalist investigating the conflict. The double role of allowing gamers to play god with virtual people and then share this experience with real people, opens up a different understanding of what a game is and how real life itself is very much like a game. The underlying principle is not about feeling in control for manipulating the lives of others, but more about the use of the game as a metacognitive tool – doing actions that promote reflections about one's own life.

The difficult task of building and managing the complex social, emotional and economic well-being of people in real life can be done safely in a virtual environment and this can teach people some profound lessons about life. Will Wright the creator of SIMS describes how parents observed the change in their children's perception of life and relationships after playing *SimCity* and *The SIMS*. The games make unconscious decisions that we take in life apparent by projecting them onto characters or environments and make them react accordingly. For Wright (2004, 1) a game like *SIMS* gives people a different lens through which they can look at life:
"By building your life into a toy, it enters your consciousness. People start to see the juggling act. They wake up a bit more and see that they have been playing this game in real life, but never realised".

When scholars and educators criticized the darker side of SIMS life including criminal elements (the SIMS Mafioso), prostitution and thieves, Wright reacted in a positive way claiming it a genuine simulation of reality and thus merits deep reflection. 'It makes the game more interesting. It is pretty playful and harmless, it is something our society is grappling with…We need to learn to live with it as a society.'

The added value of such gaming scenarios is not just becoming aware of social problems and their impact on citizens. Gamers own such problems and through reflection they grapple with possible solutions. Games become 'tools to think with' about fundamental existential issues. The player is provided with the opportunity of taking on the virtual identity of a character whose cultural models differ from one's perspective. This virtual identity is then projected on to the real one, in the process developing a deeper understanding of one's personal and social realities. By interacting with the other SIMS one would experience the 'other' from the inside. And since the cultural models built into the game are not actually those of the gamer, s/he will be in a better position to reflect on them in a more overtly conscious way than say an American living a way of life as portrayed by the SIMS. This metacognitive activity makes the gamer bring to consciousness these assumed models and through reflection changes or confirms one's relationship with them. A gamer taking on both the American and non-American projective identities will find the whole thing much more complex than initially conceived and surely will be much more reluctant to accommodate for one while totally excluding the other.

2.1.3 Games as conceptual artefacts

This investigation is driven by the strong conviction of the potential and the catalytic nature of games in providing innovative scenarios for future learning and knowledge building through design and re-enactment approaches as a process of externalising and integrating the intra-individual experience into the external world. Instead of learning history by assimilating disjointed facts, history games create experiences that promote a deeper understanding through 'playing god' in managing a civilisation. Cognitive and affective processing lead to the embodiment of game play anchored in the external gaming environment in a way that remembering means re-enacting all the components. Instructional approaches assume a sequential approach where content knowledge is first internalised and subsequently acted upon – the acquisition prior to application principle. Learning history through a game, by building and managing a civilisation, changes this process. The learner does not first have to 'bring the outer world inside' in order to be able to deal with its 'inside representative'. Instead one can deal with the world 'out there' directly. The acquisition of historical knowl-

edge (content and process) is happening 'internally' and 'externally', proportionately and simultaneously without any staggering or chunking and in a mutually interactive way.

Games also promote insight into knowledge domains through the highest human intellectual activity – learning and understanding through designing. This is the fundamental principle underpinning the constructionist model of learning – understanding something by building a model. In building a complex, functional, self-sustaining system, all interacting factors and the modality of interaction have to be identified. Games offer a range of design levels when dealing with artefacts. At the basic level one can add physical features to an artefact like putting together parts for building a racing car (*Need for Speed*) or designing terrain where to play a skirmish in *Age of Empires.* Managerial games demand a deeper level of interaction and understanding demanding the control of a whole range of factors for developing complex interacting systems: *Simcity* – designing and managing an efficient city; *SIMS* – simulating a middle class American society; *Spore* simulating biological evolution from simple units up to entire civilisations. Epistemic games demand the most elaborate design skills for simulating domain expertise. Will Wright (2004, 1) the creator of *Spore,* explains the insight into a domain gained by such a design approach: *"Until you build a hand, you don't realise how difficult it actually is and we know more about almost everything than we know about the brain."*

The design approach demands extensive knowledge of both the domain/s around which a game is developed and of digital design tools. More important, it demands creating models how to integrate these different aspects and re-present them in a comprehensive and functional system that engages people to learn through an interdisciplinary approach about the game theme. Papert (1998) advocates this approach for promoting deeper forms of learning:
"When they get the support and have access to suitable software systems, children's enthusiasm for playing games easily gives rise to an enthusiasm for making them, and this in turn leads to more sophisticated thinking about all aspects of games."

Bereiter (2002, 106) calls this sophisticated thinking as 'Deep understanding of the domain involving a more intense relationship with the various aspects of the domain, the ability to use and treat intelli-

gently related tools and conceptual artefacts, developing further interest in the domain that leads to deep and complex involvement, thinking about the domain in terms of inter-relations, developing the ability to use an artefact as a tool through which further understanding is developed and shared, and deliberating on and sharing insights into problems related to the artefact and their solution.'

Thus the use of games for this investigation is based on a paradigm shift that considers learning not only as a process of internalising domain knowledge through pedagogical simplification and structuring but more as a process of acquiring a deep relationship with a field of expertise. The emphasis is on externalising domain expertise by simulating it into digital artefacts that are highly immersive, complex, authentic, adaptive and comprehensive re-presentations of reality. This is an innovative way for promoting insights into domain learning. Games serve as an excellent metaphor for pedagogically re-engineering knowledge domains and for stimulating educational advancement through innovative, technology intensive propositions.

Section 2.4.3 outlines the research about Constructionist approaches both within and out of school contexts and the epistemological shift they promote. Such an approach triggers a shift from an instructional paradigm to one that embeds and embodies (Gee 2003) learning experiences in real life simulations. It is a shift from 'Representation' to 'Simulation', 'Re-presentation' and 'Re-enactment'. Representing refers to the modality of knowledge structuring and the type of media involved, employing linguistic or graphic mode of communication. Simulation of a process or event provides faithful, dynamic, multi-medial representation and re-presentation of complex real life processes and scenarios. Re-presenting deals with the model organising the various levels of interactions with the structured knowledge and medium. Re-enactment represents the modality of interaction both with medium and model, mainly through the roles provided by the game.

In a typical classroom such as a history or biology lesson, representation is mainly done through language-based narrative and argumentation involving oral presentations, text and possibly static pictures. It may involve historical documentation in the form of video clips or films. In this case re-presentation involves a 'transmissionist' model through which facts, dates, events, personalities and concepts are passed. Re-enactment would involve role-playing, following vir-

tual simulations or visits to relevant historical, archaeological sites or others of scientific interest.

In contrast epistemic and managerial games like the history-oriented *Age of Empires*, *Civilisation*, *Rise of Nations* or others represent, re-present and help user to re-enact historical eras, events, personalities and scenarios in a much more engaging, dynamic and comprehensive way. Representation is achieved through a rich multimedia environment combining a range of audio-visual effects with ingenious modes of interaction. The re-presentation of domain knowledge is done through a dynamic evolutionary model depicting history as a developmental process involving searching, managing and controlling resources driven by personal and collective survival mechanisms. The re-enactment involves 'playing the expert' or 'playing god' where user has to manage 'from the inside' the evolving domain environment or civilisation controlling all the different aspects and variables of the game.

Domain knowledge is thus learned through an immersive experience in an authentic environment that simulates life in a particular historical era or event. It is not hearing about but experiencing directly that world. Gee (2007) discusses this immersive re-enactment for the first person shooter game SWAT4 and for the squad based shooter, real time strategy game *Full Spectrum Warrior* that was originally designed as a training tool for the U.S. Army. He argues that learning in any domain should be renovated through such immersive re-enactments that make users understand a world (domain) from inside – thinking, feeling, acting and having the same values as a domain expert. For Gee (2007, 16) the implication is that 'If *Full Spectrum Warrior* lets me see and be in the world as a soldier, why can't we have a 'Full Spectrum Scientist?' These immersive re-enactments are extremely motivating and have long term effects by proposing a 'mature professional identity'. Players are empowered to re-enact and experience from inside the profession they plan to achieve, to experiment in a safe way with different projected professional identities and evaluate each of them.

Game-based design approaches not only challenge established instructional practices through their potential to develop active, self-directed learning exploiting natural capabilities but most important they equip younger learners with the best social skills for surviving in a knowledge society. According to Selfe *et al.* (2007) games propose a

complementary dimension to current educational practices not only from a pedagogical perspective but more important by creating spaces to prepare the younger generation for a pre-figurative world. They contend that while living and accommodating for the post-figurative world of their parents and teachers, young learners have to face the pre-figurative world of the present and the future.

With very little help from adults who in turn do not understand the need and have the necessary skills to prepare them for this highly dynamic future, students must get hold of the tools and find the way on their own obtaining support from affinity groups. They conclude that "Success in a world of rapid technological change may well depend on the ability to develop new literary practices that prove increasingly effective in translational digital landscapes like gaming environments" (Selfe *et al.* 2007, 32). On the same vein, Gee (2003, 21) proposes that active learning for the future will be characterised by 'experiencing' the world in new ways, forming new 'affiliations', and 'preparation' for future learning'. According to Papert (1998) and Shaffer (2006) digital games can change education by making active learning possible on a massive scale through simulating real world expertise that facilitate innovative and creative thinking just as innovators do in the real world.

In conclusion, the above discussion justifies the use of games as a medium and technology for this investigation. The epistemological, educational, sociological, motivational justifications were discussed in relation to different pedagogical scenarios. The use of games in such contexts is not a straight and rosy path. Many constrains play a direct role in determining the efficiency and practicality of this approach. The following section discusses these constrains.

2.2 Critical perspectives to games and gaming

Though research highlights a number of examples of good practice and points to a range of benefits in using games for learning, it also explores the constrains and challenges that practitioners may have to face both at an institutional and at an individual level. Besides constrains from schools, one may have to deal with issues related to the negative impact of gaming.

2.2.1 Constrains influencing the use of games in schools

Various reports, research reviews and investigations focus on factors that influence use of games in schools. For McFarlane, Sparrowhawk and Heald (2002) student motivation is enhanced mainly when students use games familiar from their home environment and when they have a degree of autonomy in playing the game. Sandford *et al.* (2006) focuses on the role of teachers in influencing use of games, the particular context in which a teacher works – their experience, their teaching style, their familiarity with the curriculum followed and the wider culture of the institution and the effective use of existing teaching skills rather than the development of any new, game-related skills.

Regarding the instructional task in which games are integrated, the underlying model for the game need only be accurate to a certain degree as inaccuracies within the game model can be used meaningfully in a lesson. Klawe and Phillips (1995) and Buch and Egenfeldt-Nielsen (2006) point to the importance of not relying solely on the video game but actively pursuing links with other teaching forms, thus providing for a fuller learning experience. Sandford *et al.* (2006) also points to the technical infrastructure of the school (including personnel and facilities) institutional and professional factors (including the organisation of time and space in the school, cultures of collaboration/knowledge sharing, traditions of 'best practice' in lesson planning, and classroom rituals), the extent to which games can be 'disaggregated' and appropriated to meet the specific needs of individual teachers' personal experience of games play, their personal and professional identities, and the pervading cultural expectations of children's attitudes to and expertise in playing computer games.

Three categories of constrains are identified that affect the use of games in schools preventing them from becoming a mainstream activity. Regarding *Constrains in Educational Settings* Sandford *et al.* (2006) points to concerns over curriculum and assessment that determined the selection of student age to use games in lessons, the fixed length of lessons constrains both the planning and implementation of game-based learning in schools, and the range of gaming ability amongst students which had an impact on teachers' lesson plans. McFarlane, Sparrowhawk and Heald (2002) consider the limited valuation of gaming skills by school and the mismatch between games content and

curriculum content. Kirriemuir and McFarlane (2004) also point to the mismatch between game and curriculum content. They also consider the long time needed for both the student and teacher to orient themselves within the game. There is also the difficulty in persuading scholar community members and school stakeholders as to the potential/actual educational benefits of computer games. On a more global level cultural acceptance of games as media through which learning can take place involves the contestation of the wider public perceptions of games. Consequently many adopt a 'wait and see' position that should be challenged by initiatives adopting the use of games guided by research and examples of good practice.

Other researchers point to the scepticism from both students and teachers. Egenfeldt-Nielsen (2006) quotes a number of studies (Egenfeldt-Nielsen 2004; Gros 2003; Hostetter 2003; Kirriemuir & McFarlane 2002; Prensky 2004; Squire 2004) indicating that students may be reluctant to engage with video games based on scepticism which stands in stark contrast to the usual idea of all students embracing video games. The challenge is to find game designs that can make learning and playing work together, or, at least, not one against the other (Egenfeldt-Nielsen 2005; Grundy 1991; Healy 1999; Magnussen & Misfeldt 2004).

Kirriemuir and McFarlane (2004) identifies three *constrains met by teachers.* One is the lack of time available to teachers to familiarize themselves with the game and methods of producing the best results from its use. The second concerns the amount of irrelevant content or functionality in a game which could not be removed or ignored, thus wasting valuable lesson time. The other constrain is the considerable effort needed to keep the students 'on track' within the game many times considered as an extra burden in relation to high stakes assessments.

Several reports and researchers identify a number of *game-related constrains* associated with either the surface or deep structure of games. Regarding surface structure McFarlane, Sparrowhawk and Heald (2002) claim that the more complex a game is the higher is the preparation time, while Gros (2003) argue that it is more difficult to adapt games to the class timings once they were created for many exploration hours. Games which were not created with an educational purpose may have a complex menu system that can confuse and deviate from a particular objective in the game.

A number of constrains arise from poor game design. For Magnussen and Misfelt (2004) the games' interface can distract the students from achieving the defined educational goal. Games can have software problems, not very clear interfaces, provide limited feed back or even integrate illogical rules (Becta 2001). For Gros (2003) games with loud sounds and very noisy music compel students to use headphones which stop dialogue and group discussion.

Constrains of a more technical nature include difficulty in buying a license for each student Kirriemuir and McFarlane (2004), copy-protection features and lack or limited technical support (Sandford *et al.* 2006). Kirriemuir and McFarlane (2004) refer to compatibility between school hardware and other software to allow transfer of data between applications and the fact that the equipments at school are usually not satisfying for the needed requirements to play the most demanding games.

Other constrains are related to the deep structure of games, that is, how they mediate interaction with the domain and between different users. Becta (2001) refers to the difficulty in choosing games with the adequate level of interest and challenge to the user and that is relevant for the subject (Kirriemuir & McFarlane 2004). For Gros (2003) games transform themselves and become less entertaining when played with an educational purpose. Becta (2001) refers to the problem of motivational habituation having positive effect on gaming but decreases interest in the school. It also complains about the content and style of several games that are created mainly for boys and about the inclusion of violent characters that demand or satisfy the need for aggression or obsessive control and that may promote the transfer of attitudes and beliefs to reality. This report also complains about the fact that games created to be played by a single player may provide superficial cooperation.

2.2.2 Negative effects of games

While educational games are specifically designed to promote prosocial behaviours, in most recreational games violence and competition are standard integral features. Consequently gaming is often associated with a range of negative effects including addiction, aggression and violence, social withdrawal, poor academic performance and

health risks. Negative impressions, lack of information, folk theories linking gaming and individual behaviour and lack of debate about empirical results from research lead to pessimistic attitudes and misconceptions.

One of the main concerns is the addictive behaviour of gamers, who are assumed to be compulsive users of games not capable of deliberately quitting a game when they should be following other duties. Kirriemuir and McFarlane (2004) challenges such an extreme view quoting various longitudinal research studies, stating that in many cases what are considered to be cases of addiction are actually transient phases of excessive involvement rather than enduring dependencies from which the victim finds it very difficult to escape. The same researchers quote a number of investigations showing that school children in UK dedicate more time to watch TV than to play video games. de Frietas (2008, 67) declares 'Despite some negative psychological studies finding a link with leisure game-play and addiction, the use of educational games and simulations on the whole does not show addictive behaviours, possibly because they are not as engaging as leisure games.'

The issue of violence in entertainment games is an important one, as it crucially affects the acceptability of digital games in general and especially in the educational sector. Views on violence and game players are indiscriminate, often polarised and entrenched, even amongst academic researchers. A number of fundamental issues need to be clarified through empirical research and dispassionate discussion taking care of identifying true sources and causalities. An objective analysis should be carried about the assumption that video games are violent. The meaning of 'violent' needs to be defined using a comparative framework that integrates other media such as the internet, TV, cinema, comic books and literature. Another important issue that needs to be clarified by research is whether 'violent' video games attract players who already possess violent behavioural attributes, or whether the playing of 'violent' games makes game players more aggressive and facilitates the transfer of violent acts from the game into their own lives. The culture for violence cannot be attributed solely to games. There is an urgent need for developing objective classification instruments that take into consideration different age groups and culturally acceptable criteria.

Regarding the effect of video games on aggressive behaviours, researchers and commentators adopt two contrasting stances: games as triggers of violent behaviours against games as therapy to aggressive and violent impulses. The first approach employs a behaviouristic approach quoting the General Aggression Model (Anderson, Anderson & Deuser 1996) that emphasises the reinforcement of behaviours through model imitation (Anderson & Bushman 2001; Bensley & Van Eenwyk 2001). Mitchel and Savell-Smith (2004, 11), quote Bensley and Van Eenwyk who point to a number of theories seen to support the view that playing such games exacerbates aggressive tendencies.

According to *Social learning theory* players are led to observe and imitate antisocial behaviour which is then transferred into real-life action. *Arousal theory* asserts that gaming stimulate aggressive dispositions or lead to the imitation of the same behaviours when a player gets angry. For *Cognitive priming theory* violent computer games activate related cognitive structures evoking thoughts of aggression increasing the possibility of interpreting ambiguous behaviour as aggressive and to respond in kind. *General affective aggression theory* claims that longer-term increases in aggression may also result if the extent of playing has led to aggression-related knowledge structures or 'scripts'. Thus for a number of researchers, gaming does present unique dangers including addiction, the encouragement to identify with the aggressor and active participation in the violent game, Anderson and Dill (2000). The increasing numbers of game users and the progressively more explicit and realistic representations of violence are making the situation more critical (Ellis 1990; McCormick 2001).

Researchers like Winkel, Novak and Hopson (1987), Ellis (1990) and Gee (2007) consider aggression as a personality trait influenced by situational and social factors. Funk (1992) and Griffiths (1999) pointed to children becoming more aggressive after having watched or played a violent video game. Anderson and Dill (2000) claim that the effect of violent video games appears to be cognitive in nature by priming aggressive thoughts. Longer-term effects include players' learning and practicing new aggression-related scripts that become increasingly accessible when real-life conflict situations arise. Anderson and Bushman (2001) refer to the reinforcement effect by repetition of each violent-media episode. Aggression-related scripts are rehearsed, elaborated, differentiated and integrated deeply. Mathews

(2005) research on short-term effects of exposure to violent media shows through fMRI (functional Magnetic Resonance Imaging) that teenagers' brains had increased activation in the area associated with emotional arousal and the "fight-or-flight" response. They showed less activation in the prefrontal portions of the brain associated with planning, focus, and self-control. They concluded that the brain responds differently to violent situations depending on the amount of past violent media exposure through video games, movies and television. He acknowledges that his study focused only on short-term effects so it doesn't shed light on whether the change in brain function translates into more violent behaviour.

Yet research and literature reviews produce an unclear picture with often contradictory conclusions on the effects of violent games on people (Dill & Dill 1998; Griffiths 1999). The underlying methods, results and conclusions of some studies, which produced positive correlations between violent games and behaviour, have been questioned in several reviews, including a brief filed by 33 scholars with the US Court of Appeals (Heins 2002). Goldstein (2005) argues that studies of violent video games are clouded by ambiguous definitions, poorly designed research, and the continuous confusion of correlation with causality.

Kirriemuir and McFarlane (2004) also point to the longevity of the effects of violent video games on people, and especially children, which is questioned by several reviewers of the literature in this area, eg. Bensley and Van Eenwyk (2001). It is pointed out that the nature of research of this type is that results are collected during or shortly after the experiment, therefore not providing any data that can indicate the long-term effects of violent content or conduct within games.

Several researchers, such as Anderson and Dill (2000), note the increasing 'realism' within video games and state this as a reason for ongoing research into any linkage between such media and violent or aggressive behaviour. A widely discussed example is in the game *Grand Theft Auto III*, where the player is able to engage in sexual practices with a prostitute, then (in a separate act) kill her to retrieve the fee. Even with this example, there are proposals that this might be used as a resource to stimulate classroom debate on morality within contemporary culture (Gillespie 2002; Wright 2004).

The second approach is based on the Aristotelian Catharsis theory. Mitchell and Savill-Smith (2004) and Kirriemuir and McFar-

lane (2004) discuss how violent games could actually be beneficial in an educational context serving as useful means for coping with pent-up and aggressive energies. Their therapeutic value is in providing a safe outlet for aggressive tendencies and can be useful in managing aggression claiming that observing aggressive play has a relaxing effect by channelling latent aggression and reducing drive after attaining goal. Bensley and Van Eenwyk (2001) support this view and extend the argument referring to Hull's (1943) 'Drive Reduction Theory'. Prensky (2006, 21) confirms this perspective quoting Jones (2002), in *Killing Monsters*, showing how kids have always gotten to act out their violent impulses through games and other media, and so do not need to in real life. In their ethnographic approach, Pandey, Pandey and Shreshtha (2007, 14) quote an enthusiastic gamer describing how gaming serves as an opportunity to release his anger and also as a way to know and experience how some people might be capable of acting in certain ways under given circumstances, helping him to avoid trouble in life.

Prensky argues that violent crime in the U.S. has significantly gone down during the same period that game playing has dramatically increased. Gee (2007, 11) compares the American with the Japanese society claiming that while the later play more video games and watch more TV yet their society is much less violent than the American. More importantly, the overwhelming majority of normal kids who see some violent movies and play some violent games, but receive the usual, societal counter-messages, do not and will not act violently in public or in private. Pandey, Pandey and Shreshtha (2007, 38) quoting Brigstocke, state that 'Computer games don't affect kids, I mean if Pac Man affected us as kids, we'd all be running around in darkened rooms, munching pills and listening to repetitive music.'

Recent research confirms disagreement. Like Mathews (2005), psychologist Bruce Bartholow, the lead researcher of a team from the University of Missouri-Columbia investigating brain activity of game players suggests a causal link between games and aggression. People who play a lot of violent video games didn't see them as much different from neutral as they become desensitised. Jonathan Freedman, a psychologist from the University of Toronto in Canada, stresses that what this type of research is showing is nothing but desensitisation to images. There's no way to show that this relates to real-life aggression. And Professor David Buckingham, an expert on the media and children at the

Institute of Education, added there was still no consensus on whether violent games caused aggressive behaviour or were just played by violent people. For him, the debate we are seeing is very similar to the one that has raged for years about TV. The truth is there are many factors that can lead to violence, such as being withdrawn and isolated, so it is hard to say it is because of one thing. "In the absence of any proof, I think we have to be agnostic about it. However, I think there is an argument about the morality of some games," BBC Technology News (2006), quoting sources from *New Scientist*.

Prensky (2006) cautions serious researchers and educators about the intentions and affiliations of naysayers. He points to specific examples of 'easy target' politicians who use the violence of games as an easy card to catch votes. Others are propagandists, looking to legitimise themselves with legitimate-sounding names scaring adults with inflammatory terms. Both Prensky (2006) and Kirriemuir and McFarlane (2004) criticise the application of Anderson's model to explain violence in games as most of Anderson's evidence is based on studies of TV with minor references to case studies involving video games.

In summary, it is highly unlikely that the issue of games and violence will be 'resolved' (it should also be noted that parallel debates surrounding other media have existed for much longer). As well as having vocal proponents on both sides, the large amount of research (of varying quality, and often fragmented or out of context) has failed to reach a consensus. This is arguably because more reliable investigations would require researchers to study significantly more players and to examine cause-and-effect relationships over long periods of time (years, instead of days or even hours).

Mitchell and Savell-Smith (2004) discuss a number of studies related to health issues. Excessive gaming may lead to eyestrain, headaches, chest pain, fatigue and mood swings Tazawa *et al.* (1997), abnormal metabolic and heart rates (Dorman 1997; Emes 1997), tendonitis and repetitive strain injury (Emes 1997; Cleary, McKendrick & Sills 2002). Where gaming causes sleep deprivation it is also associated with black rings under the eyes and muscle stiffness in the shoulder (Tazawa & Okada 2001). In susceptible persons long hours looking close to a monitor (Kasteleijn-Nolst Trenité *et al.* 1999) with flashing lights and continual change of geometric patterns can trigger epileptic seizures (Funk 1992, 1993; Emes 1997; Ricci & Vigevana 1999; Singh *et al.* 2001). Ricci and Vigevana (1999) claim that seizure activation may

result from non-visual activators, such as cognitive or decision-making factors, sleep deprivation, emotional excitement, or hand movements. Other researchers consider such side-effects to be relatively minor or temporary (Griffiths 2002) and playing computer games is comparable to a mild intensity exercise. With normal use, playing may neither improve nor harm physical fitness (Emes 1997).

A number of psycho-social issues are associated with excessive gaming. Bowsworth (1994) found gamers are no more likely than non-gamers to be involved in risk-taking such as alcohol or drug abuse. Frequent gamers have a greater tendency to show social isolation and less positive behaviour towards society (Roe & Muijs 1998); gamble more (Gupta & Derevensky 1996); steal or show delinquent behaviour to finance play (Griffiths 1996); show low self-esteem, particularly with girls (Funk & Buchman 1996).

Self-esteem is one of the main issues indicated by researchers (Cesarone 1998; Roe & Muijs 1998; Colwell & Payne 2002; Jones 2002). Increasing proficiency at gaming may afford players a temporary sense of mastery, control and achievement they normally lack and that may become a substitute for social relationships (Roe & Muis 1998). For both males and females, particularly where there is low self-esteem, the 'compensatory' effects of gaming may reinforce a tendency to escapism or to addictive behaviour leading to feelings of inadequacy and depression. Glissov, Siann and Durndell (1994) do not support the idea that heavy gamers are less sociable and agree with Colwell, Grady and Rhaiti (1995) that gamers, particularly boys, spend more time with friends, both online and offline collaborating in swapping information and ideas about the game.

Mitchell and Savell-Smith (2004) state that excess gaming may result from playing for fun, challenge, nothing else to do, doing like friends, diversion, arousal or tranquillising effects, due to dependent or addictive personality. Griffiths and Hunt (1998) claim that boys are more likely to be dependent than girls though females are just as likely to become addicted to home computer games and that the earlier children began playing computer games the more likely they can become dependent.

Ryan *et al.* (2006, 347) synthesizes the discussion about the educational benefits of games in a very practical way quoting sources for each side of the argument: "Some scholars have argued that participation

in computer games may foster a number of negative effects, including increased tendencies toward violence, lower psychological and physical well-being, lower achievement and productivity, and more impoverished personal and familial relationships. In contrast, other scholars have argued that psychological benefits can be derived from game experiences, including a sense of efficacy and power over one's environment, as well as improvements in learning. Given the variety and complexity of computer game activities, it seems evident that games have the potential to yield both psychological harms and benefits to players."

As a conclusion, in line with Ryan *et al.* (2006) the best approach to adopt is to promote a pedagogy based on the use of games but controlling for potential negative effects. Regarding serious and educational games, the benefits of such a pedagogy clearly outweigh any negative outcomes. The decision to use games as the technology and medium for this investigation was determined by a number of compelling positive factors. These include the rich personal experiences that games offer to users, the engaging nature of the medium, the accommodation by games to instructional and constructionist pedagogical approaches, the need to promote games as an innovative learning approach, the need to reconceptualise domain learning from different perspective especially by simulating expertise, the resonance of games with the psychological and social make-up of young people and the need to challenge established perceptions. But the most compelling two aspects arise from the conviction that there is dire need to sensitize people about the potential of this area and hence the need to engage in research that addresses these needs and proposes examples of good practice.

The following sections outline the research done about games and gaming considering normative aspects of games and their use (About), pedagogical aspects of games and their use in educational contexts (With) and the effects 'From' games.

2.3 Research ABOUT games

Gaming as a physical and social experience is determined by game appeal which is a function of its design as manifested in different genres. Review of literature about this aspect was complemented by an investigation reported in Paper 2 to gather empirical data about

gaming patterns and trends of the sample of Maltese college students. This approach was used to identify the parameters guiding the investigation and hence lead to the eventual experimental set up. The first step was thus a review of the normative aspects of gaming, including patterns in game adoption, user choices (hardware, game titles and genres), playing time, motivation to play and game appeal in relation to the surface and deep structure of games. Thus this section provides a comparative discussion of literature in relation to local data obtained during the preliminary phase of this investigation.

Analysis of the rapidly growing game market show that games are becoming the most frequently used 'interactive media' amongst all age groups. Ryan *et al.* (2006) claim that games are the world's largest entertainment medium and participation in gaming is commonplace across a variety of demographic groups, capturing an ever-increasing proportion of both youth and adult leisure time and energy. They quote Yi (2004) who claims that annual revenues from video games had surpassed those of Hollywood, a trend that continued to widen.

Research about preferred game content, as expressed from the game genres and titles used, shows differences between age groups, Sherry *et al.* (2006) and Mitchell and Savill-Smith (2004). Interest in imagination and physical enactment games declines with age, while interest in traditional games increases. McFarlane, Sparrowhawk and Heald (2002) found that children's access to games varies as they get older. Their preferences are clearly for adventure, race games and shooting/arcade though girls are far more likely to favour adventure games than boys throughout. Sherry *et al.* (2006) found that young adults show their strongest preference for traditional games while imagination games are the least liked. The researchers attribute this to the fact that traditional games are less time consuming and therefore may appeal more to busy students who have less time to dedicate to gaming. There is the added advantage of already knowing the rules and conventions of the games hence time is not spent on deciphering the game. Such games evoke a feeling of nostalgia and familiarity that is constantly activated through playing these games and their sequels.

In the investigation with Maltese college students reported in Paper 2, user choice was quantified through a survey (Appendix 1) requesting information about the time spent on playing digital games, preferred gaming device and preferred game titles. The preferred game genre was worked out from game title preference. Data was used to

compare choice trends between male and female students, first and second year college students and between a sample of Maltese and Swedish college students.

Paper 2 also explored trends in the use of different gaming devices. Overall young children were more likely to play games on a gaming console rather than a PC, but most played on more than one platform and PC use only dropped below 50% for Key Stage 3 boys, McFarlane, Sparrowhawk and Heald (2002). Facer (2001) estimated that 70% of children in UK played computer games and 68% play games on their mobile phone every week. Sales of latest gaming consoles (Xbox 360, Sony 3 and Nintendo WII) show a persistent increase both with adolescent and adult consumers. Yet the PC remains the main gaming device, a trend that was confirmed by results from this investigation.

Time dedicated to play in relation to age of gamers is another important factor considered by various researchers. Though investigations are often oriented towards 'snapshot' results as opposed to tracking gameplayers over longer periods of time, longitudinal research does not show a long-term significant commitment to games over other activities (Kirriemuir & McFarlane 2004). Marsh and Thompson (2001) found that 3 to 4 year-olds in UK watched television for time periods far greater than playing of video games and quote the European comparative study (1997/1998) showing that people aged between 6 and 16 spent on average 32 minutes per day playing electronic games, but 136 minutes watching television. Facer (2001) and McFarlane Sparrowhawk and Heald (2002) suggest that younger children (at primary or lower secondary levels) are more likely to play games regularly than children in the upper years of secondary school.

Maltese male college students spend 6.7 hours per week and females 2.5 hours per week, comparing well with tendencies of British Columbia teens (Media Lab Analysis report 1998; Sherry *et al.* 2006) and the Swedish control group, where there was a significant difference in playing time by gender but no significant difference by group (Paper 2, section 4.1.3). A significant difference in playing time was found between the first and second year Maltese student cohorts with the former playing for longer periods while the latter dedicating more time to study in preparation for the critical end of course exams.

Research on patterns of game play in adults (Mitchell & Savill-Smith 2004; Prensky 2001, 2004; Gee 2003, 2005, 2007; Selfe & Hawisher 2007) persistently show the high percentages of youth that

play games and that they did this since their young years. Ritchell (2004) claims that the demographic profile of video game players is not anymore in the younger ages. The average age of game-console users is 24 years and this increases to 29 if computer use is included. These sources also point to the fact that young people are much more invested in games than in film, television or books.

de Frietas (2008, 67) insists that there is a distinction between leisure and educational games. 'While leisure games studies have shown that age, gender and cultural differences pervade, a recent study is revealing that there was no significant difference between age, gender and culture regarding the use of specifically educational games. The finding confirms that serious and leisure games are still distinct categories, also indicating that educational games may be used with mixed age, gender and cultural groups to equal effect.'

Gender-related trends in gaming have been the subject of many research studies. Though results are open to discussion, recent research reports Mitchell and Savill-Smith (2004); Kirriemuir and McFarlane (2004); Bonanno and Kommers (2008); Sandford *et al.* (2006) point to the more intense and persistent gaming activity shown by males. Kirriemuir and McFarlane (2004) argue that games are no longer exclusively the preserve of teenage boys. Girls may play the same games as boys but differently. They quote Fromme (2003) who hypothesises that girls generally lose interest in games as they age and use PCs for other uses, while boys still use PCs primarily as game machines. The researchers argue that it is important to challenge the self-perpetuating myth of gaming as a male only activity and argue that female gamers do exist but are often rendered "invisible" by male-dominated gaming communities, the games industry and academic research. The proportion of gamers who are female seems to be growing and this may be related to the increase in social gaming through both on-line and offline multiplayer options.

Considerable research has been done about motivation to play games both from the perspective of World 1 and World 2 experiences. The World 1 perspective deals with extrinsic motivation focussing on what makes games appealing. The World 2 perspective is concerned with intrinsic motivation, that is, what makes gaming an engaging experience. The former is discussed here in relation to the surface and deep structure of games while the motivational outcomes were discussed under section 2.1.2.b.

Early generic studies (Malone 1981; Amory *et al.* 1999) identified fantasy, challenge and curiosity as the three main ways in which games motivate players. Ryan *et al.* (2006) argue that people's willingness to play any particular game depends on factors associated with enjoyment and how games that differ in controllability, structure, and content appeal to basic human motivational propensities and psychological needs. Games' attraction will vary as a function of its personal appeal, design and content. Game designs also differ in the autonomy afforded *within* the game, such as the degree of choice one has over the sequence of actions, or the tasks and goals undertaken. Autonomy is enhanced by game designs that provide considerable flexibility over movement and strategies, choice over tasks and goals, and those where rewards are structured so as to provide feedback rather than to control the player's behaviour.

For school age children, data from McFarlane, Sparrowhawk and Heald (2002) suggests that level of challenge is the most important motivating factor. The Entertainment Software Association (ESA 2001) survey with frequent computer and video game players identified four main reasons for gameplay: 87% stated that the number one reason was because it's fun; 72% because games are challenging; 42% because games are an interactive social experience that can be shared with friends and family; and 36% because games provide a lot of entertainment value for the money. The 'Teaching with games project' (Sandford *et al.* 2006) points to the generational divide in games play with a significant majority of teachers (72%) not playing games for leisure, compared with 82% of students playing games outside lessons at least once a fortnight. Boys were also more likely to play games for leisure than girls. The majority of teachers and students surveyed reported that they thought games would motivate students to engage with learning. Therefore no clear consensus emerges on the reasons why people play digital games. Researchers point out that the individuality of the player provides a sometimes complex set of reasons for game play. Poole (2000) notes that videogames are powerful, but they are nothing without humans to play them. So the inner life of videogames - how they work - is bound up with the inner life of the player.

Analysis of gaming tendencies driven by game appeal observed with Maltese college students (Paper 2) discloses a number of underlying cognitive and motivational gender-related trends. Females' option for puzzle, adventure, fighting, and managerial games confirms Sherry *et*

al. (2006) findings that females' top reasons for playing include challenge and arousal. Males' preference for first person shooters, role playing games, sports and strategy games indicates gratification of different needs: challenge, social interaction especially squad-based gaming and their preference for command structures. Males want to feel in control, they are not afraid of taking risks in learning and prefer to learn by doing. Females favour a more concrete, contextualised, intimate "bricolage" approach as they do not like to take risks and tend to avoid competition while learning. Paper 4 discusses the preferred gaming environment by Maltese college students with males choosing solitary gaming while females preferring to play games in company of others.

The appeal of different game genres is determined by both surface and deep structure of the game. Surface structure determines the modality and intensity of physical interaction with the game interface including the mediation of presence and making controls intuitive that leads to 'flow' as discussed in section 2.1.2.b under motivational outcomes.

The deep structure is determined by the model organising the domain content and the gaming model both influencing the type and intensity of interactions with the domain, between the game and gamer, and between different gamers. Game use and the whole gaming experience is a product of the interaction between the deep structure and user's individual tendencies. Squire (2002) emphasises that research on collaborative gaming should focus on shared practices, language, resources, understandings, social interactions, roles and relationships that emerge during gameplay. This is a key recommendation for this investigation.

Extrapolating from discussions amongst experienced players, Bartle (1996; 2004) characterizes interaction between game and gamer into four types. Killers wish to *act on* (i.e. kill) players; Socialisers wish to *interact with* players; Achievers wish to *act on* (i.e. achieve within) the virtual world; and Explorers wish to *interact with* (i.e. explore and manipulate) the virtual world. Building on Bartle's theoretical model of player types, Yee (2005; 2006) has presented several studies of players' behaviour, focusing on Massively Multiplayer Online games. Using factor analysis he identified three overarching, non-exclusive, motives. Players focused on *achievement* seek game mastery, competition and gaining power within the game. *Social* players want to interact with

others and develop in-game relationships. *Immersion* players desire to escape real life problems, engage in role-play and "be part of the story." Ryan *et al.* (2006) claim that Yee's work is among the first to bring a statistical methodology to the exploration of how players may differentially value virtual worlds. These authors promote Rigby's (2004) suggestion that these categories or typologies largely reflect the structure and content of current games, rather than the fundamental or underlying motives and satisfactions that can spark and sustain participation across all potential players and game types.

Consequently this works considers the emergence of gaming patterns as a by-product of the interaction between the game structure and individual or collective characteristics, rather than standardised categories. The influence of gender-related neurocognitive propensities with different games are explored in Paper 4 showing different interaction patterns for males and females when using the same game. Paper 8 explores the interaction between game structure and gamers' perception. Different game genres are perceived to promote different types of interactions that lead to the development of different skills. Interaction with games is also determined by gamers' perceived usefulness of game features that influence mode of interaction with the domain and gaming models. Paper 8 explores also the degree of interaction mediated by the deep structure of different games used in collaborative contexts and proposes an 'index of sharability' as a quantitative measure.

2.4 Research WITH games – the pedagogical perspective

This section deals with the research done about the use of games for learning, training and knowledge building. Squires (2002) declares that the pedagogical value of a medium like gaming cannot be realized without understanding how it is being enacted through classroom use. Four priorities of this area of research are: understanding how learning occurs through game play, examining how gameplay can be used to support learning in formal and informal learning environments; explore teachers' adoption and adaptation of any pedagogical materials developed to embed games with the objective of maximizing games' potential to support learning regardless of designers' inten-

tions; and designing games explicitly to support learning. Thus the use of edutainment and commercial games will be discussed both within and out of school contexts considering the role of teachers, factors that influence the effective use of games and the research about constrains limiting the use of games for learning.

2.4.1 Using games in schools

One area of research is concerned with edutainment, commercial educational video games that focus on teaching the player certain specific skills. Most deal with elementary school reading, maths, geography, spelling, critical thinking skills and a range of psychomotor skills. Though having a strong educational component, these games often do not reflect the motivational drive of commercial titles (Facer *et al.* 2003; Leyland 1996). According to Kirriemuir and McFarlane (2004) the development of games for education is driven by the desire to harness the motivational power of games in order to make 'learning fun', a belief that 'learning through doing' in games such as simulations, offers a powerful learning tool and that gaming is an appealing setting to practice all kinds of basic skills. The underlying assumption is that when these are part of a challenging adventure their appreciation changes dramatically. The learning objective is hidden while the activity appears driven by exploration, discovery and adventure, a condition termed 'stealth learning' (Kirriemuir & McFarlane 2004). For Egenfeldt-Nielsen (2006) drill-and-practice is useful but works best in combination with other teaching forms (Cotton 1991; Loftus & Loftus 1983).

Many researchers criticize this approach. For Prensky (2006), edutainment is mostly graphics-enhanced skill-and-drill (or as he calls it "drill-and-kill") and Papert (1998) called them Shavian reversals that combine the bad of both aspects. He also considers stealth learning as downright immoral by tricking children into learning and doing math when they think they are just playing an innocent game. Rieber, Luke and Smith (1998) object to use motivation as a 'sugar coating' for designing games and criticize the approach of designing games for making curricular subjects fun to learn. Kirriemuir and McFarlane (2004) claim that this strategy failed to motivate learning because the games have been too simplistic in comparison to competing video

games since tasks are repetitive, poorly designed and do not support progressive understanding as the range of activities is severely limited within the game, usually concentrating on one skill, or accumulation of homogenous content. Kiili (2005a & b) and Egenfeldt-Nielsen (2006) criticize this behaviouristic approach that compels users to keep on experimenting with actions until their scores improve. They point to the inferior quality of technology, gameplay, graphics and underlying 'trial and error' principles and claim that edutainment does not enhance learning but focuses on training that lets the player perform mechanical operations characterized by rote learning with shallow understanding of the skill or content.

Although this approach may work for some basic subjects, the scope of learning is limited and results in weak transfer with little appreciation of the skills, because these are not fundamentally understood. He insists that there is common agreement that many behaviourist edutainment titles fail to integrate learning with the game. Kirriemuir and McFarlane (2004) also criticize the fact that the target audience becomes aware that it is being coerced into "learning", possibly in a patronising manner and that 'learning by stealth' suggests that learning can only be enjoyable when it is unconscious. This argument is sustained by various researchers. Prensky (2006) argues that learners do enjoy unforced learning, regardless of the degree of consciousness, when they have a sense of their own progression and where the learning is relevant, authentic and appropriate for them (McFarlane 1997), even when it is hard work (Gee 2007).

Egenfeldt-Nielsen (2006) gives a comprehensive list of investigations about the educational effect of games in different school subjects. He concludes there is no doubt that video games facilitate learning, but the evidence for saying any more than this is weak. Few current studies compare video games with other teaching styles, which is the ultimate test. Few incorporate debriefing explicitly, which the related area of simulations usually sees as central to the educational use of games and simulations (Lederman & Fumitoshi 1995). Results showing that students learn from video games are not sufficient backing for the educational use of video games. There is a need to examine whether video games are worth the initial efforts in learning the interface, setting up computers and other problems (Egenfeldt-Nielsen 2004). For Egenfeldt-Nielsen (2006) the central question that should drive the use of

games for learning is: what is it that video games offer that sets them apart from existing educational practice?

The role of the teacher, or mediator, is often as important as the game itself in terms of whether useful learning has taken place (Birmingham & Davies 2001; Leemkuil 2006). Many researchers argue that since video games have not been developed with curriculum explicitly in mind they are not explicitly educational, but that they provide opportunities for interested teachers. Researchers are consistently finding that teachers play an important role in facilitating learning with video games, in terms of steering use in the right direction, in providing an effective debriefing that can catch misperceptions and interesting differences in students' experiences while playing, and may also use educational titles in ways that extend a title's narrow focus. This is confirmed by McFarlane, Sparrowhawk and Heald (2002) pointing to the role of teachers in highlighting and indicating elements of game structure and form which would enable some of the games to be incorporated into the school context. On the other hand Egenfeldt-Nielsen (2006) quoting various sources warns that if we rely too much on teachers we may be disappointed by their reluctance to engage with games and their lacking knowledge of how to use games.

Thus the use of educational games in schools depends on constrains arising from educational settings, constrains met by teachers and those that arise from the game itself. The next section outlines research about the potential of commercial games in educational and training contexts.

2.4.2 Research about bridging 'in' and 'out' of school learning through gaming

Researchers also explored the learning potential of commercial games. Egenfeldt-Nielsen (2006) proposes the possibility of using some action games to train motor and visual skills like eye-hand coordination. He quotes a number of studies (Dawes & Dumbleton 2001; McFarlane, Sparrowhawk & Heald 2002; Kirriemuir & McFarlane 2003) showing that adventure, strategy and simulation games are more suited for educational purposes. This is confirmed by Sandford *et al.* (2006). Since games rarely focus exclusively on one topic and on basic skills they are used fairly haphazardly for education. The educational goals of com-

mercial video games are indirect rather than direct and these can lead to a skewed focus in the learning process. However, their strength is that the motivational part is well documented from success on the commercial entertainment market (Kirriemuir & McFarlane 2002).

Kirriemuir and McFarlane (2004) suggest the development of online communities associated with games in education to promote collaboration through discussion, reflection and planning of gaming session. They argue that developers are paying more attention to the role of such interaction by creating online communities within which various 'educational games' can be found and activities that generate discussion and debate are shared. These contribute significantly to learning related to games and thus warrant research and evaluation.

2.4.3 Research about using games in constructionist approaches

While there is a growing body of research about using games for learning in school contexts as attested by previous sections, only sporadic cases exist of constructionist approaches, that is, learning by designing games and using games for knowledge building. Papert (1998) solicits this approach 'Forget about making games to teach children multiplication or spelling or any of those old-fashioned basic skills. The really basic skill today is the skill of learning, and the best use of games is to leverage their tendency to enhance it. Learners can engage with a microworld and construct different objects and connections that can work as virtual shared artefacts.'

The most noted contributions within this field are the works of Kafai (1995; 2001) which have stood the test of time. Up through the 1990s, she developed the idea of children designing games, turning them into producers of knowledge and letting them play with objects in different ways. According to Kafai and Resnick (1996), there is no doubt that programming and maths knowledge can be acquired through designing video games. Arguably, designing video games makes it possible for the learner to approach a subject in an active way, thereby constructing a personal representation of knowledge by using physical artefacts. The student's learning experience draws on different perspectives while giving rise to a variety of actions and thus to a fuller understanding of a given topic. The interest in microworlds

has been especially strong in relation to maths and science (Goldstein & Pratt 2001; Hoyle, Harris & Judd 1991; Hoyles, Noss & Adamson 2002; Miller, Lehman & Koedinger 1999; Reiber 1996; White 1984). Attempts have surfaced in which constructionism is used as a different approach to video games (McCarty 2001; Woods 2002).

Outside school contexts leading research institutions facilitate the process of learning and knowledge building through designing games. Mamamedia.com is a site that promotes engaging activities to help kids gain technological fluency and expand their minds through playful learning. It helps them design and animate characters, make their own digital cards and invent games. Mitchell Resnick from MIT developed the game design kit 'Scratch' to promote engaging activities that help users gain technological fluency and expand their minds through playful learning. Users can design and animate characters, make their own digital cards and invent games. Similar tools for creative learning are available from on-line commercial outlets.

On the same vein, leading gaming console manufacturers and game design companies encourage and facilitate the development of user-generated content. Cieslak (2006) reports about Microsoft's initiative to entice budding game developers into designing innovative games. The XNA Game Studio Express is a set of game development tools for the Xbox 360 available free to download for Windows XP and for Vista aimed at hobbyists and students. Microsoft has teamed up with 10 universities in the US who will be adding it to their curricula. Developers will then be able to share their efforts via Xbox Live. The website Miniclip.com facilitates the development and promotion of Flash-based mini-games. This constructionist approach needs to be promoted within educational contexts and researched accordingly. But its adoption is very slow if not seriously restricted due to epistemological, pedagogical and methodological conflicts as discussed in various section of this work.

To conclude this section, despite all the criticism and constraints, research attention about the educational uses of mainstream games is both growing and gaining momentum, as evidenced by the number of publications, new academic research groups, and conferences dedicated solely to this field. To maintain this momentum rigorous investigation should be carried out where computer and video games are used in educational settings (both in and out of school), in order to add to models of how people learn, collaborate and contribute through gaming, and to provide justifiable cases for others to examine and fol-

low. Kirriemuir and McFarlane (2004) claim that the value of collaborative learning and the role of computers in promoting such activity have been thoroughly researched. How collaboration translates into a multiplayer gaming environment and how these environments might be used to support learning, remain some of the most interesting areas for potential further research and development. This investigation explores this collaboration in contiguous gaming groups through an interactions approach, motivated by the need to develop pedagogical models to manage and exploit such collaborative contexts.

Egenfeldt-Nielsen (2006) points to four major problems this research field needs to address. These are the lack of separation between different ways of using video games for learning (de Freitas 2005); underdeveloped theory on facilitating learning through video games (Kirriemuir & McFarlane 2003); a weak theoretical knowledge of video games (Mitchell & Savill-Smith 2004); and an incomplete use of previous literature owing to the variation in terminology, place of publication, and researcher backgrounds (Squire 2002). This investigation addresses these shortcomings by embedding gaming experiences in an epistemological framework that proposes research about the educational use of games along the three Popperian dimensions. It proposes a process-oriented methodology that considers learning as interactions along the domain, game and community dimensions. It also evaluates games according to the degree of interactions mediated by the game's surface and deep structure, together with promoting awareness of gaming trends, gaming culture and examples of good practice.

2.5 Research about effects FROM games

Research about the interaction between the game as physical and conceptual artefact with an individual's cognitive, affective, conative and social dimensions is reviewed in this section. The influence of these individual attributes on gaming is discussed in relation to the research and findings reported in the published papers listed in Part II of this thesis. Essential components of this gaming experience are the individual positive and negative learning outcomes that were discussed in section 2.1.2.b about educational outcomes and negative effects of games section 2.2.2 as part of the rationale for adopting games as the technological medium for this investigation.

2.5.1 Individual attributes

Both solitary and collaborative gaming are deeply influenced by a number of primary individual characteristics including personality, gender, attitude to gaming and satisfaction of personal needs that give rise to idiosyncratic gaming experiences. Each of these individual characteristic is discussed in the following sections.

(a) Personality

Research about the interaction between personality dimensions and collaboration in class is very scarce. In their investigation about the influence of personality on social participation in learning environments, Caspi *et al.* (2006, 133) declared that 'To the best of our knowledge, very few published papers reported on the relationship between participation in class and personality traits'. No research works could be traced about personality and participation in technology-intensive environments, not the least collaborative gaming environments. A considerable amount of research is currently being done about personality and identity in Massive Multiplayer online games (Yee 2004; 2006; Steinkuehler 2004; 2006; Bainbridge 2007).

In collaborative contiguous gaming, personality type determines participants' reaction to the social context. Previously classified through the Myer-Briggs Personality type indicator, personality is being assessed through the Big Five-factor Model (B5FM), Goldberg (1990) that measures conscientiousness, openness to experience, neuroticism, extroversion and agreeableness. Though this model has generated a great deal of empirical research, it also created a lot of debate about its consistency and external validity. Researchers report conflicting results for classroom situations. Very few investigations used this model to investigate the influence of personality factors on participation in technology-intensive learning environments.

Despite the notion that virtual environments are well suited to introverted students (e.g. Berge 1997), there are no reports of correlations between the B5FM and participation in such environments. However, Caspi *et al.* (2006) maintain that in studies conducted in a non-academic context reporting on correlations between personality traits and internet usage, mixed results were obtained. Using the B5FM in relation to role adoption in role-play games, Yee (1999) found the Openness and Agree-

ableness factors to be weak in that no respondents scored below the average. As a consequence he questioned its validity and changed to a version of the Myer-Briggs Scales. Using these scales to measure personality of players in Massive Multiplayer On-line Role-Play Games (MMORPGs), Yee (2004) performed multiple regression of personality with Person/Avatar similarity. The results show that Introverts are more likely to behave similarly while Extraverts tend to behave more differently. Mulchay (1997) in her anthropological studies about Role-Play Games gives detailed characterisations of introverts and extroverts in virtual environments without referring to any standard instrument.

Aiken (1999) concluded that much contemporary theorizing about personality consists of fairly simple hypotheses or theories concerning relationships between variables rather than comprehensive, grandiose conceptions pertaining to the causes and effects of human behaviour. Most often these theories consist of a few interrelated concepts from which predictions and explanations of certain bits of behaviour are made. Furthermore, any theory must provide a clear picture of the dynamic interactions of heredity and environment in shaping personality or the relative contributions of organic and experiential factors in its determination. Since Cognitive Neuroscience provides a valid method that addresses these fallacies to explain the relation between causes and effects manifested by different type of personality, Paper 6 adopted this methodology describing the extro-introvert personality dimension in terms of Approach and Withdrawal behaviours respectively (Davidson 1995). To assess approach/withdrawal behaviours Paper 6 uses an adapted version of the Myer-Briggs Personality type that assesses the extro/introvert dimensions (Appendix 8) assuming that participants with an Extrovert tendency show more approach behaviours while introverts show greater tendencies to withdrawal ones.

(b) The role of gender in influencing game play

The influence of gender on gaming is a key research area. Throughout the course of this investigation the gender effect was persistently evident amongst the sample of college students participating in this study. Extensive review of literature was thus done to arrive at a comprehensive conceptualization of the phenomenon. Section 2.3 above synthesizes the discussion about normative aspects of gender in the use

of games as discussed in Paper 2. Here the emphasis is more on how the gender effect influences both individual and collective comportment. It is also points to research showing that gender itself is influenced by environmental influences.

Paper 4 *'Gender-based Neurocognitive Propensities influencing Gameplay'* gives an extensive review of research about gender-related individual and social propensities. Reference is first made to research carried out in Europe and US with different age groups and ICT applications that consistently point to the greater experience and mastery approach adopted by boys which eventually extends into stylistic tendencies into adulthood. A review of the literature points to a number of physical, cognitive and social gender-related differences that clearly show the evolution of underlying biological mechanisms determining individual and collective interactions within specific socio-cultural environments. This paper categorises these gender-related differences and extends their implications to the psycho-social climate within collaborative gaming contexts.

Reference is made to research describing how sexually differentiated primary abilities evolved in humans through sexual division of labour. The role of hunting in males led to the development of navigational abilities as a consequence of travelling over a wide territory and 3D eye-to-hand co-ordination in manipulating tools. Females are superior in linguistics and social skills related to their role in food gathering. In males biologically determined primary abilities and the psycho-social skills developed in 'Rough-and-tumble' play (Pannksepp 1998) are eloquently manifested and exploited during action, fighting and sport games showing this highly evolved 'aggression management' mechanism, as discussed in Paper 4, section 1.3. Other game genres capitalise more on the visuo-spatial skills like orientation, manipulation of three-dimensional objects, target following, localisation, maze following and navigation.

Paper 7 discusses the influence of gender on group dynamics elaborating on the role of underlying sexually differentiated social skills involving gender scripts, coalition-based competition and gender-based neurocognitive and affective propensities.

A number of environmental factors that affect the mutual influence between gender and gaming have been investigated. Research about gendering of digital games focuses mainly on the image of

females within commercially available games. Kirriemuir and McFarlane (2004) emphasises that there is a general lack of female game characters and this discriminates against females because they look for and develop gaming experiences different from those of males. Griffin (2007) highlights the distinctiveness of women's interaction with games quoting Lanza in Herz (1997) claiming "Girls are looking for experiences and boys are looking for bragging" (Herz 1997, 173).

Bryce and Rutter (2002) caution that gender and gaming research has focussed discussion too much on analysing the representations within a game (content) rather than on the experience of playing involving deeper analysis of gender specific motivation to play games. In MMORPGs there is a lot of play with gender, age, ethnicity and sexual orientation. Bryce and Rutter conclude that gaming practices are undergoing rapid social and technical changes and, at the same time, it is noticeable that gendered perceptions of gaming are changing. This is not a phenomenon unique to gaming and is consistent with the increased participation of females in other leisure activities. Gender relevance to games and gaming is a complex and rapidly evolving issue, and effectively needs to be researched within a wider social context than that of the gaming experience alone.

This merging of differences in gaming between males and females is influenced by other factors beyond gaming. The decrease in the gap between male and female neurocognitive propensities as a result of media exposure has long been investigated. Investigating environmental influence of the development of sex-related differences in spatial and mathematical ability, Baenninger and Newcombe (1995) claimed, citing a number of meta-analyses that have shown this pattern that, many gender differences were actually decreasing. Crawford, Chaffin and Fitton (1995) also stressed a decline in gender differences in spatial visualization skills in the past 40 years. Stumpf (1995) acknowledges the reduction in some gender differences with time but points out that gender differences across a number of cognitive dimensions were still quite robust despite the reduction over time.

These trends and Griffin's (2007) observation about the power of narrative in female gamers, point to the underlying driving gender-based neurocognitive and affective propensities, mainly female rehearsal-based memory strategies, linguistic propensities and their person-oriented social approach. These propensities, which actually

drive the externally manifested comportment and thus cut across game content, gamers' age and culture, compelled this investigation to adopt a neurocognitive and affective perspective for interpreting the gaming experience and motivation as discussed in Paper 4.

(c) Attitude to gaming

Gender-related primary abilities and socially learned 'gender scripts' influence perceptions and beliefs about the use of digital technologies. Paper 5: *'Exploring the Influence of Gender and Gaming Competence on Attitudes towards using Instructional Games'* discusses the influence of gender and gaming competence on entry attitudes in collaborative gaming. Attitudes are defined according to the 'Theory of Reasoned Action,' Ajzen and Fishbein (1980) that emphasizes the importance of assigning attitudes towards behaviours (gaming) and not to objects (games). Since attitudes are a function of beliefs, learners and teachers will only use games for learning if they come to believe that gaming leads to positive task and person-oriented outcomes.

The review also outlines the evolution in instruments used to assess attitudes towards use of technology and in particular to the use of digital games. Selwyn (1997) 'Attitude to Computers' scale that integrates the four distinct constructs A*ffective component, perceived control*, *perceived usefulness* and *behavioural components*, is discussed in relation to other instruments. In the absence of any instrument to assess attitude to gaming, Selwyn's model was used to develop a survey for the theme focussed investigation reported in Paper 5 to identify the different attitudinal components to gaming and explore their pedagogical implications, Appendix 7. This instrument was used to assess and compare the general attitude of males and females to gaming and also to compare gender variation in different attitudinal components. The paper also explores the interaction between gaming competence and attitude to gaming.

(d) Need satisfaction

Participation in collaborative gaming is motivated by the drive to satisfy personal needs. The pedagogical model, described in section 2.6, that organises the investigations reported in the various published papers, considers learning as an evolutionary process from novice through the 'expe-

rienced' stage up to the expert level. Hence three pedagogical levels are identified each addressing different personal needs (Reeve 1997) along the domain, technology and community dimensions. The basic level addresses the need for competence through acquisition of knowledge and skills related to the domain or technology being used and the social skills related to the community. The second pedagogical level addresses the need for relatedness and affiliation through participation and sharing along the three dimensions. The third level addresses the need for self-actualisation through management of power relations by providing opportunities for mediation of personal expertise and contribution in communities of practice related to the domain or gaming world.

This study focuses on two aspects of gaming competence: perceived gaming competence and quantifying gaming experience. As a quantitative measure of gaming experience, gaming competence is calculated in terms of the number of hours dedicated to playing games every day or week and to the repertoire of preferred game titles. Ryan *et al.* (2006) confirm the direct positive correlation between gaming competence and the number of hours dedicated for playing or the number of preferred game titles. This is the formula used in Paper 5 to explore the correlation between gaming competence and attitude to gaming. The same formula was used in section 3.3 of Paper 6 to explore correlation between gaming competence and the three covariates: frequency of task and person-oriented interactions, directionality of interactions, and individual gaming role. In Paper 7, the same formula was used to set up groups that vary in composition regarding individual gaming competence. Then in section 3.1.2 the influence of perceived competence and gap in gaming competence were explored in relation to frequency and directionality of interactions, and in relation to roles adopted in the group.

Research also established that players behave in collaborative gaming contexts according to the perceptual assessment of their competence in relation to others. *Cognitive evaluation theory* (CET; Deci & Ryan 1980; 1985; Ryan & Deci 2000) is specifically concerned with contextual factors that support or thwart intrinsic motivation. CET proposes that events and conditions that enhance a person's sense of autonomy and competence support intrinsic motivation, whereas factors that diminish perceived autonomy or competence undermine intrinsic motivation. Competence is defined as a need for challenge and feelings of effectiveness (White 1999; Deci 1975). CET proposes

that factors that enhance the experience of competence, such as opportunities to acquire new skills or abilities, to be optimally challenged, or to receive positive feedback enhance perceived competence, and, in turn, intrinsic motivation. Perceived competence would thus be enhanced in gaming contexts where game controls are intuitive and readily mastered, and tasks within the game provide ongoing optimal challenges and opportunities for positive feedback. Ryan *et al.* (2006) hypothesize that perceived competence is among the most important satisfactions provided by games, as they represent arenas in which a person can feel accomplishment and control.

In Paper 8 perceived competence is explored in relation to game genre. Through a survey assessing nine perceived competences comprising acquisition, sharing and mediation along the domain, technology and community dimensions, different games are rated according to the extent users perceive the facilitation of these competences. The paper demonstrates how games could be classified according to the competencies they are perceived to facilitate.

As a socialising process collaborative gaming is driven by the need for relatedness. Section 4 of Paper 3 elaborates on the formation of affiliations, friendship bonds and camaraderie through the socio-emotional processes of impression formation, mentalising, social monitoring and interpersonal communication. Once the need for relatedness is satisfied, the highest personal need, that for self-actualisation, becomes a priority shown through the adoption of leadership (expert) roles. Paper 3 concludes discussing how the needs for competence, relatedness and self-actualisation are yet driven by the more fundamental biological need, that of 'outsmarting' others.

Ryan *et al.* (2006) links needs satisfaction to the motivational pull of games by enhancing the feeling of well-being through experiences that enhance volition, effectiveness and social connection. The psychological pull of games is largely due to their capacity to engender feelings of autonomy, competence and relatedness. This not only motivates further play but enhances psychological wellness including subjective vitality, self-esteem and positive affect. Relatedness is experienced when a person feels connected with others (La Guardia, Ryan, Couchman & Deci 2000; Ryan & Deci 2001).

Researchers focused on gaming contexts to investigate the cooperative and competitive aspects of this socialisation process, considering

games often as a facilitator to social, communication and peer activities (Kirriemuir & McFarlane 2004). An early study by Greenfield (1984) already found that half of all young people who spent time in video games arcades weren't actually playing games at all - rather they were using the arcade as a social gathering space. Fromme (2003) describes several surveys indicating that playing games with others is popular with German children, while Tobin (1998) argued that boys' gaming was not simply a process of 'playing the game' but more of an activity embedded in social interactions.

Using the game *Civilization III,* Squire (2004) investigated how learning in history is facilitated through the surrounding social environment. Squire concludes that good games engage players in educational environments in multiple ways creating dynamic learning opportunities. Discussions lead different players to articulate and defend different strategies, rethinking their orientation to the game and produce important 'taken-as-shared' meanings. Egenfeldt-Nielsen (2006) refers to various studies (Gee 2003; Jessen 2001; Kaptelinin & Cole 1997; Linderoth 2002; Squire 2004) to show that video games mediate discussion, reflection, facts and analysis facilitated by the surrounding classroom culture and the student's identity. In other words, video games are interesting not for their content but for the way new explorations initiate negotiations, constructions and journeys into knowledge.

This social orientation to gaming motivates this investigation to explore the state of well being and the degree of relatedness in different experimental contiguous collaborative gaming contexts. The state of well being is captured by quantifying the socio-emotional climate through the type and frequency of person-oriented interactions. The degree of relatedness is expressed through levels of friendship. Section 3.1.2 of Paper 7 explores how different combinations of gaming competence in a group influence the state of well being of its members referring to the socio-emotional climate. Section 3.1.3 explores the effect of friendship heterogeneity in a group as an expression of different degrees of relatedness on the socio-emotional climate. Paper 8 extends this methodology to explore the influence of game genre, user control provided by a game and the degree of 'sharability' on the socio-emotional climate in experimental groups.

2.5.2 Conclusion

Evaluating literature about games and gaming reveals a number of gaps. There is a need for further research about the nature of collaborative game-based learning and how to interpret and evaluate collaboration in such contexts through comprehensive models. For example Kiili's (2005b) 'Experiential gaming model' emphasises solely the physical experience of gaming. Combining constructivist and pragmatist approaches learning is defined through cognitive and behavioural components as a 'construction of cognitive structures through action or practice in the game world'. He declares that the model is 'not concerned with the role of social interaction in learning' (Kiili 2005b, 18).

A model for collaborative game-based learning should not be based on such a restricted view of learning and should move beyond domain-oriented or experiential conceptualisations. It should integrate the three Popperian aspects of the collaborative gaming experience and merges them with a metacognitive dimension. Through a process-oriented methodology the model should show how these dimensions are inter-related and how gamers can be guided to develop their personal gaming experience. This approach should acknowledge the different levels of competence that participants in collaborative gaming contexts may demonstrate along the domain, technology (digital game) and community dimensions. The motivations and needs associated with these different levels of competence should be addressed through interactions at the task level but also at the socio-emotional level involving interpersonal verbal and non-verbal communication and role adoption in the group.

Squires (2002) referring to Malone (1981) and Cordova and Lepper (1996) claims that there have been few studies of game players that attempt to characterize players interactions and experiences in game playing environments. He emphasises that analysis of gameplay should be done through models outside the domain of Educational Technology drawing on research traditions and metaphors from other domains. For this purpose further research into different related domains will be carried out. But this will be organised around a pedagogical model inspired by the underlying connectionist epistemology discussed in chapter 1 of this document. This should lead to the identification of the main factors that determine interactions in collaborative gaming that will enable

the formulation of the major research questions (section 2.7). Theme focused investigation will be organised around these research questions through the methodology developed in chapter 3.

2.6 Towards a process-oriented methodology

After deciding to adopt digital games as the technological medium for this investigation the next step was to determine whether to investigate gaming as a solitary experience or in a collaborative context. Researchers have been pointing to the key influence of the context when using games for learning. Clegg (1991) argues about the significance of the instructional context enveloping gaming that is considered as a more important predictor of learning that the game itself. Specifically, how the game is contextualized, the kinds of cooperative and collaborative learning activities embedded in gameplay, and the quality and nature of debriefing are all critical elements of the gaming experience. Learning and knowledge building is conceptualized not as a function of the game itself - or even a simple coupling of the player and game, but as transformations that occur through the dynamic interactions between subjects, artefacts and mediating social structures. Reviewing research about games in educational contexts, Squires (2002) points to the obvious bias towards studies involving case-studies about the use of specific games in solitary gaming modes related to instruction in some curricular subject. In her seminal work Gredler (1996) already pointed to the paucity of studies characterising players' interactions and experiences in game playing environments.

Squires (2002) corroborates this claiming that despite this increasing attention as a maturing medium, the pedagogical potential of games and social contexts of gaming have been woefully unexamined. The educational value of the game-playing experiences comes not from just the game itself, but from the creative coupling of educational media with effective pedagogy to engage students in meaningful practices. Leemkuil (2006) reaffirms that games can offer powerful educational experiences through the support of two categories of tools. Instructional tools include 'task facilitation tools' such as providing feedback, monitoring facilities and guidance by means of hints and prompts. 'Task consolidation tools' include additional assignments, a help or advice system. The other way is to use the group in a gaming context as a peda-

gogical tool to enhance cooperation and collaboration through debriefing and group discussions. 'Many studies show the benefit of careful guiding, supporting, scaffolding, introducing and debriefing the video game experience' (Egenfeldt-Nielsen 2006, 203).

Developments in other fields of research, mainly the video game industry, pedagogy and cognitive neuroscience also emphasise the importance of interpreting human behaviour from a social perspective. Digital games are evolving beyond the solitary context into a ubiquitous, social and collaborative enterprise (Steinkuehler 2006; Taylor 2006; Prensky 2006; Waters 2007b). Considering the social motives driving solitary gaming, this activity is hardly considered as an individual experience but more appropriately as a form of extended collaboration within gaming peer groups. The release of a new game unleashes an aggressive competition among enthusiastic gamers to establish who will be the first to 'crack' the game. Equipped with an inside view of the game structure and gaming tactics the winner will acquire a leader-expert connotation among peers. This vantage point enables him to pass first hand information and guide others in finishing the game, thus re-affirming one's competence, status and identity within a gaming community. Gee (2007, 20) confirms the social dimension of solitary gaming:

"Even single-player gaming often involves young people in joint play, collaboration, competition, sharing, and a myriad of websites, chat rooms, and game guides, many of them produced by the players themselves."

The social nature of gaming is manifested more strongly in LAN (Local Area Network) gaming parties, Massive Multiplayer On-line Games (MMOGs), virtual worlds like 'There.com', 'Second Life', 'Habbo Hotel', 'World of Warcraft', and contiguous co-operative gaming contexts such as Cinegames (Carvajal 2007). Many times enthusiastic gamers form groups to collaborate in designing new games or "Mods' of existing ones (Waters 2007a). These contexts serve both as focal points for technology-mediated social interaction and as safe environments where gamers can experiment with their projected identities within affinity spaces.

At a more sophisticated level ambient games integrate real with virtual environments, creating networks of players socially interacting in space and time.

"You've got gaming that will actually pick up your surroundings and make that part of the game arena. Other players in relation to you also become part of that physical game reality" (Richtel 2004).

The seminal works of Salomon (1990) about analytic and systemic approaches to analyse Technology-Intensive Learning Environments (TILEs), Salomon (1996) about teamwork and Dillenbourg *et al.* (1996) on collaborative learning emphasise the need to concentrate more on trying to understand the role that independent variables play in mediating interaction. On the same vein, research about shortcomings of technology-intensive collaborative learning environments (Kreijns, Kirschner & Jochems 2003) identifies Task and Person-oriented interactions (T&POIs) as fundamental components of such contexts.

Cognitive Neuroscience (Eg. Frith 2007; Frith & Frith 2003; Frith & Wolpert 2003) recommends that all human activity should be observed and interpreted considering the biological basis for social interaction. Geary (1998) and Pannksepp (1998) discuss play from a neuro-affective perspective describing the underlying neurological, hormonal, physiological and psycho-social aspects of play. A very relevant psycho-social aspect of play is 'Rough-and-tumble' play also known as 'Play fighting'. This perspective is discussed in Paper 4, where play is considered as an activity that provides the practice necessary to develop the skills needed for survival and reproduction in adulthood. It frequently manifests itself as 'Coalition-based competition' evident in males of species where conflict in adulthood is resolved through physical aggression.

Boys organize themselves into groups and compete against other groups. They compete as members of teams and must simultaneously coordinate their actions with team mates, gratifying themselves in acting as a representative of a group. Coalition-based warfare develops the physical, social and cognitive capacities to manage in and out-group formations and the strategic coordination of in and out-group activities. These skills are all manifested in multiplayer games where males dominate due to these propensities. These research dimensions compelled the adoption of a process-oriented approach and provide this investigation with a solid scientific platform to interpret experimental contexts and results from an interactions perspective.

Collaborative gaming gives rise to various levels of interactional organisation. The strategy adopted by this investigation is to use both

the game and the group as tools to promote learning and knowledge building, considering these as an enhanced process of interactions along the three Popperian gaming experiences. As a World 1 physical object a game provides the context for the expression of direct interactions by a group arising from imitation, argumentation and negotiation. The group process facilitates the acquisition of gaming skills and domain learning. Through the intra-individual processes of mentalising (Frith & Frith 2003), social monitoring and interpersonal comparison, the group promotes reflection about the interaction between the intra-individual and the external gaming experience.

Through this reflection each member is challenged to accommodate or change his/her attitudes, beliefs, behaviours, understandings and skill level – the elements that constitute one's idiosyncratic gaming experience. Thus collaborative gaming address a wider range of learner needs. While solitary gaming satisfies mostly the need for competence, collaborative contexts satisfies the higher needs for relatedness, affiliation and self-actualisation (Reeve 1997). Participants in collaborative gaming can develop relationships (both task-related and off-task) and at a deeper level form bonds with other members of the group. More competent gamers may take a leading or mediating role for promoting gaming knowledge and skills. Ryan *et al.* (2006) relate part of the motivational pull of games to the gratification of the need for relatedness through social interaction.

But this does not mean that collaborative gaming does not have its pitfalls. A number of factors may limit collaboration. The game may serve more as a destructor rather than a stimulator of interactions thus reducing interpersonal communication and interferes with the development of a positive socio-emotional climate. It may alter group structure leading to sub-grouping and thus altering the interaction pattern. Several factors that may restrain collaboration may take over. These include a competitive attitude, conflicting gaming experiences and competences, conflicting personal needs, unaddressed attitudes to gaming and clashes with learning and social styles. These competing needs have to be addressed in order to promote an efficiently interacting group and to create a healthy positive social climate that facilitates communication and interaction.

Adopting collaborative gaming as a central pedagogy is a challenging and elaborate task, as it involves a complex system of interacting

variables. The methodology proposed by the seminal work of Dillenbourg *et al.* (1996, 1), still considered as a milestone in this area of research, will guide this investigation:

"For many years, theories of collaborative learning tended to focus on how individuals function in a group. More recently, the focus has shifted so that the group itself has become the unit of analysis and the focus has shifted to more emergent, socially constructed, properties of the interaction. In terms of empirical research, the initial goal was to establish whether and under what circumstances collaborative learning was more effective than learning alone. Researchers controlled several independent variables (size of the group, composition of the group, nature of the task, communication media, and so on). However, these variables interacted with one another in a way that made it almost impossible to establish causal links between the conditions and the effects of collaboration. Hence, empirical studies have more recently started to focus less on establishing parameters for effective collaboration and more on trying to understand the role which such variables play in mediating interaction. This shift to a more process-oriented account requires new tools for analysing and modelling interactions."

This investigation will apply the proposed process-oriented approach to collaborative gaming organising it around a pedagogical model inspired by the underlying connectionist epistemology. It will integrate recommendations from the literature review pertaining to the different research domains contributing to the analysis of the collaborative gaming context. Paper 3 discusses the development of this process-oriented pedagogical model that will serve as an organising framework for the investigation. Figure 1 synthesises this taxonomic model that integrates interactions with underlying concepts, theories and processes operating in collaborative gaming. Skill imitation, negotiation and argumentation generate task-oriented interactions related to competence development along the domain and technology dimensions. On the other hand, the psycho-social processes of impression formation, mentalising, social monitoring and interpersonal communication generate categories of person-oriented interactions.

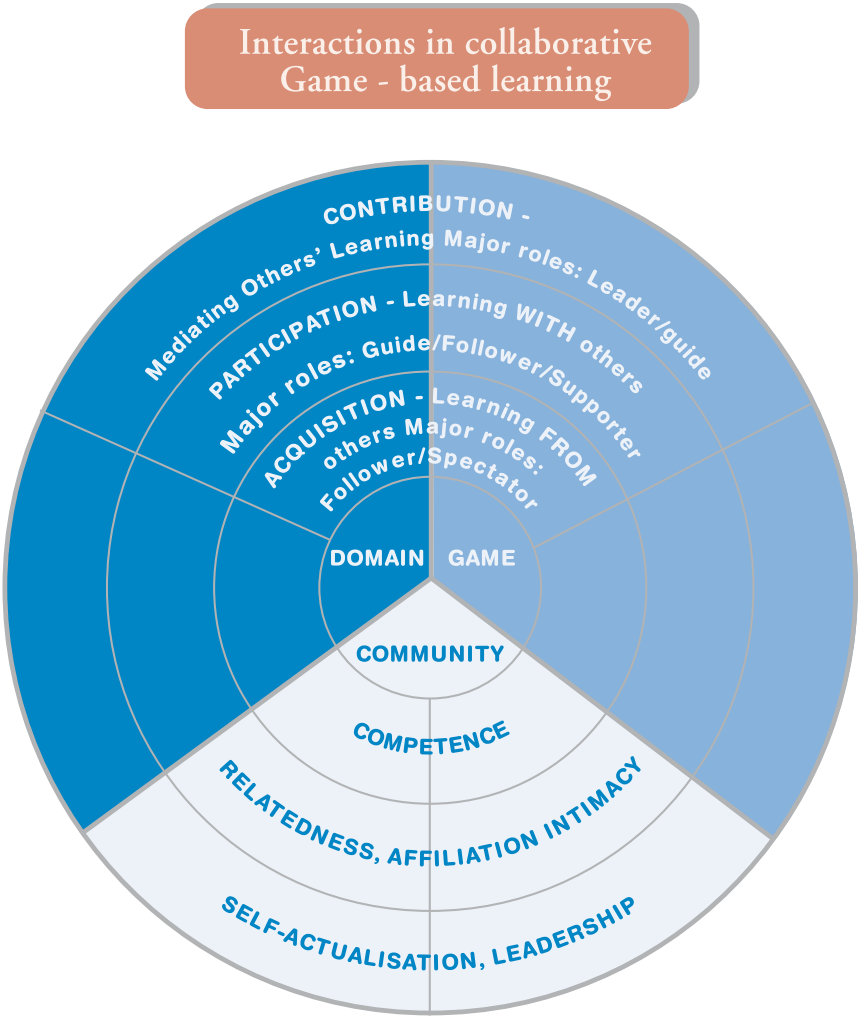


Figure 2A: *Model representing processes in collaborative gaming*

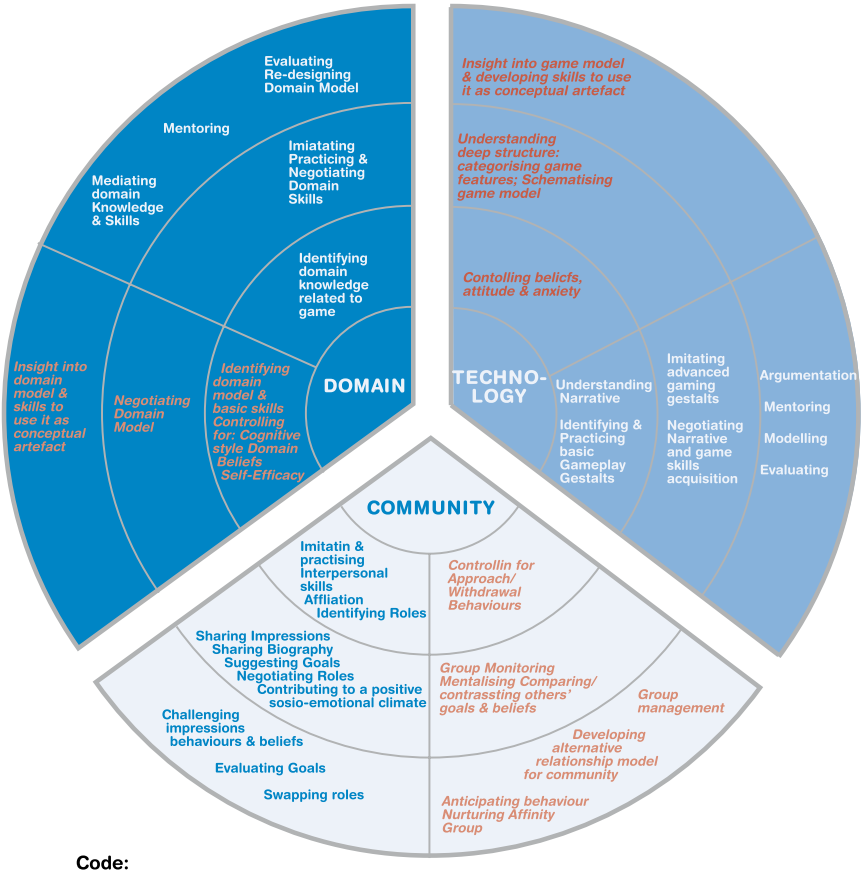


Figure 2B: *Interactions at the Experiential and Metacognitive levels of the Game, Domain and Community dimensions*

Experiential level	*Metacognitive level*
Game	
• Understanding Narrative • Identifying and practising Basic gameplay gestalts	• *Controlling beliefs, attitude to gaming and anxiety.*
• Imitating advanced gaming gestalts • Negotiating narrative and game skills acquisition	• *Understanding deep structure of the game* • *Schematizing game model*
• Argumentation • Mentoring • Modelling • Evaluating	• *Insight into game model* • *Developing skills to use it as conceptual artefact*

Figure 2C: *Interactions along the Game dimension*

Experiential level	*Metacognitive level*
Domain	
• Identifying domain knowledge related to the game	• *Identifying domain model and basic skills.* • *Controlling for cognitive style, domain beliefs and self-efficacy*
• Imitating, practicing and negotiating domain skills	*Negotiating domain model*
• Evaluating and/or re-designing domain model • Mentoring • Mediating domain knowledge and skills	*Insight into domain model and skills to use it as conceptual artefact*

Figure 2D: *Interactions along the Domain dimension*

Experiential level	*Metacognitive level*
Community	
• Imitating and practicing interpersonal skills • Affiliation • Identifying roles	*Controlling for Approach and Withdrawal behaviours*
• Sharing impressions • Sharing Biography • Negotiating roles • Contributing to create a positive socio-emotional climate	• *Group monitoring* • *Mentalising* • *Comparing and contrasting others' goals and beliefs*
• Challenging impressions, behaviours and beliefs • Evaluating goals • Swapping roles	• *Managing group* • *Developing alternative relationship model for community* • *Anticipating behaviour* • *Nurturing group affinity*

Figure 2E: *Interactions along the Community dimension*

The model has sectors that represent the different dimensions and circles representing the various pedagogical levels. The concentric circles enclose three areas representing the three pedagogical levels that a novice learner has to go through to become 'experienced' and then expert along the domain, technology (gaming) and community (contiguous group, virtual communities and affinity spaces) dimensions (Alexander & Murphy 1999). In the model these dimensions are represented by the three sectors each sub-divided into two smaller sectors. (Figure 2B) The sub-sectors printed in black, normal font represent the experiential component of that dimension capturing interactions within World 1 and 3. The other sub-sectors printed in red, italicised font represent the reflective component capturing mainly the process of interactions between World 2 with Worlds 1 & 3. Each small section includes experiential or reflective interactions related to the specific dimension and pedagogical level intersecting at that part of the diagram. Figures 2 C-E represent the enlarged dimensions of interactions of Figure 2B.

The first (inner) novice level integrates World 1 interactions characterised by acquisition learning (Learning *From* others), mostly through imitation of psychomotor, cognitive and social skills during apprenticeship. This addresses the need for competence along the three proposed dimensions. Along the domain dimension learners acquire domain-related declarative, procedural and conditional knowledge in relation to a wide range of topics (or domain model of a game). Typical interactions at this level will include learner initiated actions such as imitations, asking help to understand initial conceptualisations or procedures, and asking for clarifications while consolidating concepts and skills through practice. The corresponding metacognitive activity involves monitoring and organisational interactions while systemizing knowledge around domain core themes in the process of identifying or formulating a domain model and related skills regime. It also involves developing an awareness of natural propensities in information processing and controlling for domain-related personal beliefs.

Acquisition along the technology dimension includes developing a working competence based on knowledge and skills related to the use of different tools, in this case understanding surface structure of a game. Typical interactions will include identifying tool options, testing tool features and imitating use of tool as part of practicing basic gameplay gestalts (Lindley 2002). Metacognition involves rationalising belief system about games, controlling attitude to gaming and developing affective strategies to manage anxiety. Competence along the community dimension means acquiring interpersonal skills leading to affiliation and adoption of particular roles. Metacognition here implies rationalising and controlling individual propensities related to perception, beliefs and reactions to social interactions in groups counteracting natural inhibiting propensities.

The middle ring represents the 'experienced' level that includes interactions both with World 1 and 3 characterised mainly by participatory learning (Learning *With* others). This level addresses the need for relatedness, affiliation and intimacy with the contiguous gaming group and any domain-related 'Communities of Practice' or game-related affinity spaces. Participation in learning and knowledge building involving negotiation and argumentation widens the 'zone of proximal development' (Vygotsky 1978) along the domain and technology dimensions that leads to the joint construction of distributed knowledge and skills through task and person-oriented interactions. The group serves

as a forum for negotiation and argumentation along all dimensions. Participants assess and refine their knowledge and skills through further imitation, guided practice and negotiation. Parallel activity occurs regarding gaming where the group provides apprenticeship in developing advanced gaming gestalts and understanding deep structure of the game. Along community dimension negotiation and argumentation manifests themselves in sharing impressions about gaming with other participants, sharing domain and gaming biography, negotiating roles, suggesting goals and promoting interpersonal communication.

At this level of competence metacognition would involve monitoring interactions in the process of developing distributed knowledge and skills along the three dimensions. The domain model is further elaborated through discussion and negotiation, while the deep structure of games is further understood through the categorisation of game features and the schematisation of game model. Along the community dimension, through mentalising (mind reading), group monitoring skills are identified and practiced. This mainly involves challenging individuating impressions and evaluating the goals and beliefs of other colleagues by comparing incoming impressions with social scripts.

The outer ring represents the expert level, including mainly World 3 interactions characterised by contributory and mediation forms of learning and knowledge building (*Mediating* others' learning) that addresses the need for self-actualisation. Domain or gaming experts communicate their highly refined knowledge and skills or mediate the learning of less competent learners through discourse enhanced by digital conceptual artefacts. Mentoring, modelling and evaluating domain or game models and skills are all expressions of leadership that satisfies the need for self-actualisation and power. Thus more competent participants show a higher level of interactions related to evaluation and modification of domain and game models, together with negotiation in mediating them through mentoring and modelling.

Along the community dimension contribution implies monitoring and managing group interactions by challenging behaviours, impressions and beliefs, evaluating group goals and suggesting alternative roles. Metacognition involves developing insight into domain and game models with the necessary skills for using these models as conceptual artefacts. Insight into community functioning is shown by interactions to nurture group affinity, ability to anticipate others' behaviour and proposing alternative relationship models for the group.

Table 1: *Categories of interactions in technology-intensive collaborative gaming/learning environments*

Domain	Technology (game)	Community
Experiential interactions		
Imitations	Identifying tool options	Imitating group behaviours
Asking for help	Testing tool features	Identifying roles
Practice	Imitating use of tool	Sharing biography
Assessment	Suggesting tool features	Suggesting goals
Refinement	Mentoring novice users	Negotiating roles
Innovation	Modelling use of tool	Swapping roles
Metacognitive Activity		
Describing domain model	Controlling affective aspects	Controlling for social style
Discussing domain model	Categorising game features	Comparing/contrasting goals
Elaborating domain model	Schematising game model	Analysing others' expressions
Evaluating domain model	Evaluating game	Proposing alternative roles
Modifying domain model	Modifying game	Anticipating behaviour

Using this model and corroborating proposed categories of interactions with observations from pilot experimental sessions involving collaborative gaming, Paper 3 identified the categories of interactions given in Table 1.

Using this proposed scheme a list of observable task and person-oriented interactions was developed. The final list of *Task-Oriented Interactions* (TOIs) includes focussed reception, interacting with game, imitating game actions, reference to personal biography regarding gaming, asking (help), giving help, responding, sharing, providing feedback, confirming, suggesting. *Person-oriented interactions* (POIs) were categorised into those that promote a *positive* climate (pPOIs) including pleased looks, jubilant expressions, approving gestures and recommending game. *Negative POIs* (nPOIs) promote a *negative* climate including neutral looks, expressions of disagreement or rejection, disapproving gestures, disengagement, hostile reactions and censuring game.

Further research and corroboration of this process-oriented model with experimental observation had to be carried out to arrive at the

main factors that influence these key generative process and hence interactions in collaborative gaming environments. The next section describes this stage of the investigation.

2.7 Research questions and factors determining interactions in collaborative gaming

The main objective of this investigation is to determine which factors have to be controlled to create the optimal conditions for learning in collaborative gaming contexts. These factors are identified considering recommendations from seminal works about collaborative learning. The proposed process-oriented framework considers learning from the perspective of interactions along three dimensions: the domain (content area of the game), technology (skills in handling gaming device and playing the game) and community (communicating and interacting with gaming colleagues and game related virtual communities).

Experiments conducted to understand the mechanisms for efficient collaboration decomposed the dependent variable (work alone) into several other measures of performance, such as the improvement of monitoring and regulation skills (Brown & Palincsar 1989; Blaye & Chambres 1991). This kind of research let to a body of contradictory results, within which the positive outcomes largely dominate (Slavin 1983; Webb 1991). But some negative effects are stable and well documented, for instance the fact that low achievers progressively become passive when collaborating with high achievers (Salomon & Globerson 1989; Mulryan 1992). Dillenbourg *et al.* (1996, 1) state that 'there is a simple way to understand the controversial effects observed: collaboration is in itself neither efficient nor inefficient. Collaboration works under some conditions, and it is the aim of research to determine the conditions under which collaboration is efficient.' For this purpose one has to vary these conditions systematically both the dependent variables (work alone / collaborative learning) and independent variables (the composition of the group, the features of the task, the context of collaboration and the medium available for communication).

In this investigation, the dependent variable will be the collaborative gaming condition, more specifically the type, frequency and directionality of interactions that occur in group-based gaming. The independent variables were identified through preliminary investigations.

Data about gaming patterns (time, gaming device, preferred game genre and titles, motivation for gaming) was gathered through a questionnaire. The second method was through structured video analysis of gaming sessions for different treatment groups using a number of protocols specifically designed to analyse the different interactions. Analysis of both data sources corroborated by informal semi-structured interviews led to the identification of the following three major categories of factors as key determinants of interactions within collaborative gaming contexts. Each major category comprises a number of subordinate factors which are discussed separately in the indicated papers:

1. **Individual factors:** Personality dimensions (Paper 3), Gender-related neuro-cognitive propensities (Paper 2, 3 &6), Attitude to gaming (Paper 5 & 6) and Gaming competence (Paper 5, 6 & 7)
2. **Group-based characteristics** (Paper 6) **–** Group Roles, Friendship level, Composition by gaming competence, Composition by gender
3. **Game features** (Paper 8)**:**
   - **Personal appeal –** Genre (demanded neurocognitive skills), perceived usefulness, perceived competence facilitation and perceived need satisfaction
   - **Design -** degree of autonomy (user control) and interactiveness (sharability)

The interaction between the dependent and independent variables will be investigated through a number of experimental setups based on key research questions comprising a number of sub-ordinate empirical research questions. The four main research questions are:

1. **Which are the major gaming tendencies and patterns of the student sample?**
2. **What is the influence of individual characteristics on interactions during collaborative gaming?**
3. **What is the influence of group characteristics on interactions during collaborative gaming?**
4. **What is the influence of game features on interactions during collaborative gaming?**

The first question is related to the investigation about gaming patterns of the student sample. The data collected through this survey was used

in subsequent investigations. The other three questions are related to the three identified major factors that influence interactions in collaborative gaming. They provide the framework for designing and organising the experimental context for conducting theme focussed investigations that are reported in published papers. The detailed empirical research questions structured by the above-mentioned main questions are identified in Chapter 3 and then used in chapter 4 for compiling the results from the theme focussed investigations.

3 METHODOLOGY

"A focus on the individual learning in social and cultural solitude is increasingly seen as conceptually unsatisfying and ecologically deficient. As Bronfenbrenner (1997) has pointed out, "in ecological research, the principal main effects are likely to be interactions", and these interactions are, to a large extent, between an individual, his or her social surrounds, and the artefacts culture provides."
Salomon and Perkins (1998, 1).

The complexity of the experience in technology-intensive collaborative learning environments, as described in the proposed constructionist process-oriented model, can be captured by a methodology that combines qualitative and quantitative techniques to identify and quantify interactions along the domain, community and technology dimensions. The advantages of combining both techniques lie in the balance that is established between gathering data from which generalisations could be generated and contextualising the research through observation and participation in the experimental setting.

Gredler's (1996, 538) seminal work on investigating gaming contexts recommends such a blended approach for developing and interpreting profiles of student interactions within these complex situations. She proposes the collection of qualitative data in the form of analysis of students' problem-solving efforts by requesting students to verbalise their thoughts as they work through the exercise and by videotaping the sessions. The transcriptions of the videotapes are then analysed and coded to identify the specific steps implemented by each students. She also proposes semi-structured individual interviews with students after experimental session(s) with the game to explore students' non-cognitive reactions to the experience.

Consequently from a normative, quantitative perspective, it was decided to proceed at two levels: (1) gather information about key student characteristics and (2) quantify the frequency and directionality of identified interactions from video recordings of gaming sessions. This data was to be supported and interpreted by qualitative means including semi-structured interviews with gaming participants and analysis of communication modes (verbal, body language and role adoption) as observed from video recordings.

The relevant methodology is thus developed in this chapter. First the main research questions are elaborated into more specific sub-questions (section 3.1) that could be easily operationalised in experimental settings. The normative aspect of the gaming experience of the sample of college students, as stated in the first major research question and related subsidiary ones, is discussed in Section 3.2 from the perspective of exploring the physical gaming experience. This is followed by a description of the methodology (Section 3.3) used to develop the theme focussed investigations for capturing the type, frequency and directionality of interactions in collaborative gaming. Reference is made to the instruments developed and procedure adopted. The first part of Section 3.4 focuses on the investigation about the influence of gender on distinct psychomotor and social skills as part of the exploration about the intra-individual gaming experience reported in Paper 4. Then it elaborates on the second major research question about individual factors influencing interactions in collaborative gaming. The following sections (3.5, 3.6) discuss the investigations related to the remaining two major research questions about the influence of group and game characteristics on interactions. The chapter concludes with an evaluation of the different data gathering techniques (Section 3.7).

3.1 Elaborating the specific research questions

The first step in developing theme focused investigations around the major research questions identified at the end of the literature review was to elaborate each major question through a number of subsidiary empirical research questions. Each of these investigations was structured to operationalise a set of empirical research questions. This is reflected in the separate sections of the published papers. The four main research questions (see also Chapter 2.7) were extended to encompass the following sub-questions:

1. Which are the major gaming tendencies and patterns of the student sample?
   - Which gaming device is mostly used by students?
   - Is there a difference in the time dedicated by male and female students for playing digital games?

- Is there a difference in the time dedicated for playing digital games by Maltese and Swedish male and female students of the same age?
- Is there a difference in the time dedicated for playing digital games by male and female students across age cohorts?
- Is there a difference in game genre preferred by male and female students?

2. What is the influence of individual characteristics on interactions during collaborative gaming?
   - How does the intro/extrovert personality dimension affect interactions and individual roles during collaborative gaming?
   - What is the Influence of Gender-related neurocognitive propensities on interactions in Collaborative gaming?
   - What is the influence of different attitudinal components on interactions in collaborative gaming?
   - Are there any gender-related differences in 'general attitude to gaming'?
   - Does gaming competence influence 'Attitude to gaming'?
   - How does individual gaming competence affect interactions of participants in collaborative gaming?
   - Is there any interaction between individual gaming competence and roles adopted during gaming?
   - Is there any interaction between individual gaming competence and gender?

3. What is the influence of group characteristics on interactions during collaborative gaming?
   - Is there any difference in type, frequency and directionality of interactions between male, female and mixed gender groups?
   - Is there any difference in type, frequency and directionality of interactions between groups having different composition by gaming competence?
   - Is there any difference in type, frequency and directionality of interactions and individual gaming roles between gaming groups with different combinations of friendship amongst participants?

- Is there any difference in type, frequency and directionality of Interactions, socio-emotional atmosphere and individual gaming roles in groups with a leader as compared to those without a leader?
- Is there any difference between the frequency, type and directionality of Interactions, socio-emotional atmosphere and individual gaming roles in groups with different numbers of participants?

4. What is the influence of game features on interactions during collaborative gaming?
   - Does game genre influence game choice and use?
   - Is there any difference in perceived competence mediation between different games?
   - Is there any relation between perceived usefulness of game features and enhanced volition to use a game?
   - Do different game genres vary in their social appeal by promoting different levels of Person-oriented interactions and expressions of friendship?
   - How do games influence interactions during collaborative gaming by the level of control and range of options they provide?
   - Is there any relationship between game 'sharability' and type, frequency and direction of interactions during collaborative gaming?

3.2 Exploring the physical gaming experience

The gaming experience of college students, as detailed in the first research question and its subsidiary ones, was explored using a survey entitled *My preferences for digital games*, (Appendix 1). Participants had to fill in important personal details (name, school, class and date when filling survey), indicate the preferred gaming device (PC, Playstation, Mobile phone, other), choose from a number of options the average time spent playing games per day or per week, indicate the preferred social gaming environment (alone, with parents/sister/brother/best friend/a group of friends), select from a list the favourite game/s (various randomised genres were included), write down any other favourite games not included in the list provided and list the three mostly preferred dig-

ital games. The investigation was carried out with a sample of 367, 16–18 year old college students (324 Maltese and 43 Swedish) with a gender distribution of 66% female (n = 241) and 34 % male (n = 126). The survey was completed by students at the commencement of lessons or tutorial sessions forming part of an advanced Biology course.

From the survey data, a list of digital games named by students was compiled, indexed and classified according to the following game genres: Adventure Games, Fighting Games, First Person Shooters, Role-Play Games, Car Racers, Sports, Simulations, Managerial Games, Strategy Games and Puzzle Games. All the games mentioned in the survey by the respondents are listed in the Appendix of Paper 2.

The game index number and genre was entered in the student data sheets. Subsequently all data from survey sheets was entered in SPSS data sheets under the following variables: name, college, form, class, age, gender, gaming device, time dedicated to play, game preferences, game genre. Statistical analysis, results and emerging gaming patterns were discussed in Paper 2. The determining role of gender on game use was immediately identified within this age group. The results were interpreted from a neurocognitive perspective and it was decided to explore further collaborative gaming from the gender perspective using the interactions approach. The data and results also provided insight about potential variables operating in gaming contexts and the experimental possibilities these propose. Hence experimental sessions had to be designed and appropriate instruments developed. This is elaborated in the next section.

3.3 Organising the experimental setting for the theme focussed investigations

Following the publication of Paper 2 with data about the normative aspect of gaming of the student sample, Paper 3 was developed to give an organisational model to the investigation and most important to identify the main categories of interactions manifested in collaborative gaming. Equipped with an organised theoretical model, with a set of focussed research questions and with a method to quantify interactions in collaborative gaming scenarios, the study entered the phase for carrying out the theme focussed investigations. The next section discusses the organisational aspects for realising these theme focussed investigations.

The following procedure was used to organise collaborative gaming sessions during the experimental phase for exploring the influence of the identified key factors that influenced interactions in collaborative gaming:

i. Setting up experimental groups with different composition based on identified criteria
ii. Recording gaming sessions on video
iii. Analysing recorded student and gameplay videos for type, frequency and directionality of interactions
iv. Computing typologies of interactions on to data sheets
v. Entering data into SPSS
vi. Analysing data in SPSS according to identified research questions
vii. Recording and discussing results in papers for publication

3.3.1 Subjects and experimental groups

During this experimental phase collaborative gaming sessions were recorded on video using groups set up from a sample of students attending the first year of a two-year course in advanced Biology at the same pre-university college.

Following analysis of the questionnaire (Appendix 1) about gaming preferences given at the beginning of the scholastic year, groups for experimental sessions were organised according to gender, friendship level and gaming competence, ensuring that different experimental combinations were set up.

Group Composition by Friendship included three categories:

1. Friendly – all participants had a friendship history thus showing a degree of familiarity and camaraderie.
2. Partly friendly – group made of two separately friendly sub-groups or one including a sub-group having a friendship history and an equal number of newcomers.
3. Non-friendly – all participants are new comers and had no friendship history.

Three types of groups were set up according to the *gaming competence* of its members.

1. Competent groups comprising solely enthusiastic gamers

2. Mixed competence groups having equal number of enthusiastic or moderate gamers as non-gamers.
3. Less competent groups comprising solely non-gamers.

Gaming competence was worked out considering the number of hours per week (h/w) dedicated to playing games and the repertoire of preferred games (pg) assuming that enthusiastic gamers dedicate more time and have a wider repertoire of games. Three categories of gaming competence were identified:

Table 2: *Categories of gaming competence*

Gaming Category	Descriptor	Time Hours per week	No. of preferred games
1	Enthusiastic	above 8	above 5
2	Moderate	2 – 7	2 – 4
3	Non-gamers	0 – 1	0 – 1

Fifteen experimental groups with 3, 4, 5 or 6 participant in each were organised according to the different combinations given in the table *Composition of Experimental Groups* (Appendix 2). A total of 57 students, 20 (35%) males and 37 (65%) females were involved. The gender distribution of the participants was 35% male (n = 20) and 65% female (n = 37). Their mean age was 16 years, with a range from 15 to 17 years. The sample is a good representation of the population of Biology students. In a previous investigation about cognitive style of students (Bonanno 2001) within the same department, the sample used was much bigger (n = 581) but the percentages were very similar, 37 % males (n = 212) and 64 % females (n = 369).

Once these experimental groups were set, a schedule was developed for the different experimental sessions. Participants were informed two times about their session date - at the start of the treatment phase (beginning of academic year) when students were asked to book session and record it in school diary, and three days before the treatment to confirm availability. From a data analysis perspective, the group combination in the Table 2 gave a set of independent variables that will be entered in SPSS linking them with both individual variables (gender, individual competence) and group variables (group number, group composition by gender, friendship level, group gaming competence).

3.3.2 Recording experimental sessions

The main objective of this phase of the investigation was to identify type, frequency and directionality of interactions from video recorded gaming sessions. This demanded recording simultaneously students playing the game and also recording the gameplay as seen by students on the computer screen. For this purpose experimental groups were asked to report to the College's 'Media Room' during a free session in their timetable to play assigned games as a group. Games were played using a Laptop PC which was connected through a converter card to a VCR. This VCR was in turn connected to a TV so that students had the opportunity to watch the game being played both from the Laptop monitor and from the TV. At the same time a camcorder fitted on a tripod was placed in front of the students to record group activity. After the session, group recordings were transferred from the camcorder cassette to larger standard video cassette to be used for analysis. The master camcorder cassette was kept as a backup and video analysis was done using the copy.

3.3.3 Digital games used

A thorough search for potential digital games to be used in the context of science education was quite disappointing considering the entertainment oriented gaming industry that invests much less in educational titles. At the time, the prototype digital games – Biohazard, Environmental Detectives, and Replicate – were being developed by MIT researchers as a joint venture with Microsoft. Unfortunately this promising project was passed on to other game production firms but never materialised into a commercial product though 'Environmental Detectives' was released for pocket PCs in the later phase of this investigation.

The best science and technology-oriented game that could be used for this investigation was Sid Meier's *Alpha Centauri* (AC), a science fiction role-playing game in which user has to act the role of a captain landing his spaceship on a planet to colonise it. He has to manage it and build a civilisation using available resources while constantly dealing with social and environmental threats. The game has a compelling introduction using real life videos and an enticing narrative that is very

appealing to students' imagination. But on starting playing the game, students immediately showed their disappointment and rejected it after a few minutes, complaining of over-controlled gameplay that reduce player options to simple, repetitive, mechanistic moves. This definitely limits gamers' imagination to resolve problem situations through very pre-defined solutions. Many groups stopped playing the game after just a few minutes requesting different games to continue the session. Yet this game was used as planned in a number of experimental sessions giving the opportunity to compare interactions profiles of a less appealing game with others that proved to be more engaging.

After a number of sessions having strong negative reactions against AC, it was decided to change the strategy game to the history-oriented game *Empire Earth* (EE) which was immediately acclaimed by students for the balanced intermix between narrative and gameplay. While it was quite difficult to keep students using AC from disengaging after a few minutes, EE engrossed students for longer periods, many times resisting the termination of the session. The game has introductory tutorials to train users in gameplay skills employed later while playing different roles in the game. These introductory scenarios were used during experimental sessions to record students' interactions. Each scenario in the game, which takes an average of 12 minutes to complete, provided an optimal gaming segment allowing for changing roles during the game. During each scenario three or four students took turns as 'executor' by taking control of the keyboard and mouse to manage the game.

Mind Maze (MM) is a puzzle game in Microsoft's Encarta package serving as a self-assessing instrument for users of the Encarta Encyclopaedia. After initial log-in procedure, players have to select the difficulty level (beginner, intermediate and difficult) and the domain in which they would like to have the questions on which the puzzle game is based. Gameplay comprises manoeuvring through a labyrinth of passages in a medieval castle selecting doors and passages on basis of possibilities given by the game after answering content-related questions until arriving at the treasure at the end of the labyrinth. Once a player finds the treasure, a more difficult level can be played. In the experimental sessions the biology or history options were used, the later with student groups having history as a secondary subject. Most of the students enjoyed playing the game, especially female groups who showed

immediate engagement and change of attitude shown through the adoption of a more proactive role.

With a small group of female students, who were able to attend for a number of longer sessions SIMS Deluxe, Need for Speed and Rise of Nations were used. SIMS is a managerial game where players have to build game characters who own a house in a particular neighbourhood. It is a very person-oriented game simulating social interactions. Need for Speed is an action racing game used to explore briefly the type of reactions generated in a friendly female group. Rise of Nations was used to explore how females go about when presented with a totally new game. Since this game was used in a very short session few comparisons and conclusions could be made.

3.3.4 Instruments used

The instruments used to collect and analyse data about the response variables (type, frequency and directionality of interactions) were common to all the theme focussed investigations and related papers. The *Student Interactions Observation Sheet* (Appendix 3) was used to tally Task and Person-oriented Interactions (T&POIs) along a 30 minute time line when observing participants interacting during the video recorded gaming session. The video recording was analysed repeatedly each time focussing on a different group member. The process was repeated for every group member to quantify the time spent in different individual gaming and friendship roles using the *Student Role Observation Sheet* (Appendix 4). The video recordings were analysed for a third time for each participant to quantify the direction of interactions using the *Observation sheet for direction of interactions* (Appendix 5). This instrument recorded the frequency each student addressed directly the other members of the group or the whole group in an anonymous way. The name of the other group members was entered in the first column under the heading 'Addressing'. Computation and rescaling of these interactions were done on basis of gender and gaming roles using the grid at the lower part of the instrument.

Since collaborative gaming sessions were not structured by time leaving groups free to finish any assigned gaming activity, this meant that the various experimental groups took different time spans for finishing the same assigned gaming task. These were then standardised

through rescaling, expanding proportionately all shorter sessions using the longest session (52 minutes) as standard. The instrument Computation, *Rescaling and Recoding Data Sheets for SPSS Variables* (Appendix 6) compiles this data for three gaming sessions for three students. The first column recodes the response variables (type of interactions) as entered in SPSS. For each of these variables the computed value (C = total number of interactions recorded during video analysis) and the rescaled value (R = number of interactions recorded in one session, divided by session time in minutes, multiplied by 52).

Using these common instruments to quantify the 'Response Variables', the investigations and related papers explored the main factors influencing interactions in collaborative gaming through a number of identified 'Predictor variables' related to individual, group and game characteristics. The following sections apply the procedure discussed above to investigate various key factors identified as influencing interactions in collaborative gaming. Each of these themes was elaborated in a paper that was published and included in part II of this thesis (Papers 5-8). For each paper the main research question, a description of the student sample and instruments used for collecting and analysing data are reported.

3.4 Exploring the influence of individual characteristics on collaborative gaming

Since gender was a key predictor variable identified from the review of literature and corroborated through the preliminary survey, it was decided to carry an in-depth analysis of this strong influencing factor. For this purpose Paper 4 extended the investigation beyond the neurocognitive aspect to explore further the influence of gender on distinct psychomotor and social skills.

The first part discusses the physical gaming experiences outlining the investigation reported in Paper 2. The social propensities in gaming of males and females was explored using data obtained from the section about preferred social gaming environment in the preliminary survey (Appendix 1). The data was analysed with gender as predictor variable and preferred social gaming context as response variable.

The last section of Paper 4 utilises the interactions profiles obtained from video analysis of the gaming sessions where different games were

used and examine these having gender as predictor variable with Task and Person-oriented Interactions as response variables. Gender-related interactions profiles for the different games showed how game features and gameplay triggered characteristic behaviours and cognitive activity in male and female participants. The paper concluded discussing the pedagogical implications of these gender-based neurocognitive propensities especially when designing games or game-based learning. Following this analysis a decision was taken to structure experimental groups according to gender that is considered as one of the main predictor variables when analysing and comparing interaction profiles.

In the initial phase of the exploration about the intra-individual gaming experience, analysing pilot experimental sessions showed clearly that besides gender a number of other individual characteristics influenced collaborative gaming. Task and person-oriented interactions depend on entry attitude to gaming, individual gaming competence and personality type of each participant.

Through interviews with students during preliminary explorations, it became evident that entry attitude to gaming was a strong predictor of engagement with the gaming task. Paper 5 synthesises the investigation carried out to explore the influence of attitude to gaming and individual gaming competence in relation to gender. In collaborative contexts, gender-related attitude to gaming influences learners' interactions along the domain, technology and community dimensions. Building on various seminal works from the affective domain, the survey *My Feelings when Playing Digital Games* (Appendix 7) was developed for measuring four components of attitude to gaming - Affective components, Perceived control, Perceived Usefulness and Behavioural components. The survey included 21 statements each scored on a 5-point Likert scale. Twelve statements described situations with positive feelings, while nine other statements describe situations involving negative feelings such as fear, lack of control and hesitation.

This investigation was carried out with 170 college students (16-18 year old), 67% female (n = 113) and 33% male (n = 57). By summing the scores for each attitudinal component four computed variables were derived. Another variable, labelled General Attitude was created by summing these four computed variables. Statistical analysis for each component was done with gender as independent variable and computed variables for each attitudinal component as dependent

variables. The last part of Paper 5 explores the relation between gaming competence (as categorised in Table 2, section 3.3.1) and attitude to gaming.

Paper 6 compiles all investigations about individual characteristics, mainly personality dimensions, gender, attitude to gaming and individual gaming competence. Personality dimensions are discussed from the perspective of the *Myer-Briggs Personality Type Indicator, the Big Five-factor model* (B5FM) and Cognitive Neuroscience. The Approach/Withdrawal tendency (Extro/Introvert personality dimension) was assessed through a short survey, *My Personal Style* (Appendix 8), that was developed using statements both from the Myer-Briggs and the B5FM. Since literature demonstrates that the extro/introvert dimension exerts the main influence on collaborative contexts, with the other four factors exerting minor influence, it was decided to focus mainly on the extro/introvert personality dimension. The underlying assumption was that extroverts adopt more leading roles compared to the more receptive ones assumed by introverts. Statistical analysis was carried out considering personality type as the predictor variable, while frequency and directionality of task and person-oriented interactions as response variables. The results were discussed considering the importance of personality, gender and gaming competence as predictors of interactions in collaborative contexts and how this profiling method could be used in learning and in designing games.

3.5 Exploring the influence of group composition on collaborative gaming

The investigation reported in Paper 7 explored the influence of group characteristics on frequency and directionality of interactions during collaborative gaming. Identified predictor variables included group composition by gender (male, female and mixed gender groups), collective gaming competence (groups of competent gamers, groups with a mix of competent and non-gamers, groups of non-gamers), level of friendship (groups of gamers with a friendship history, group including members with a friendship history and newcomers, groups with no friendship history), emerging collective gaming strategy (groups ending up with a leader, groups with distributed leadership role) and group size (groups comprising three, four, five or six members).

The response variables included both frequency and directionality of T&POIs. The *Observation sheet for Direction of interactions* (Appendix 5) was extended to include directness versus anonymity (one-to-one, one-to-all, total number of interactions) and interaction between leader (L), executor (E) and participant (P) roles in group (L-E, L-P, E-L, E-P, P-L, P-E, P-P). GLM statistical analysis of different combination of these variables led to an important set of results about managing the group during collaborative game-based learning which are discussed both in the conclusion of Paper 7 and elaborated further in chapter 5 as part of the proposed pedagogical model.

3.6 Investigating games as physical and conceptual artefacts

The objective of the last set of investigations summarised in Paper 8 was to evaluate games through a process-oriented approach by analysing user perceptual analysis with interactivity at the task and socio-emotional levels. It is based on the assumption that appealing games give more autonomy to users, are more 'sharable' and enhance group activity manifested as higher frequencies of T&POIs.

Two approaches were used in this investigation. Surveys were used to collect data about game features (predictor variables) that determine game appeal. This comprised a number of response variables forming part of the internal experience of gamers, mainly behaviours manifesting gender-related neurocognitive propensities, perceived competence facilitation, perceived usefulness of specific game features and perceived needs satisfaction along the domain, gaming and social dimensions. The second approach explored how game design features (predictor variables) influenced T&POIs (response variable).

Data collected from the preliminary survey (Appendix 1) about gaming tendencies was used to answer the first empirical research question (ERQ 1) in Paper 8 about the influence of game genre on game choice and use. The assumption is that the appeal of game genre to male and female users depends on the intuitive evaluation of the type of neurocognitive skills that are demanded by a game, both at the individual and collective levels.

Research question 2 focused on the interaction between game genre as predictor variable and perceived competence facilitation as response

variable. This was investigated using a number of surveys dedicated to evaluate specific games. The survey *Perceived Competencies Facilitated by a 'Named Game'*, (Appendix 9) lists the perceived competences facilitated by a game along the domain, technology and community dimensions through pedagogical activities involving acquisition learning, sharing, mediation and contribution. Based on this template, a number of surveys dedicated to specific games were developed. These are listed in appendices 10-14: evaluating *Empire Earth, Age of Empires, Civilisation, Need for Speed, and SIMS. Alpha Centauri* was not included as no students were found who play it. These surveys were carried out with a sample of 86 students (64 males = 74%; 22 females = 26%) who were chosen on basis of their familiarity with the games being investigated. In this case a strong gender effect emerged, showing the greater familiarity of males with games.

Another survey about perceived usefulness of game features entitled *Useful and Appealing Game Features* (Appendix 15) was integrated within each of the dedicated surveys for exploring perceived competence facilitation. Both surveys were administered as one instrument in one session for gathering data related to research question (ERQ) 2 and 3. This research question explores the interaction between game appeal and perceived usefulness of features found within a game such as tutorials, time-lines and reference tools, together with new features to be added to the game in the event of further development such as instant messaging tools, on-line connection and integration of game editing and design tools.

The last three research questions (ERQs 4-6) of Paper 8 explored the influence of different predictor variables on T&POIs as quantified from analysis of video recordings. RQ 4 explores the influence of game genre on social interaction, the socio-emotional climate and satisfaction of the need for relatedness. RQ 5 explores the influence of the degree of control and autonomy delegated by a game to the user (predictor variable), on TOIs and roles adopted by participants during collaborative gaming. The effect of game genre on interactions is explored in RQ 6 from the perspective of game sharability. Games which offer low level of interactivity provide poor gameplay based on simplistic binary decisions, while highly interactive games allow players to interact at different levels with higher frequencies and repertoires of interactions directed to different group members. Quantifying the interac-

tion profiles of different games used in experimental sessions makes it possible to rank the games according to degree of sharability.

3.7 Evaluation of the empirical procedures and data gathering

This section evaluates the instruments and procedures used in this investigation discussing the reliability and validity of the approach and the underlying integrative model together with the construct validity of the range of variables explored in this investigation.

Kirriemuir and McFarlane (2004) comment on the taxing nature of research involving games. They claim that games are an interdisciplinary subject serving as a research context for a wide range of different fields. This offers a challenging situation for locating research across a range of areas and then having to deal with confusing overlaps and differences in terminology used in respect of games across these different research fields. Actually this characterized the initial phase of this investigation during which insight into the research carried out in various fields had to be developed in order to arrive at a workable methodological approach. The same demands were experienced for arriving at a comprehensive pedagogical model that could be useful in designing and evaluating the complex situation of collaborative gaming contexts comprising a wide range of interacting variables. To cover the theoretical, methodological and interpretive aspects of this investigation in a comprehensive and disciplined way, a more extensive research and reporting processes had to be undertaken. The published papers demarcate eight research cycles each focussing on a major aspect of the collaborative gaming context.

This investigation uses a combination of qualitative and quantitative research methods. It can be best described as a qualitative framework with quantitative components. Krathwohl (1998, 243) claims that qualitative methods are especially useful for exploring a phenomenon, for understanding it, and for developing an understanding of it into a theory. Burns (2000, 13) claims that 'Unlike many of the traditional, more narrow approaches to the educational experience, the qualitative mode of inquiry is characterised by methodological eclecticism, a hypothesis-free orientation and an implicit acceptance of the natural scheme of things.' These methods humanise situ-

ations and make them come alive. Since they focus on process rather than product, they are particularly useful in describing multidimensional, complex interpersonal interaction where the limited focus of quantitative measures would be inadequate. Burns (2000) comments on the strengths of qualitative descriptions for suggesting possible relationship(s), causes, effects, and even dynamic processes in school settings. Thus they communicate well to practitioners.

This investigation followed Krathwohl's (1998, 242) research model involving the simultaneous pursuit of data gathering, report development and data analysis; the continuous data reduction through the stages; and the merging of the streams of activities in the closing stages of the study. During the first stage data was gathered through surveys. This led to the second stage involving the summary and packaging of data using triangulation across participants, groups, experimental context and methods. During this stage quantitative methods were used to analyse video recorded gaming sessions. In the context of developing the papers for publications, data was analysed to establish both internal relationships and relationships to the proposed pedagogical framework. Yet this process led to the identification of gaps in data related to the different variables operating in collaborative gaming, thus leading to other research cycles involving further reviews of literature, repackaging and selection of central data related to identified themes. These themes were organised into a revised explanatory framework by integrating them under higher order factors. The final stage involved the development and testing of clusters of propositions around the main factors that were identified as exerting major influence on collaborative gaming through theme focussed investigations. The emerging trends and results were then used to construct the final explanatory framework.

The three major techniques used in gathering data were questionnaires, video analysis and interviews. The experimental sessions involving collaborative gaming recorded on video were organised according to pre-set conditions controlling various variables. Surveys were administered before experimental sessions while interviews were used as a follow-up activity. The use of multiple approaches is highly recommended since triangulation leads to a better corroboration of results and if used sequentially in an evolutionary strategy, these approaches help in deciding the next steps in an investigation (Krathwohl 1998).

Burns (2000, 419) maintains that triangulation explains more fully the richness and complexity of human behaviour by studying it from more than one standpoint and/or using a variety of methods combining qualitative and quantitative methods. Thus in this investigation qualitative methods were first used to identify effects and then quantitative methods were employed to determine their size. Referring to the work of Metfessel and Michael (1967), Krathwohl (1998) discusses the strengths and weaknesses of a variety of data-gathering methods.

3.7.1 Questionnaires/Surveys

Questionnaires are quick, economical to administer and easy to score and summarise. Burns (2000) list a number of other advantages. Since each respondent receives the identical set of questions or statements, phrased in exactly the same way, this leads to better standardisation and higher reliability. Respondents are free to answer in their own time and at their own pace and if confidentiality is guaranteed more truthful responses can be obtained as compared to other approaches that involve direct contact with researcher. On the negative side there is no assurance that respondent correctly understands questions or directions. The investigator may know exactly what is meant by a question, but because of poor wording or differential meaning of terms, a significantly different interpretation is made by the respondent. As a result of design these instruments may prove to be non-flexible thus limiting respondents from providing free expression of opinion. Alternatively, open-ended instruments may produce data that cannot be merged easily for systematic analysis. Another shortcoming mentioned by Burns (2000, 581) is the unknown motivation of respondent for answering the questionnaire. Tuckman (1994, 233) cautions about 'acquiescence response bias' caused by the use of scales in scoring statements that lead respondents to act out of boredom, disinterest, or hostility by always marking a single choice. This is controlled by using item reversal where responses to items written in one direction will cancel out or neutralise items written in the other. Ideally half the items should be written in each direction, for example half dealing with positive feelings and half with negative ones.

In developing the questionnaires used in investigations to explore different aspects of games - Normative aspects of games, Appendix 1;

Attitude to gaming, Appendix 7; Perceived competence facilitation, Appendices 10-14; and Useful and appealing game features, Appendix 15 - two important limitations had to be considered. Tuckman (1994) discusses the 'social desirability response bias' arising from the tendency to respond in a way that shows oneself in the best possible light. Since gamers experience a lot of social pressure arising from the negative connotations of gaming in relation to academic performance, they tend to project an unauthentic picture of their gaming experience. Tuckman (1994) suggests three ways to minimize this bias: 1) not revealing the true name or purpose of the questionnaire prior to its completion, 2) including items that measure a variety of topics or aspects of a single topic, 3) including filler items dealing with unrelated themes. Tuckman points to the fact that it is difficult to disguise the nature of the attitude being measured, and so more responses can be expected to reflect social desirability rather than true feelings. The halo effect is another bias mentioned by Krathwohl (1998). This is tendency to respond to rating scales in terms of a general image of the person or the ideal conception of a gamer rather than rating the specific characteristic requested.

In this investigation it was not possible to disguise the title and the purpose of any of the instruments used and no filler items were used since questionnaire length was a critical factor. Thus the desirability response bias was controlled by including various aspects related to the theme of the questionnaire and each aspect was assessed through a number of statements. It is assumed that respondents will not be able to answer all statements pertaining to a theme in a socially desirable way. In the case of games it is very difficult to control for the halo effect as respondents may adopt extreme conceptions. If one focuses on promoting a positive image of a gamer s/he may tend to blow up his/her gaming capabilities. On the other hand if a participant reacts from an academic point of view, the academic image is boosted through the denigration of the gaming identity. Thus during administration of the survey, emphasis was continually made on gaming as an educational and recreational activity that complements but does not compete with academic duties.

The survey about normative aspects of gaming (Appendix 1) was found to be a valid instrument that quantifies accurately the different variables describing the individual gaming experience. The final version used in the experimental sessions was derived after evaluat-

ing various prototypes. To avoid the Hawthorn effect, mainly the special attention that researcher may give to students declaring themselves as competent or avid gamers, the instrument was administered at the beginning of a normal subject lesson enforcing the 'business as usual' climate. The different sections of the instrument were read and explained at the beginning of the session ensuring all participants had no difficulties in understanding or working through the instrument. Students had to complete the survey on their own though researcher was available to answer any queries. To control for the Pygmalion effect whereby researcher consciously or inadvertently influence subjects' decisions in the desired direction, researcher avoided going round the room supervising students while they were marking the questionnaire but stayed in front of the group sitting at the side of the room. Personalised remarks or passing feedback through any form of body language were avoided. During informal interviews this effect was controlled by having researcher follow a pre-structured discussion plan comprising the main points relevant to the theme in question.

The validity and reliability of the instrument used to measure attitude to gaming (Appendix 7) are directly related both to the standardised source instrument, Selwyn's (1997) 'Attitude to Computer' and to its structure. All statements were faithfully and accurately applied to the collaborative gaming situation taking all necessary precautions not to change the nature of the statement and to keep the proportional representation of the four attitudinal components as in the original instrument. Nonetheless, this new version of the instrument will be validated and standardised in the future through longitudinal surveys using larger student samples. A number of researchers already contacted the author asking for permission to use the instrument or close modification of it in their investigations. This provides the opportunity to validate and standardise the instrument on an international basis.

The instrument used to assess the intro/extrovert personality dimension (Appendix 8) includes statements from validated and standardised instruments (Myers & McCaulley 1985; Goldberg 1990) thus reducing the possibility of expressional ambiguities. It is limited by the subjectivity of all self-reporting instruments, mainly the mood-related discretional momentarily assessment and understanding of each separate statement. As a control measure, the instrument was administered in the middle of the first experimental session when students felt com-

fortable and acclimatised to the experimental setting. The statements were read out clearly by the researcher moving systematically through the survey. Students were encouraged to ask for clarifications in case of difficulties. Since this instrument was used more to indicate rather than to measure personality type, it was administered once without having confirmatory runs of the survey at a later stage of the investigation. The quantitative aspect of personality type was determined by using the innovative approach of quantifying the frequency and directionality of interactions. The validity of this approach was confirmed by the significant correspondence between the determined personality type and the interactions profiles obtained.

One of the variables identified as influencing interactions in collaborative gaming was individual gaming competence. The scheme used to categorise gaming competence was developed following suggestions made by other researchers (Rigby 2004; Ryan et al. 2006). Its reliability was internally tested by establishing the statistical significance of the correlation between time dedicated to play games and the number of preferred games. A strong statistical correlation at the 0.01 level was found confirming its validity for the intended use.

The instrument developed to assess 'Perceived gaming competence facilitation' (Appendices 10-14) also needs to be validated and standardised. To ensure both precision and accuracy, versions dedicated to the evaluation of different games were developed adapting the statements to the game parameters. While the nature of the statements (type of competence) was not changed, the qualifying nomenclature was adapted to the game title. During development of the instrument it was not possible to use the item reversal technique to control for the 'acquiescence response bias' while writing down the different competences. Describing a perceived competence through a negative statement created a lot of ambiguity that increased the chance of misinterpretation. Therefore all statements were written to express positive perceptions. The principle of using multiple themes to described perceived competences was retained so that each competence was described through multiple statements.

To enhance methodological consistency and validity, a standard procedure was used while administering this survey. The level of proficiency of each student in playing a particular game was established during an informal interview after which a version of the instrument was

assigned to the student according to the identified game. The assigned instruments were given to students at the beginning of class sessions. Instructions were read and explained ensuring understanding of scoring mode. Then the statements were read slowly and clearly making sure that the statements were understood correctly before scoring. Researcher stayed in front of students at the side of the room avoiding preferential exchanges and ensuring good verbal communication in case of queries.

3.7.2 Video analysis

This technique was used to gather data in relation to the quantitative aspect of this investigation where frequency and directionality of interactions were measured in relation to other identified variables. The observation sheets were developed following recommendations by Burns (2000) who describes the techniques developed by Bales (1950) and subsequently by Flanders (1970). Observers are required to record pre-defined behaviours within a stipulated time. Thus to quantify participants' behaviour during collaborative gaming sessions recorded on video, interactions were tallied on observation forms (Appendices 3-5) that included a list of interactions to be observed and details about students and experimental groups. The sheet was divided in columns each representing one minute along a time-base.

According to Krathwohl (1998) and Burns (2000) observation forms like these are easy to complete and can be scored objectively by following standardised guides for observations. They have a built-in point of view regarding what is important to observe. The main advantage is that analysis of gaming activities is simultaneous with collection of the data when observer categorises observations as they are made. But there is the possibility to lump unlike acts together or deviate from specified criteria. Researcher may overlook meaningful behaviour that is not reflected in the instrument.

A second area of concern is related to methodological shortcomings. Task and person-oriented interactions were identified and quantified by the author through repeated observation of video recordings of the gaming sessions and tallying interactions on relevant data record sheets. Sample sessions were rated by different persons to check for researcher's subjectivity and a number of sessions were rated by the

author on different days to check for consistency and bias. The joint probability of agreement approach was used for random samples of different types of interactions. Since most ratings resulted in the 60 – 70% range, the recording method was considered to have an acceptable level of consistency.

The reliability and validity of both the instruments and the method were enhanced by repeatedly evaluating the list of interactions on the 'Student interactions observation sheet' (Appendix 3) while recording interactions for different sessions ensuring that each interaction included in the instrument describes a discrete action. A guide was developed to be used while analysing video sessions where each interaction was described in detail distinguishing clearly what should be recorded and what should be left out. This guide was read at the beginning of each video analysis session and kept handy for reference during the exercise. Consistency was also controlled by having sessions rescaled using a common time base.

One must also point to the validity of the dual approach adopted for capturing both task and person-oriented interactions to quantify the influence of a number of factors on gaming and on group activity. The two types of interactions are strongly linked to each other, one reinforcing the other. Thus assessing both provides a more robust methodology for capturing underlying interacting variables and processes. This is in line with recommendations from seminal works in a number of fields that emphasises the intimate relationship between cognitive, affective and conative aspects of human behaviour (Damasio 1994; Kreijns, Kirschner & Jochems 2003; Gallese 2003; Frith & Wolpert 2003; Gazzaniga 2004; Gazzaniga, Ivry & Mangun 1998). This is a more reliable approach for capturing the complexity in collaborative gaming.

3.7.3 Interviews

Together with surveys and participant observation, informal semi-structured interviews were also used to capture participants' beliefs, feelings, perceptions, motivations and behaviours in relation to games and collaborative gaming contexts. Throughout the investigation unstructured or semi-structured informal interviews were carried out with students, individually or in groups, participating in any of the

data capturing situations. Normally this took place after administering one of the instruments or after gaming sessions. Appendix 16 includes a guide used for a semi-structured interview after administering the instruments 'Perceived competence facilitation' and 'Useful and appealing game features' with students who were proficient in the use of the game 'Age of Empires'. The first questions are intended to create discussion about gameplay tactics and strategies. The next set of questions inquires about domain model and contemporary applications. The rest of the questions have a pedagogical orientation attempting to focus discussion on using games in instructional and constructionist approaches.

These interviews allowed for deeper and more elaborated responses from students or groups of students. The lack of structure to the dialogue will provide a window into the routinely constructed interpretations and habitual responses of each individual (Burns 2000). As a process the interview was used to capture nonverbal responses that revealed feeling about the particular gaming aspect being discussed. Most of these idiosyncratic reactions and expressions corroborated the data obtained through surveys or on video.

Obviously a number of biases decrease the validity of the interview as a research technique. In just a short time so much information can be communicated that it may prove to be difficult to analyse and summarise. Interviewer would have to reconstruct the whole experience introducing further bias in the process. To control for this some of the discussions were recorded on audio or video. In discussions about games there is also the possibility of the interviewer influencing responses by the particular direction taken and specific emphasis made. Adhering to the pre-planned guide limits this bias. At the same time the interviewee may start accommodating to the proposed ideas in an attempt to please the interviewer. This was partially controlled by randomising the questions or discussion topics so that accommodation patterns get aborted by constant change of ideas and positions. The interviewee may feel that confidentiality of response is more limited than the anonymous response to a questionnaire.

Thus controlling for these biases turns the interviewing process into a more authentic introspective tool. The insight obtained through these interviews facilitated the construction of a framework that integrated the various sources of data and the diverse components of the system.

3.7.4 General comments

These instruments were used in theme focussed investigations to gather data about the different variables interacting in collaborative gaming contexts. These explorations were developed through a cyclic process during which the various versions of the instrument were evaluated and refined until arriving at the final form that was used in experimental settings. The fact that these instruments were not validated and standardised using large random student samples limits the reliability of the data collected. Thus the consistency in measurements of the instruments used for quantitative aspects of the investigation and inter-rater reliability of those used in more qualitative situations needs to be evaluated.

During the course of the investigation the validity of the model adopted, that is, measuring interactions along the domain, technology and community dimensions in relation to the three identified pedagogical levels was constantly confirmed. Any situation in group-based gaming was found to be determined by the individual characteristics of the participants, by the game title or genre, by the surface and deep structure of a game by the composition of the group and by the level of participants' competence in each of these dimensions.

The same level of consistency and validity was continually experienced, not only in relation to the organising model, but most important regarding the underlying processes operating in technology-intensive collaborative learning environments and the main factors influencing interactions as identified from literature review. Constant resonance was observed between the theoretical framework developed from literature and the methodology adopted to analyse these contexts. Triangulation confronted observations recorded by quantitative (proposed interactions-based instruments) and qualitative (in/formal interviews) methods with theoretical models and the adopted methodology. This reflection on the process of the investigation helped to develop a more coherent conceptualisation of the collaborative gaming experience and thus fine tune the methodology of the various research cycles.

At a metacognitive level, the investigation had to grapple continually with the complexity of the adopted methodology. The use of such a comprehensive model integrating a wide range of variables that had

to be analysed separately could easily lead to a degenerate, fragmented approach. Yet literature constantly emphasises the avoidance of simplistic approaches that focus solely on single or a small number of variables because the actual collaborative gaming situation is in itself complex. Researchers have to adopt approaches that acknowledge the complexity and the dynamic nature of collaborative activities. At this point one may refer again to the quotation from Dillenbourg et al. (1996) in section 2.6 underpinning the model used for this investigation and also to the one heading this chapter both emphasising this integrative aspect. Consequently, throughout this investigation striking a balance between the analytic (single factor) and systemic approaches (Salomon 1990; 1996) proved to be a continual challenge that was addressed by integrating all factors and variables within an operational model keeping in focus the rather complex experimental situation.

At the operational level this presented quite a problem because the experimental setting never permitted the implementation of all theme focussed investigations within one group. Due to academic and administrative constrains it was not possible to run all instruments with any of the experimental groups. The typical context allowed for only three instruments (one questionnaire, gaming session recorded on video, informal interviews) to be used with any of the groups attending a limited number of sessions. Although this gave relevant and valid data showing interesting interactions between the variables, a comprehensive interactions profile could not be developed for each group and thus empirical modelling for the whole set of variables of each experimental group was not possible. Modelling could only be done with a small number of factors explored with a particular group participating in separate experimental settings.

Actually this level of analysis is very complex demanding extensive and elaborated investigations that definitely fall outside the boundary of a single doctoral investigation. So this study considered only the level of factor identification and methodological integration rather than that of statistical integration. A more extensive and structured experimental set-up has to be developed involving a number of researchers each administering all theme focussed investigations with a small number of groups over longer periods of time.

4 RESULTS

"Games offer opportunities for learning that are qualitatively different from those of direct instruction. The challenge is to develop the associated knowledge base for complex student-directed learning." Gredler (1996).

This chapter compiles the results obtained by the various investigations organised around key themes related to the collaborative gaming experience. Results are categorised according to the main research questions (RQ). The following summary of various categories of analysis and abbreviations are useful while reading through the concise summary of the empirical findings in this chapter:

- Task-Oriented Interactions (TOIs): focussed reception, interacting with game, imitating game actions, reference to personal biography regarding gaming, asking (help), giving help, responding, sharing, providing feedback, confirming, suggesting.
- Person-Oriented Interactions (POIs): a) pPOIs = positive POIs: pleased looks, jubilant expressions, approving gestures and recommending game b) nPOIs= negative POIs = neutral looks, expressions of disagreement or rejection, disapproving gestures, disengagement, hostile reactions and censuring game.
- Roles during gameplay: supporter, executor, spectator, participant
- Gender interaction: male, female
- Personality type: extrovert, introvert (also expressed as approach, withdrawal behaviours).
- Directionality of Interactions including an initiator and a receiver: ILE – Interaction from Leader to Executor; ILP – Interaction from Leader to Participant; IEL – Interaction from Executor to Leader; IEP – Interaction from Executor to Participant; IPL – Interaction from Participant to Leader; IPE – Interaction from Participant to Executor; IPP – Interaction from Participant to Participant.
- General Linear Model: GLM

4.1 Major gaming tendencies and patterns of the student sample

The first main research question focused on gaming tendencies and patterns. Section 4.1 summarises the key findings of the original Papers 2 and 4 presented in Part II. The sub-questions of the main research question serve as subtitles in the following texts.

4.1.1 Gaming device mostly used by students

The Personal Computer was found to be the most common gaming device 56%, followed by the Play Station 17%, the Mobile Phone 10%, Nintendo 1% and None (no preference) 16%. The mobile phone 13% was the second most preferred gaming device, followed by the Play Station 12%, the PC 1.5% and Nintendo 1.5% while the Xbox was the least used (1%). 71% did not give any response (None) to this item in the questionnaire.

4.1.2 Time dedicated by students for playing digital games

Average playing time for males was found to be 6.7 hours per week and for females 2.5 hours per week. Logistic regression shows that for low playtime values, there is a greater probability for female allocation while for a higher playtime value there is a greater probability of male allocation.

4.1.3 Time dedicated for playing digital games by Maltese and Swedish students of the same age

On average Swedish males dedicated more time to playing digital games than Maltese males. Conversely, Maltese females dedicated more time to playing games than their Swedish counterparts. A Two-way ANOVA with Gender and School (Junior College and Thorildsplan Gymnasium, Stockholm) as the Predictor variable and Playtime as the Response variable gave a $p < 0.001$ ($F_G = 54.32$) and $p < 0.860$ ($F_S = 0.03$) respectively. The gender difference observed for the whole

sample applies also to the different sub-samples. Males, in both sub-groups, play more than females. On the other hand, when comparing the difference in mean playing time for student groups from the two colleges, the $p < 0.86$ value showed that the difference in mean time dedicated by the Maltese and Swedish students to playing digital games was not statistically significant.

4.1.4 Time dedicated for playing digital games by students from different age cohorts

The different age cohorts were Maltese First and Second Year College students (16-17 and 17-18 years old respectively). Both male and female first year Maltese students dedicate more time to playing games. Two-way ANOVA taking Form and Gender as the predictor variables and Playtime as the response variable gives a $p < 0.73$ ($F_F = 3.23$) and $p < 0.00$ ($F_G = 49.70$) respectively. The p value for Form ($p < 0.073$) shows a tendency that cannot be ignored between the mean playtime of the two forms. First year students tend to dedicate more time to playing than second year students. Within the Maltese sample, there is a highly significant difference in playtime arising from gender, with a $p < 0.000$ ($F_G = 48.99$). In all groups males dedicate more time to playing games than females.

4.1.5 Game genre preferred by male and female students

The most popular game with males (9% selecting it as their first preference) is the First Person Shooter 'Half-Life', followed by the Football game 'FIFA' (7%). The two games mostly preferred by females are the puzzle games 'Solitaire' (10%) and 'Snake' (9%). The difference between sexes was statistically significant ($\chi^2 = 29.34$; $p < 0.001$).

4.1.6 Social context for gaming preferred by male and female students

A highly significant difference regarding the preferred gaming social context was obtained ($\chi^2 = 16.22$; $p < 0.001$): 69% of the males prefer solitary gaming compared to 31% who prefer playing games in

company with others. The reverse tendency applies for girls who prefer gaming with others (57%) to playing games alone (43%).

4.2 The influence of individual characteristics on interactions during collaborative gaming

The second main research question focused on individual characteristics of players. Section 4.2 summarises the key findings of papers 5 and 6 presented in Part II.

4.2.1 The influence of the intro/extrovert personality dimension on interactions and individual roles during collaborative gaming

(a) Type of interactions

Extroverts show statistically significant higher task-oriented interactions involving *Asking* ($p < 0.056$; $F_A = 3.72$) and *Suggesting* ($p < 0.049$; $F_S = 3.97$). They also show more POIs manifested as expressions of approval or *disapproval*, ($p < 0.004$; $F_D = 8.44$). In general extroverts tend to show more frequent communication activity and POIs.

(b) Directionality of interactions

Extroverts show higher means for 'One-to-One' interactions and 'Total number of Interactions'. Extroverts are more active participants in a group, communicating directly with colleagues in a non-anonymous, directed way. Conversely, participants with high frequency of interactions showing a tendency for person-to-person interactions are extroverts. A more withdrawn person showing less person-to-person and one-to-all (anonymous) interactions can be classified as an introvert. Figure 3 gives the interactions profile developed for a group of five participants having different personality tendencies.

A and B were categorised as extrovert by instrument used to assess personality type and showed more 'initiating' (directing) and 'receiving' interactions. Members C, D and E classified as introvert are characterised by either a more restrained interactions pattern or total lack of interactions. The means for interactions that A directs to B (AB) and

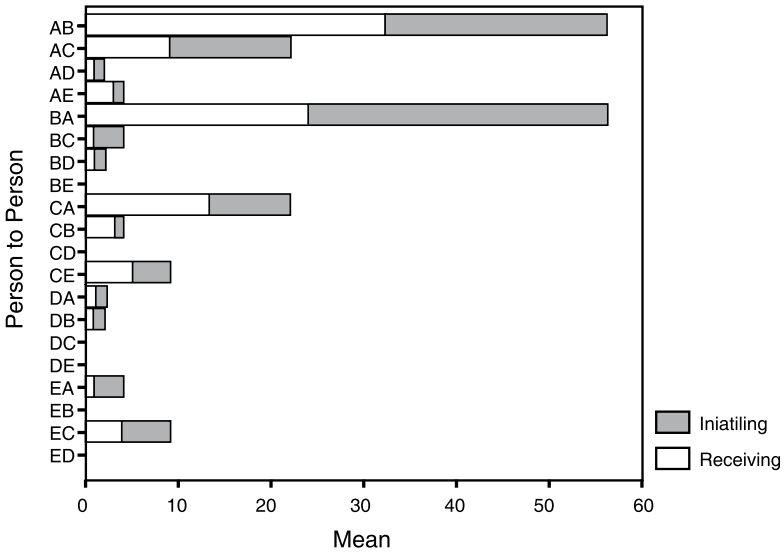


Figure 3: *Interactions profile for a group of five participants with different personality tendencies*

that B directs to A (BA) are much higher than those for interactions that C directs to A (CA), D directs to A (DA) or E directs to A (EA). The figure gives all the other direction possibilities arising or received by the different dyad combinations of participants.

(c) Personality and gaming roles

Extroverts tend to adopt a Supporter role ($p < 0.018$; $F_{Sup} = 5.77$) while Introverts a Spectator one ($p = 0.04$; $F_{Spec} = 4.31$). No significant interaction was recorded between personality dimensions and the other roles which were Leader ($p < 0.608$; $F_L = 0.26$), Guide ($p < 0.980$; $F_G = 0.001$) and Follower ($p < 0.238$; $F_F = 1.41$). A statistically significant interaction was obtained between the introvert personality dimension and the spectator role. Higher means were also obtained for introverts showing 'leader' and 'guide' roles. Both results point to the task-oriented strategy adopted by Introverts emphasising much less interpersonal interactions. On the other hand Extro-

verts show a higher mean for the Follower role and a statistically significant value for the Supporter role indicating a more person-oriented approach in collaborative gaming.

A statistically significant higher mean was recorded for Extrovert leaders interacting with Executors, ($p < 0.005$; $F_E = 10.81$). Introvert Executors showed a tendency to interact more with participants than with the leader. Computing together leader interactions (ILE + ILP), Executors' (IEL + IEP) and those of Participants (IPL + IPE + IPP), a significant interaction was obtained only for Extrovert Participants ($p < 0.029$; $F_{EP} = 4.95$). These show higher means than Introverts for interacting with Leaders, Executors and other Participants. This confirms the above recorded trend that Extroverts exploit collaborative gaming to foster interpersonal interactions while Introverts interact with others driven by task exigencies. Extroverts correspond to Bartle's (1996) *Socializers and Explorers* and Yee's (2006) *Social Players* who 'interact with others to develop in-game relationships'. Introverts are consistent with Bartle's *Killers or Achievers* and Yee's *Achievement* and *Immersion* players who tend to seek more 'game mastery, competition and gaining power within the game.'

4.2.2 The Influence of gender-related neurocognitive propensities on interactions in collaborative gaming

The influence of gender-based neurocognitive propensities was manifested by the type of games players preferred to interact with. Higher percentages of females opted for Puzzle and Fighting games while a higher percentage of males preferred First Person Shooters, Role Playing games, Sport and Strategy games. The pattern that emerged confirms the command strategy adopted by males showing higher frequency of interactions related to gameplay and game management (navigational activity). Females tend to adopt a more reflector role showing higher frequencies of interactions related to the task at hand involving mainly rehearsal and retrieval skills.

4.2.3 The influence of different attitudinal components on interactions in collaborative gaming

General attitude to gaming was investigated in Papers 5 and 6 through four attitudinal components: Affective comportment, Perceived Usefulness, Perceived control, Behavioural components.

(a) Affective comportment

Males were found to be less apprehensive to gaming than females and feel more confident when using and navigating through games (Survey statement 1: $\chi\chi^2 = 12.13$; $p < 0.016$). Both sexes are not inhibited by beliefs arising from negative perceptions of looking stupid with others when playing games (Survey statement 5: $\chi\chi^2 = 2.42$; $p < 0.659$). Both sexes perceive gaming as an intelligent and socially accepted activity.

Regarding hesitation in the use of hardware (Survey statement 16: $\chi^2 = 14.58$; $p < 0.006$), males show full confidence with gaming devices, while females are more hesitant. The fact that both sexes don't feel uneasy about using games (Survey statement 8: $\chi^2 = 2.89$; $p < 0.590$) shows that gaming is accepted as an enjoyable experience.

(b) Perceived usefulness

The therapeutic effect of games (Survey statement 2: $\chi^2 = 10.38$; $p < 0.034$) is appreciated more by male gamers who agree that games provide unique relaxing experiences, enabling them to work better. Most females do not share this belief. Diversion and catharsis (Mitchell & Savill-Smith 2004; Kirriemuir & McFarlane 2004; Bensley & Van Eenwyk 2001; Prensky 2006; Pandey, Pandey & Shreshtha 2007) are more pronounced in male gamers. Females tend to be more sceptical than males about the instructional potential of games, considering that other tools (Survey statement 13: $\chi^2 = 8.47$; $p < 0.076$) provide what can be learned from games. Games provide experiences that conflict with female rehearsal-based information processing strategy and their non-competitive social approach. Males consider games as more useful learning tools since these accommodate to their neurocognitive propensities – a manipulation-oriented information processing approach (Halpern & Wright 1996; Casey 1996), a 'command' strategy (Rommes 2002) for executing tasks and a competitive social comportment, (Turkle 1988;

Turkle & Papert, 1991). Both sexes consider gaming as a way to enhance the learning experience to a degree that justifies the extra effort (Survey statement 6: $\chi^2 = 6.67$; $p < 0.154$), that gaming provides more interesting and imaginative ways for learning (Survey statement 17: $\chi^2 = 3.75$; $p < 0.441$) and that games provide efficient and effective learning experiences (Survey statement 21: $\chi^2 = 0.86$; $p < 0.931$).

(c) Perceived control

Males feel much more confident in self-teaching anything related to gaming (Survey statement 3: $\chi^2 = 15.34$; $p < 0.004$), solving game-related problems (Survey statement 15: $\chi^2 = 14.82$; $p < 0.002$) and feel a sense of control over gaming devices. Females lack such confidence and overtly expressed their need for guidance and support from a more competent person something utterly resisted by males. Males are more independent, perceiving themselves as competent enough to manage gaming.

(d) Behavioural components

Both sexes declare that they do not avoid using games for learning. Females declare using games when asked to do so, while males are more autonomous in their approach. Also, while college males are much more determined to get engaged in gaming, females are much less enthusiastic. A highly statistically significant gender effect was obtained in relation to avoidance of playing games for entertainment, (Survey statement 14: $\chi^2 = 19.68$; $p < 0.001$). While males are indiscriminate in their gaming engagements, females tend to play games more for learning avoiding gaming solely for entertainment.

(e) Gender-related differences in general attitude to gaming

The scores for each statement related to the various attitudinal components were computed to develop four separate computed variables: Computed Affective Component, Computed Perceived Use, Computed Perceived Control and Computed Behavioural Component. Another variable, labelled 'General Attitude', was created by summing these four computed variables. Table 3 gives these five computed variables and related statistical data.

Table 3: *Computed attitudinal variables*

	P value	F value	Mean Males	Mean Females	Mean Total
Computed Affective Component	0.001	12.30	19.36	17.27	17.96
Computed Component for Perceived Use	0.046	04.05	12.93	11.99	12.30
Computed Component for Perceived Control	0.000	28.85	12.32	10.42	11.05
Computed Behavioural Component	0.000	19.63	12.32	10.42	11.05
General Attitude	0.000	26.63	62.70	54.53	57.24

Using GLM statistical analysis for each component, with gender as predictor variable and computed variables for each attitudinal component as response variable, the p and F values were obtained. The p values for all five variables showed high statistical significance with males showing higher means and thus manifesting an overall more positive attitude for all attitudinal components.

Using the values for the General Attitude variable, another scale variable – Attitude Classification - was created. Table 4 gives the scoring range for the different variable categories.

Using Cross-tabs, the Attitude Classification Variable was analysed in relation to gender. A highly significant $p < 0.000$ for Pearson chi square ($\chi^2 = 18.10$) was obtained with males showing a very positive attitude to gaming while females show a less positive or neutral attitude to gaming.

Table 4: *Attitude classification*

Scoring Range	Attitude Classification Value Label
0 – 17	Very negative attitude
18 – 35	Negative attitude
36 – 51	Neutral attitude
52 – 68	Positive attitude
69 – 84	Very positive attitude

4.2.4 The influence of gaming competence on attitude to gaming

Using GLM statistical analysis to investigate possible interaction between Individual gaming competence as predictor variable and Computed Attitude as response variable, a highly significant $p < 0.000$ ($F_{CA} = 15.20$) was obtained. Using Cross-tabs, the Attitude Classification Variable was analysed in relation to Individual Gaming Competence. A highly significant $p < 0.001$ for Pearson chi square ($\chi^2 = 22.67$) was obtained. It is evident that Enthusiastic gamers show very positive to positive attitude to gaming, moderate gamers show positive attitude, while most non-gamers show neutral or negative attitude to gaming.

4.2.5 The influence of individual gaming competence on interactions in collaborative gaming

Enthusiastic gamers (mostly males) tend to engage in Negative POIs manifested as comments showing disagreement, disapproval and censuring of game. They also tend to be anonymous in their interactions showing mainly 'Male to All'. They tend to manifest a strong 'leadership' individual gaming role. Moderate gamers tend to engage in Positive POIs such as 'Providing feedback', 'Confirming' and 'Pleased look.' They tend to be more specific in their interactions showing mainly 'Executor to Participant' and tend to adopt a 'guide' as individual gaming role. Non-gamers tend to show Negative POIs due to their feeling of incompetence in collaborative gaming contexts adopting a passive gaming role with few TOIs.

4.2.6 The influence of individual gaming competence on roles adopted during gaming

More competent gamers adopt an active, leading or supporting role, while less competent gamers adopt passive, spectator roles.

4.2.7 The interaction between individual gaming competence and gender

Males are predominantly enthusiastic gamers while most females fall into the moderate or non-gaming category.

4.3 The influence of group characteristics on interactions during collaborative gaming

The third main research question focused on the role of individual characteristics in group-based gaming. Section 4.3 summarises the key findings of the Paper 7 presented in Part II. The sub-questions of the main research question serve as subtitles to organise the discussion.

4.3.1. The influence of group gender on the type, frequency and directionality of interactions

'Suggesting' ($p < 0.02$; $F_S = 4.04$) is the only Task-oriented Interactions (TOI) showing statistical significance in male groups implying action from a participant directed to the game executor and thus manifesting a tendency for a 'Command' approach. Statistically significant TOIs for female groups included 'Providing feedback' ($p < 0.001$; $F_{PF} = 7.82$) and 'Confirming' ($p < 0.067$; $F_C = 2.75$). This shows their more collegial tendency with game executors asking for suggestions and colleagues providing feedback, which in turn is reciprocated by 'Confirming' expressions. There was no type of TOIs showing statistical significance for mixed gender groups indicating the restraining conditions arising from underlying conflicting gender-based approaches.

Regarding Person-oriented interactions (POIs) male groups showed no statistical significance for single POIs but statistical significance was obtained for summed communication activity ($p < 0.047$; $F_{CA} = 3.12$) which include all task-related interaction. This shows a greater orientation to tasks at hand, with less emphasis on interpersonal communication. Female Groups showed statistical significance for 'Pleased Look' ($p < 0.000$; $F_{PL} = 9.42$), 'Jubilant' expressions ($p < 0.027$; $F_J = 3.70$) and summed positive POIs ($p < 0.00$; $F_{pPOI} = 10.61$). This shows a more person-oriented approach with higher levels of interpersonal communication and expressions of positive feelings.

The restraining climate prevalent in mixed gender groups is manifested through statistical significance for 'Neutral look' ($p < 0.006$; $F_{NL} = 5.34$), expressions of 'Disapproval' ($p < 0.024$; $F_D = 3.84$) and summed negative POIs ($p < 0.00$; $F_{nPOI} = 10.30$). Globally this shows the contrasting tendencies in interaction. While males tend to interact at the task level, females emphasise more interpersonal communication. This tendency is confirmed by the directionality of interactions

(DOIs). Female groups tend to show higher 'One-to-One' frequencies ($p < 0.032$; $F_{O\text{-}O} = 3.53$) while male groups show statistical significance for overall interactions ($p < 0.042$; $F_{OI} = 3.24$), including both one-to-one and one-to-all interactions. In both single gender groups interactions are more intense than in mixed gender groups.

The restraining conditions in mixed gender groups are confirmed by the statistical significance for same gender interactions – 'Male-to-Male' ($p < 0.038$; $F_{M\text{-}M} = 4.56$), 'Female-to-Female' ($p < 0.000$; $F_{F\text{-}F} = 35.70$) and 'Female-to-Females' ($p < 0.001$; $F_{F\text{-}Fs} = 12.86$).

4.3.2 The influence of collective gaming competence on the type, frequency and directionality of interactions

Competent groups tend to show more TOIs such as 'Confirming' ($p < 0.069$; $F_C = 2.72$) and 'Suggesting' ($p < 0.000$; $F_S = 8.44$). They show statistical significance for 'Disengaged' ($p < 0.001$; $F_D = 7.01$) and total 'Communication activity' ($p < 0.026$; $F_{CA} = 3.75$). This discloses the diverging and contrasting reactions. While some members stop contributing and disengage from the main group activity, those that remain on task show increased communication activity and thus statistical significance for 'Participant-to-Participant' ($p < 0.004$; $F_{P\text{-}P} = 5.95$).

Competent groups show in-group reactions confirmed by the gaming roles adopted and the expressions of friendship. These groups show statistical significance for the 'Guide' role ($p < 0.041$; $F_G = 3.25$). Leadership is equally distributed so that participants adopt a collaborative rather than a managerial approach. Their interactions are characterised by suggesting and confirming rather than directing others. They also show highly significant interaction for the lowest level of friendship - 'Detached' ($p < 0.000$; $F_D = 9.56$). In these groups friendship level shows no intermediate comportment. They are either in or out of the game. When some take the lead others tend to disengage. This shows that a conglomeration of enthusiastic gamers does not translate into an efficiently interacting group with enhanced collective gaming competence.

Mixed competence groups show no statistical significance for any TOI but show high statistical significance for negative POIs ($p < 0.000$; $F_{nPOI} = 17.89$) and 'Neutral look' ($p < 0.000$; $F_{NL} = 14.44$). These groups lack statistical significance for any directionality effect.

The gaps in competence strongly hinder gaming and communication thus resulting in a dull and passive comportment by all. They show a tendency for a 'Spectator' role ($p < 0.092$; $F_{Sp} = 2.42$) and statistical significance for 'Solitary' comportment ($p < 0.003$; $F_{Sol} = 6.24$) indicating that participants not actively contributing to the group process still monitor closely the game.

Non-competent groups show reactive TOIs including 'Focused Reception' ($p < 0.002$; $F_{FR} = 6.45$) and 'Providing feedback' ($p < 0.009$; FPF = 4.88). They also show high statistical significance for positive POIs, summed pPOIs ($p < 0.000$; $F_{pPOI} = 19.45$), 'Pleased look' ($p < 0.000$; $F_{PL} = 18.47$) and 'Jubilant' expressions ($p < 0.002$; $F_{J} = 6.38$). They are not hindered from communicating their feelings, complimenting each other even for minor contributions. This is reinforced further by the direction of interactions. Non-competent groups showed statistical significance for Participant-Executor ($p < 0.056$; $F_{P\text{-}E} = 2.98$), Male-Male ($p < 0.039$; $F_{M\text{-}M} = 3.51$), Female-Female ($p < 0.008$; $F_{F\text{-}F} = 5.07$) and Female-Females ($p < 0.009$; $F_{F\text{-}Fs} = 5.04$). They show no statistical significance for any of the individual gaming roles. Though active and focussed on task, they show no defined roles. No one is assertive enough to assume a 'leader' or 'guide' role. Regarding expressions of friendship, they show a heterogeneous comportment with no particular tendency for any friendship level.

4.3.3 The influence of different combinations of friendship amongst participants in gaming groups on interactions and individual gaming roles

Friendly groups are more proactive in their interactions with a tendency to use the gaming context to interact at a personal level. Thus statistical significance was obtained for the following TOIs: 'Providing feedback' ($p < 0.002$; $F_{PF} = 6.31$), 'Confirming' ($p < 0.002$; $F_{C} = 6.55$), 'Suggesting' ($p < 0.000$; $F_{S} = 8.61$). Partly friendly groups tend to remain more at the task level, interacting with others while focussing on the game. This strategy is manifested through the statistical significance for TOIs 'Responding' ($p < 0.049$; $F_{R} = 3.08$), 'Sharing' ($p < 0.000$; $F_{S} = 8.70$) and 'Total TOIs' ($p < 0.007$; $F_{tTOI} = 5.09$). Non-friendly groups show no statistical significance for any of the TOIs interactions thus reflecting the restraining climate.

At the socio-emotional level friendly groups develop a more positive climate rich in interpersonal communication. Statistical significance was obtained for 'Pleased look' ($p < 0.007$; $F_{PL} = 5.08$), 'Total positive POIs' ($p < 0.005$; $F_{pPOI} = 5.50$) and 'Total Communication Activity' ($p < 0.000$; $F_{tCA} = 16.52$). This contrasts with the atmosphere that develops in the other groups. The task-orientation of partly friendly groups emphasises POIs much less and a rather negative climate develops by communicating to others task-related feelings: 'Disapproving' ($p < 0.002$; $F_D = 6.67$), 'Censures game' ($p < 0.000$; $F_{CG} = 13.28$) and 'Total negative POIs' ($p < 0.028$; $F_{nPOI} = 3.65$). Non-friendly groups show statistical significance for 'Neutral look ($p < 0.01$; $F_{NL} = 4.77$) showing the emotionally inert and disengaged state of participants in these groups confirmed also by the 'Solitary' ($p < 0.000$; $F_S = 26.55$) personal friendship level.

Directionality of interactions confirms these trends. Friendly groups show their person-oriented approach through 'One-to-one' ($p < 0.001$; $F_{O\text{-}O} = 7.40$), 'Male-Male' ($p < 0.04$; $F_{F\text{-}Fs} = 3.50$) and 'Female-Female' ($p < 0.000$; $F_{F\text{-}F} = 9.04$). Partly friendly groups are more anonymous in POIs showing statistical significance for 'One-to-All' ($p < 0.000$; $F_{O\text{-}A} = 16.09$) and 'Male-to-All' ($p < 0.002$; $F_{M\text{-}A} = 7.06$). Their inclination for TOIs is shown through statistical significance for 'Total directed interactions' ($p < 0.007$; $F_{tDI} = 5.09$).

The marked differences in individual roles adopted by participants in the three group combinations are revealed through analysis of data combinations. Friendly groups tend to develop a collegial climate that distributes roles evenly. Thus individual roles fluctuate between 'Guide' ($p < 0.033$; $F_G = 3.50$) and 'Supporter' ($p < 0.002$; $F_{Sup} = 6.28$). Hence the most common direction of interactions for these roles is that of 'Participant-to-Executor' ($p < 0.002$; $F_{P\text{-}E} = 6.76$). Non-friendly groups show no statistical significance for any individual gaming roles which implies a less defined group structure, as shown by the most basic 'Participant-to-participant' direction of interactions ($p < 0.012$; $F_{P\text{-}P} = 4.64$). The discreet comportment of non-friendly groups is manifested mainly through a 'Spectator' role ($p < 0.000$; $F_{Sp} = 11.35$). But gaming activity in these groups is characterised by 'ad hoc' in-group formations where one participant assumes an executor role with another temporarily assuming a leading one. Thus while the other members are passive 'Spectators' increased 'Executor-to-leader' interaction ($p < 0.025$; $F_{E\text{-}L} = 4.66$) can be observed.

4.3.4 The influence of group organisation on type, frequency and directionality of interactions, socio-emotional atmosphere and individual gaming roles.

Using GLM Multivariate statistical analysis, interaction between different gaming strategies adopted by the group (guided, collaborative, exploratory) and clusters of interactions including separate (TOIs), computed TOIs, separate POIs, pPOIs, computed nPOIs and total Communication Activity were investigated. The only statistically significant interaction is 'Responding' ($p < 0.007$; $F_R = 5.08$) for the 'Exploratory' group. Such groups lack direction and tend to adopt a 'trial and error' strategy improvised by anyone in the group. Other participants respond to these 'ad hoc' suggestions. Collaborative groups have a distributed 'leader' role and thus tend to show more 'Sharing' ($p < 0.079$; $F_S = 2.59$) and 'Interacting with Game' ($p < 0.089$; $F_{IwG} = 2.46$). Groups with an established leader (guided groups) show no statistical significance for any of the TOIs. This implies that these groups manifest a wider repertoire of interactions with no special emphasis on any.

Regarding POIs, Guided groups show a distributed pattern with no special emphasis on any. The distributed leader role in collaborative groups gives more space for interpersonal dissonance and thus a higher level of 'Disapproving' ($p < 0.008$; $F_D = 5.05$) and 'Negative POIs' ($p < 0.068$; $F_{nPOI} = 2.74$). The exploratory approach adopted mostly by non-competent groups is quite superficial, 'Responding' and 'Approving' ($p < 0.000$; $F_A = 8.30$) any proposed action with many crossing compliments from most participants. This explains the statistically significant 'Positive POIs' ($p < 0.028$; $F_{pPOI} = 3.65$) and enhanced 'Communication activity' ($p < 0.056$; $F_{CA} = 2.93$).

Directions of interactions for guided groups are diffused and varied since there is no statistically significant direction type, individual gaming role and individual expressions of friendliness. Leaders do not structure but organise interactions without limiting variety. The distributed role of leaders in collaborative groups emphasises 'Participant-to-leader' interaction ($p < 0.075$; $F_{P\text{-}L} = 3.32$) and thus 'Supporter' ($p < 0.024$; $F_{Sup} = 3.81$) individual gaming role. The collegial approach develops a 'Friendly' climate ($p < 0.051$; $F_F = 3.04$).

The unorganised interaction pattern in exploratory groups is manifested through statistically significant interactions for 'One-to-all' ($p < 0.001$; $F_{O\text{-}A} = 6.81$) and 'Participant-Participant' ($p < 0.024$; $F_{P\text{-}P} = 3.88$) directions and a tendency for some to adopt a 'Spectator' role ($p < 0.076$; $F_{Sp} = 2.63$) and thus exhibit 'Solitary' level of friendship ($p < 0.061$; $F_{So} = 2.86$).

4.3.5 The influence of group size on interactions, socio-emotional atmosphere and individual gaming roles in groups

GLM analysis of data for TOIs reveals a smooth transition from active to more passive interaction with increase of group size. Participants in 3-person groups are very alert and focussed on task – 'Focussed reception' ($p < 0.042$; $F_{FR} = 2.81$) and 'Interacting with Game' ($p < 0.044$; $F_{IwG} = 2.77$). The directionality of their interactions confirms this enhanced activity by showing statistical significance for 'One-to-one' ($p < 0.015$; $F_{O\text{-}O} = 3.61$), 'Total directed Interactions' ($p < 0.000$; $F_{tDI} = 6.47$), 'Participant-to-executor' and 'Female-to-females' ($p < 0.002$; $F_{F\text{-}F} = 5.28$). In 4-person groups the interactive aspect is enhanced. There is a tendency for more 'Sharing' ($p < 0.088$; $F_{Sh} = 2.23$) and statistical significance for males taking more the lead 'Male-to-All' ($p < 0.019$; $F_{M\text{-}A} = 3.66$).

In 5 and 6-person groups participants tend to adopt a more passive role most of them 'Providing feedback' ($p < 0.013$; $F_{PF} = 3.74$) and 'Confirming' ($p < 0.053$; $F_{C} = 2.62$). This trend precludes any group from showing a range of TOIs so that no group shows statistical significance for 'Total TOIs' ($p < 0.517$; $F_{tTOI} = 0.76$). These larger groups tend to develop in-group formations and enhanced levels of anonymity. 5-person groups show a tendency to have bi-directional 'Leader-Executor' ($p < 0.004$; $F_{L\text{-}E} = 9.26$) and 'Executor-Leader' ($p < 0.07$; $F_{E\text{-}L} = 2.89$) interactions and show 'Exclusive' friendship comportment ($p < 0.025$; $F_{Exc} = 3.21$). 6-person groups find it more difficult to maintain organised collective activity. They tend to be anonymous in their interactions showing statistical significance for 'One-to-All' ($p < 0.000$; $F_{O\text{-}A} = 10.20$) and 'Female-to-all' ($p < 0.001$; $F_{F\text{-}A} = 6.42$). They also tend to form in-group formations as shown by the enhanced 'Participant-to-participant' ($p < 0.000$; $F_{P\text{-}P} = 6.56$)

interactions. Other participants show the lowest friendship level – 'Detached' ($p < 0.03$; $F_D = 3.07$).

The socio-emotional climate of groups also shows a transition from more positive to negative POIs as a function of group size. 3-person groups show statistical significance for 'Jubilant' behaviour ($p < 0.000$; $F_J = 6.36$) and 'Summed Positive POIs' ($p < 0.028$; $F_{pPOI} = 3.11$). 4-person groups change to a negative climate characterised by 'Disapproving' ($p < 0.002$; $F_D = 5.05$), 'Censuring game' ($p < 0.015$; $F_{CG} = 3.63$) and 'Summed negative POIs' ($p < 0.013$; $F_{nPOI} = 3.72$). Detachment characterises larger groups. 5-person groups show statistical significance for 'Neutral look' ($p < 0.031$; $F_{NL} = 3.04$) while participants in 6-person groups tend to be more 'Disengaged' ($p < 0.028$; $F_D = 3.13$).

4.4 The influence of game features on interactions during collaborative gaming

The fourth main research question explored the influence of game characteristics on collaborative gaming. This section summarises the key findings from Paper 4 and 8 included in Part II and is organised through the sub-questions of the main research question. The following abbreviations for game titles are used in the discussion below: AC = *Alpha Centauri* ; AoE = *Age of Empires* ; Civ = *Civilisation* ; EE = *Empire Earth*; MM = *Mindmaze*; NfS = *Need for Speed*.

4.4.1 The influence of game genre on gender-related neurocognitive propensities

Within the context of the discussion about gender-based propensities that influence gaming, Paper 4 discusses how different games capitalise on gender-related neurocognitive processes that manifest themselves through characteristic types and frequencies of interactions. When interacting with the science and technology-oriented, real time strategy (RTS) game, *Alpha Centauri*, males and females show different interaction repertoires. At the beginning of the game males show high levels of cognitive activity manifested through higher frequencies of 'Interaction with game', 'Focussed Reception', 'Sharing' and 'Providing Feedback'. As the game proceeds and a repetitive game-play pat-

tern is established, male exploratory or risk-taking activities decrease drastically showing their decline in motivation, externally manifested by the increase in frequency in 'Censuring the game'. Female rejection of such game play is manifested by the lack of interaction throughout the gaming session.

With the game *Empire Earth* females show a higher level of cognitive activity, manifested through longer periods of 'Focussed Reception', higher level of response and positive reactions. Males show a greater tendency to be 'Disengaged' indicating that most males are not intellectually stimulated by rehearsal-oriented RTS games. Still, when asked for help, males contributed by 'Giving Help' mainly to females who show a higher level of 'Responding' due to their more reactive rather than proactive approach.

There was no overall gender-related significant effect for the puzzle game *Mindmaze*. The game seems to be appealing for both sexes but in different ways. Males were observed to be more engaged with manoeuvring through the labyrinth of passages and doorways in the virtual medieval castle employing their navigational skills. Females were more attracted to the linguistic aspects of the game feeling more adept at recalling and corroborating information when prompted by quiz questions. This clearly demonstrates that males and females adapt to the gaming context obtaining gratification by playing games that accommodate their natural neurocognitive propensities.

4.4.2 The influence of game genre on game choice and use

Papers 2 and 4 discuss in detail gender-related tendencies in the use of games. The appeal of game genre to males and females depends on the intuitive evaluation of the type of neurocognitive skills that are demanded by the game. Paper 3, section 4.2.2 discusses in detail how the type and frequency of interactions are a product of the interaction between gamers' neurocognitive propensities and the type of gameplay mediated by the game.

At first the RTS *Alpha Centuari* engages males providing them the context where to apply their information manipulation memory strategy and their command approach. They are quickly discouraged by repetitive gameplay and restricted user control. This type of game-

play also discourages females from the beginning as it conflicts with their rehearsal-oriented memory processing. On the other hand *Empire Earth* causes the opposite reactions. Females feel comfortable at the rehearsal-oriented managerial gameplay, something that disengages males. *Mindmaze* satisfies both sexes. A symbiotic situation develops with males applying their navigational capabilities in manoeuvring through the medieval labyrinth while females get engaged in recalling information related to history questions which enable movement through labyrinth.

The type of gameplay provided by a game influences user perceptual analysis which in turn determines engagement with or rejection of a particular game. Perceptual analysis involves both intuitive evaluation of the neurocognitive skills to be employed and an estimation of the competences requested and at the same time promoted by the game. The latter is further explored in the next section.

4.4.3 The interaction between perceived competence facilitation and game genre

Empirical research question (ERQ) 2 in Paper 8 describes the technique used to explore the influence of game genre on nine perceived competences involving acquisition, sharing and mediation along the domain, technology and community dimensions of the proposed pedagogical model. To capture the major categories of perceived competences, 12 computed ordinal variables were created. These include one computed ordinal variable giving the mean for each perceived competence: Computed Domain Acquisition, Computed Gaming Mediation, or Computed Community sharing. Three other computed ordinal variables were developed to give the mean of perceived competences in each of the three dimensions included in the model, mainly Computed Domain Competences, Computed Gaming Competences and Computed Community Competences. One Way-ANOVA was used to compare the means of these computed variables in relation to the games used. Perceived competence profiles for different games showed statistical significance for Computed Domain Mediation ($p < 0.000$; $F_{CDM} = 12.25$), for Computed Gaming Mediation ($p < 0.007$; $F_{CGM} = 3.76$), and for Computed Community Mediation ($p < 0.001$; $F_{CCM} = 5.05$).

This profiling method categorises games from a process-oriented perspective by indicating how users perceive the potential of games to facilitate competence development along the domain, gaming and community dimensions. A mean above 2.5 may be considered as users' agreement that game fosters that competence. A mean above 3 shows a stronger conviction of competence facilitation, while a mean below 1.5 shows user belief that a particular competence is not promoted by a game. Games are perceived to promote different competences. *EE*, *AoE* and *Civ* are perceived to promote competences related to the history domain. *NfS* is perceived good at promoting gaming skills, while *AoE* at developing community management competences. *SIMS* is perceived as a game least effective in developing any of the competence categories.

4.4.4 Game appeal and perceived usefulness

Paper 8 ERQ 3 explores the relation between game appeal and perceived usefulness of a game through the relevant survey (Appendix 15) that formed part of Surveys about Perceived Competence Facilitation (Appendices 9-14). The ordinal scores of the statements about perceived usefulness of games features (Accurate representation of historical events; playing as enactment of historical events; usefulness of tutorials, time-lines and glossaries) were entered in SPSS and analysed through one-way ANOVA for comparing the means. A statistically significant ($p < 0.05$; FRDK = 2.48) was obtained for 'Accurate Representation of Domain Knowledge'. The mean for the three history games are: EE = 2.7; AoE & Civ = 2.67; NfS = 2.06 and SIMS = 2.43. A mean above 2.5 implies that user agrees to the perceived usefulness of the feature and hence makes game more appealing. A mean below 2.5 means that user is undecided about the feature thus having minor influence on game appeal. History games are thus more appealing because domain knowledge is represented more faithfully in them then in NfS or SIMS.

The second feature regarded the degree of vividness and reality experienced in the game environment. Students were asked if history games compared to enactment situations, if the game environment of *NFS* was close to real life racing and if *SIMS* represents faithfully life experiences. The mean for the three history games were: *EE* = 2.5; *AoE*

& *Civ* = 2.67; NfS = 1.88 and *SIMS* = 2.30. The degree of vividness and reality enhances game appeal for the history games and *SIMS* but not for NfS. The perceived usefulness of tutorials, time-lines and reference tools was investigated for the history games only. The relevant P and F values showed no statistical significance ($p < 0.167$, $F_{Tut} = 1.89$; $p < 0.213$, $F_T = 1.62$; $p < 0.813$, $F_H = .21$). Though games provide these tools they are not perceived useful by gamers. From a pedagogical perspective this implies greater emphasis on integrating these with the gaming experience to enhance the game-based learning experience.

The nominal scores from statements in the survey about possible features to be included in newly designed games (Appendix 15, question 4) were entered in SPSS and analysed through Chi square to compare the means in relation to different games used. These results show that perceived usefulness of game features is determined by game genre. Some features are seen to be more suitable with particular type of games than with others. The two major justifications for including particular tools when designing a new game are their potential to make gaming and learning more interesting and the enhancement of user control over the game. Game features have appeal to users both at the perceptual and experiential levels. From a pedagogical perspective it is very important to analyse game appeal considering both existing default game features and others that may be used to elaborate or redesign it. Such an analysis serves to develop game profiles including appealing features and related competencies that will be promoted through using a particular game.

4.4.5 The influence of game genre on social interactions and appeal

Video recorded gaming sessions were analysed to obtain frequencies of Person-oriented Interactions (POIs) and expressed friendship level for different games. GLM Multivariate statistical analysis was then applied to establish possible interaction between game type and clusters of interactions including separate POIs, computed positive POIs (pPOIs), computed negative POIs (nPOIs), total Communication Activity (ComAct) and manifested individual friendship type. POIs that gave statistical significance are shown in table 5.

Table 5: *Game type and person-oriented interactions*

Interaction	p	F	Game/s showing highest expression / interaction	Game/s showing lowest expression / interaction
Sharing	0.000	5.09	NfS	EE
Pleased look	0.000	8.09	NfS, SIMS	AC, EE.
Neutral look	0.000	5.54	AC, EE	NfS, SIMS
Jubilant	0.000	46.21	NfS	
Approving gestures	0.057	2.21	MM, AoE	AC, SIMS, NfS
Disapproving gestures	0.000	16.34	AC	
Recommends game	0.000	11.56	AoE	
Censures game	0.000	10.07	AC	
Positive POIs	0.000	13.50	NfS, SIMS	AC, EE
Negative POIs	0.000	11.77	AC, EE	NfS, SIMS
Total Communication	0.008	3.24	AoF, MM, SIMS	AC, NfS, EE
Friendship level – Solitary	0.01	3.15	EE, MM, AC	AoE, NfS
Friendship level – Friendly	0.003	3.85	AoE, NfS	EE

Game type influences relatedness by determining the socio-emotional climate that stimulates or inhibits interactions. Games like *NfS*, the *SIMS, AoE* and *MM* promote interaction, sharing and interpersonal communication that expresses and satisfies the need for relatedness. Due to features that decrease appeal, like controlled game play, uninteresting storyline, rigid and limited options, repetitive gaming activity and poorly designed game environment, games like *AC* and *EE* create a socio-emotional climate that suppresses interactivity and interpersonal communication. The expressions of friendship shown by participants while using different games confirm this. The solitary friendship condition, where participants interact with the game but not with each other, is evident in games like *EE, AC* and *MM*. A more friendly and interactive climate evolves with games like *AoE* and *NfS*. But both *EE* and *AoE* are history games. The game features in *AoE* provide a better combination to express and enhance relatedness than those in *EE*.

AoE is better at facilitating social interaction and collaboration. Different game genres vary in their potential to promote social interaction and collaboration.

4.4.6 User control and interactions during collaborative gaming

A number of experimental sessions were organised to explore collaborative gaming using six games (*Alpha Centauri, Empire Earth, Mind Maze, Great Empires, The SIMS and Need for Speed*) that vary in user control and game play possibilities. GLM analysis was used to explore possible interaction between game type and frequency and directionality of T&POIs, together with individual gaming role.

The general trend shows that games like *AoE, MM* and *SIMS* that give user increased autonomy by providing more options and control, promote more TOIs. *AC, EE* and *NfS* are more restrictive on user autonomy. The relation between autonomy and game control is confirmed through analysis of single TOIs represented in Table 6.

Table 6: *Game type and task-oriented interactions*

Interaction	p	F	Game/s showing highest mean for interaction	Game/s showing lowest mean for interaction
Reference to personal gaming biography	0.000	12.98	AoE	AC, EE, NfS
Asking Help	0.049	2.29	AoE, EE.	MM.
Giving Help	0.000	6.55	AoE	AC, MM, NfS
Responding	0.001	4.58	MM, SIMS	NfS
Sharing	0.000	5.09	NfS	EE
Providing Feedback	0.047	2.31	MM, SIMS, AoE	AC, NfS

Analysing individual gaming roles adopted during sessions using different games, the above trends are confirmed. Active roles like leader, guide and follower (one executing suggested actions) that show enhanced willingness to interact with the game, are more frequent

when using *AoE, MM, SIMS* and *NfS*, while less frequent in the other restrictive games AC and EE. The latter are characterised by passive roles – supporter ($p < 0.001$; $F_{Sup} = 4.16$) responding to others' communications and spectator ($p < 0.07$; $F_{Sp} = 2.09$) considered as a non-interacting participant.

These trends are further confirmed by directionality of interactions. Computing all directed interactions (one-one with one-all) a highly significant interaction ($p < 0.000$; $F_{tDI} = 5.62$) is obtained for *GE, MM* and *SIMS* showing more activity and hence autonomy while *AC, EE* and *NfS* show less activity due to more restriction.

4.4.7 Game sharability and interactions during collaborative gaming

Video recorded sessions of collaborative gaming using different games were analysed for interpersonal task-oriented interactions recording both their frequency and directionality. The statistically significant interactions show also that *AoE, MM, SIMS* and *NfS* are more shareable games than *AC* and *EE*. Computing all these single TOIs into one covariate called total Communication Activity (Comact), GLM analysis gave a highly statistically significant ($p < 0.008$; $F_{tCA} = 3.24$) interaction with the different games used.

Assuming that a shareable game would trigger more participant-to-participant and participant-to-all interactions, GLM analysis was done on the two covariates 'one-to-one' and 'one-to-all'. These two covariates were also computed into one covariate called Total directed interactions. Any interaction between these covariates with game type was analysed through GLM analysis. All three covariates gave a highly statistically significant interaction with game type: one-to-one $p < 0.000$; $F_{O\text{-}O} = 5.18$; one-to-all $p < 0.000$; $F_{O\text{-}A} = 5.65$; total directed interactions $p < 0.000$; $F_{tDI} = 5.8$. *NfS, SIMS* and *AoE* trigger a higher degree of 'one-to-one' interactions than *AC, EE* and *MM*. *AoE, NfS* and *MM* stimulate more 'One-to-all' interactions. The different games used in this investigation can be ranked according to their sharability using the mean of the total number of interactions. The following rank order gives the name and mean for each game starting from the most shareable with the highest mean:

NfS (84.39) > AoE (76.5) > SIMS (62.98) > MM (54.451) > AC (49.39) > EE (42.07).

Thus game sharability can be easily quantified through the type and directionality of interactions generates by a game in collaborative gaming contexts.

4.5 Concluding remarks

The picture that emerges from these results is very challenging from a pedagogical perspective. Many of the outcomes of this investigation serve as clear indicators in formulating a pedagogical framework to use games for learning in collaborative contexts. But the absence of outcomes in certain aspects is an indirect outcome pointing to conditions that need to be addressed if gaming is to be transformed into an educational experience.

Gaming as an experience with the physical environment exists but with a number of limitations that directly affect prospective educational interventions. The time dedicated to play games by Maltese students is comparable with that reported in other international studies. The fact that the Personal Computer is the most common gaming device serves as an advantage from a pedagogical perspective as it facilitates more the interactions between gaming and eventual interventions. But it also indicates that students have a limited experience of the physical world of gaming as they lack experience in the stunning and immersive gaming environments offered by the major commercial gaming consoles. This applies even more to females whose gaming experience is confined to the mobile phone which is very limited in mediating such a multimodal experience. Consequently, the initial thrust in any pedagogical intervention should address this issue by providing a physical environment offering a wider range of gaming devices and dedicated games so as to expose users to a more comprehensive and authentic gaming experience.

The time factor points to two seemingly irreconcilable processes. Girls are playing less because they are not finding gaming as conducive to their cognitive, affective and social propensities. But applying Gee's (2007) 'Performance before competence' principle it also means that they are not developing their gaming experience in any of the Popperian dimensions. This demands a more elaborate and structured pedagogical intervention with females when promoting learning and knowledge building through games.

Another evident trend that points to the restricted gaming experience in the Maltese sample is the limited range of game titles used by

students. It not only shows that gaming is used just for leisure but even in this aspect there is very little variety. Is this a conscious choice or lack of awareness and experience? Is this a tricky, self-perpetuating situation, where negative impressions obtained from low level games are reinforcing further negative attitudes and detachment? From a pedagogical perspective this poses a double challenge. Both sexes have to be made aware of good educational games and enticed to experience this contrasting but beneficial experience. With females it requires a longer and more elaborate process for addressing their restraining attitudes.

The approach adopted by this investigation to analyse attitude to gaming from an interactions perspective was found to be highly effective especially from a pedagogical point of view. Besides general attitudinal variables that give generic trends and thus limit pedagogical intervention to broad and superficial proposals, the instrument used in this investigation sub-divides attitude into four major components and in turn each component is sub-divided into a number of discrete manageable interactions. Consequently pedagogical interventions can be customised to gamers' attitudinal profile. In this respect separate differentiated pedagogical interventions have to be developed to address the gender-biased attitude to gaming.

Both this approach and related instrument should be further refined and employed to promote reflection on attitude to gaming as part of the strategy to develop a more positive outlook to gaming. The highly significant positive correlation between gaming attitude and individual gaming competence implies that attitudinal change is a direct consequence of positive gaming experiences and development of competence. This strengthens the argument in favour of providing a more stimulating environment, in intensifying female exposure to gaming, and in promoting domain learning through various gaming possibilities thus putting into practice the 'performance before competence before positive attitude' principle.

An important outcome of this investigation, that is in line with recommendations from recent research (Ryan *et al.* 2006), concern the analysis and evaluation of the gaming experience both at the experiential and perceptual levels. Game profiles should not be based solely on the surface structure of games comprising descriptions of physical features, degree of game control or instructional and gameplay tools. From a motivational perspective it is more important to profile games at the perceptual level, how the game is perceived by different categories of users.

Thus it is important to have instruments that assess perceived competence facilitation, perceived control, perceived usefulness and perceived communication facilitation. Besides addressing attitude to gaming, this profiling provides means to attend to various needs that arise at different levels of the collaborative gaming process such as autonomy (arising out of competence), relatedness and self-actualisation.

Analysing and interpreting individual characteristics such as personality dimensions using a quantitative approach that considers the type, frequency and directionality of interactions proves to be an efficient, practical and reliable methodology. Though at face value it may give the impression of a behaviourist approach, this was not the case since observed interactions patterns were linking to underlying cognitive, affective and conative factors. Interpreting these from a 'Cognitive Neuroscience' perspective proved to be a very valid and accurate approach that integrates specific behaviours into an overarching, evolutionary, empirical framework. This approach should be used and refined both for contiguous and technology-mediated collaborative contexts.

Collaborative gaming seems to alter group dynamics and promotes a unique set of conditions that contrast with those identified by research about collaborative learning in classroom contexts (de Freitas 2008, 70). While the common belief and practice is to use group heterogeneity as a stimulant for interactions, this condition seems to have a debilitating effect on collaborative gaming when varying group composition by gender, gaming competence and level of friendship. Any of these possibilities or combinations leads to a set of restraining conditions both at the task and socio-emotional level that impede communication and gaming. It is thus important to manage collaborative gaming contexts by interventions aimed both at the task and the socio-emotional levels that actually complement each other. Results describing group dynamics show that this approach demands more elaborated organisational strategies for managing collaborative gaming. The group condition has to be carefully planned, monitored and evaluated using a wider variety of criteria and organisational strategies. Organising groups by level of competence, friendship combinations or gaming strategy demand different management tactics and assessment criteria for each condition.

The differentiation of this process-oriented approach into task and person-oriented interactions is highly recommended as it gives a better analytic tool for collaborative gaming contexts. It gives a system-

atic breakdown of the components that could be orchestrated to promote an effective and efficient learning experience by challenging the cognitive-affective duality and thus facilitating holistic interventions. The fact that individual, group and game characteristics are analysed from this perspective results in a richer palette of pedagogical possibilities that enables specific objective interventions.

This interactions-oriented approach confirmed one important observation documented and discussed by many researchers and critics (Browm *et al.* 1997; Squires 2004; Egenfeldt-Nielsen 2006) – the exclusive separation of gaming from domain learning. Analysing interaction profiles, reviewing video and transcripts of recorded gaming sessions and reflecting on personal interviews reveals the paucity of engagements with domain content integrated and modelled in the game. Very little discussion or reflection occurred during the collaborative sessions using *Mindmaze, Alpha Centauri, Empire Earth, the SIMS, Need for Speed* and other about any of the subject matters (history, science and technology, human relations, social order etc.) or personal and social issues. Alpha Centauri was used to stimulate discussion about science/technology, *Empire Earth* to stimulate discussion about evolutionary aspects of history (increase in resources leads to population growth that develops the need for more resources that promotes further colonization that creates further need for technology leading to more efficiency in obtaining and managing resources etc.). On the same vein the *SIMS* was used to try to trigger reflection about personal development considering career, family and management of resources. No substantial reflection emerged about these themes as a result of these pedagogical orchestrations.

Since males are attracted to racing games, the game *'Need for Speed'* was introduced to try to stimulate discussion about racing car science, technology and design since this game, like most recent car racing games, provide tools to design own car for racing. The idea was to discuss car physics and extrapolate discussion about driving rules, responsibility and abuse. During informal post gaming interviews, gamers repeatedly emphasised that games are not there to make user think about anything serious except how to win game. Some even claimed that the situation is exactly the other way round - they play games precisely to escape from thinking.

In one LAN (Local Area Network) party, participants were using the game *'Call of Duty'* which is a shooting game embedded in very

realistic Second World War scenarios. They could select trying to shoot out enemy soldiers in urban (door-to-door) warfare based in very faithful simulations of a French, Russian and Northern African city using from simple to highly sophisticated weapons. When asked if games help them to reflect about particular historical battles, technology of weapons, the issues behind wars (power struggles, humanitarian issues etc.) their reply was that that was not within the scope of the game. In another LAN party the game *Command and Conquer* was used. This involves managing resources to promote research for developing more advanced weapons so as to control one's territory and attack competing powers. Asked if this game promotes off-game discussion about the issues behind wars, gamers confirmed that not only group discussion on these issues never surfaced, but that gaming is a separate activity from reflection. Gaming is about winning a game and proving your gaming competence with colleagues.

Confronted with this reality one may conclude that merging learning with gaming is an impossible feat and that collaborative game-based learning is a myth. But this is the experience faced by anyone using an existing tool in a new context for an innovative task. This has happened repeatedly in the evolution of physical and conceptual artefacts, not least media and learning technologies. A whole process of adaptation and innovation is needed. Through adaptations and modifications effected on the tool, on the environment, on the task itself and accompanied by user accommodation to the new set of conditions, ineffective contexts were transformed beyond recognition. Collaborative game-based learning is a viable possibility and can be an effective learning experience if games are designed and used to promote specific learning outcomes, if the environment is adapted to promote this new experience and if users are sensitised and guided into using the tool for precise objectives under a different set of conditions from those of prevalent entertaining gaming environments. The remaining part of this work integrates these findings into a pedagogy that addresses these challenges and organises the diverse aspects of collaborative gaming to promote learning and knowledge building.

5 DISCUSSION

'The power of video games is not in their present state just as it is, but in their potential: what can we do with them if we want to innovate'. Gee (2007, 3).

The main purpose of this study was to explore if the group condition serves as a pedagogical tool for enhancing the gaming and learning experience. The complexity of interacting variables present in collaborative gaming contexts was investigated through a process-oriented methodology that attempts to capture interactions both at the task and socio-emotional level. This complexity has to be managed so as to create the optimal conditions for learning and knowledge building through collaborative gaming. Referring to examples of games with an educational potential, this concluding section proposes a pedagogy for collaborative game-based learning (CGBL) and knowledge building adopting a dual strategy: Learning FROM designed (off-the-shelf) games and learning BY designing games. This approach demands training in the use of digital tools for acquiring, sharing and creating knowledge (Salomon & Perkins 1998; Collis & Moonen 2001) in the process of participating in game-related affinity spaces (Gee 2007, 87) and domain-related 'communities of practice' (Wenger 1999) as determined by game's theme.

This pedagogy is summarised diagrammatically in the interactions-model (Figures 4A-E) that integrates findings from this investigation within the framework of the Popperian 3 World perspectives (Popper 1972). Figures 4A & 4B summarizes the main principles derived from the results that should guide interventions at the experiential and meta-cognitive levels along the three dimensions. Figures 4C, 4D and 4E summarize the specific interventions at the different levels of the domain, game (technology) and community dimensions respectively.

The three major sectors of the figure represent the proposed interventions to promote interactions with the domain (content), with the game and with the contiguous and virtual communities. Each of these sectors is sub-divided into two smaller sectors. The sector printed in black, normal font represents the experiential component of that dimension capturing interactions with World 1 and 3. The other sub-sector printed in red, italicised font represents the reflective component, capturing mainly the process of interactions between the external environment and the intra-individual gaming experience. Each small section includes experiential or reflective interactions related to the specific dimension and pedagogical level intersecting at that part of the diagram.

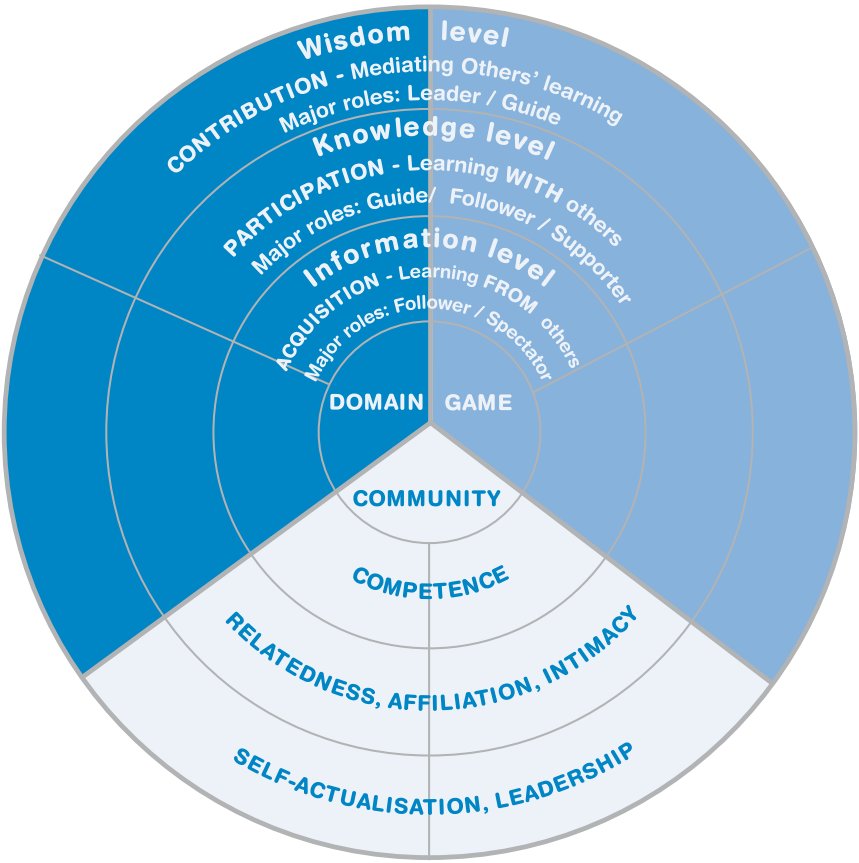
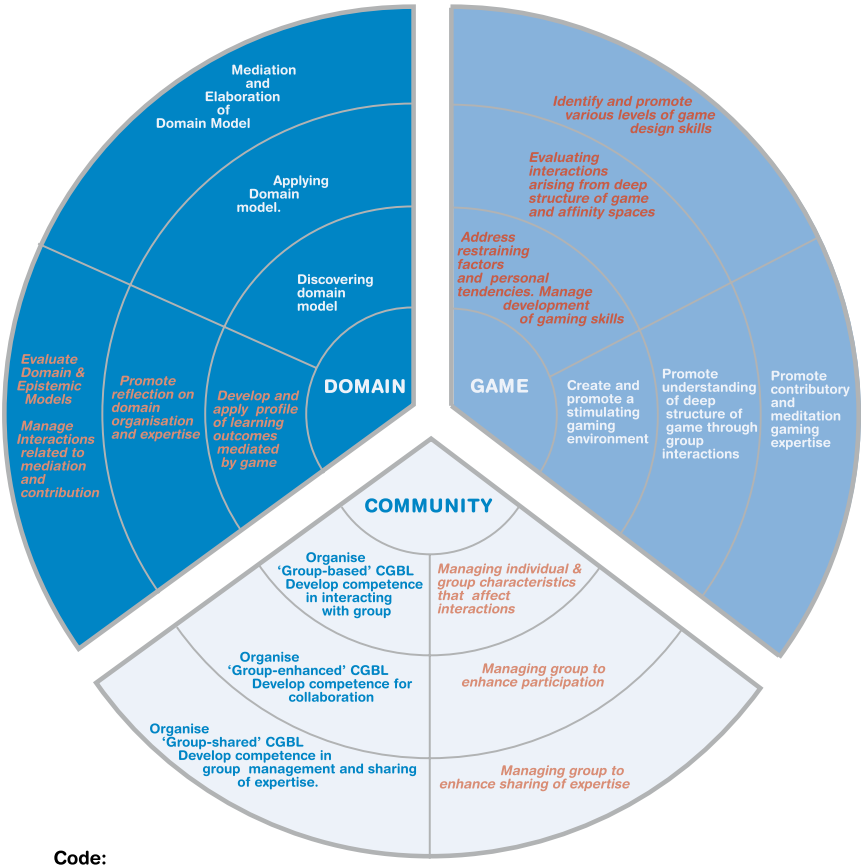


Figure 4A: *A pedagogical model for Collaborative Game-based Learning*



Code:
Normal blue/white font = Interventions at the Experiential level
Italic red/orange font = Interventions at the Metacognitive level.

Figure 4B: *Major categories of pedagogical interventions along the three dimensions of Collaborative Game-based Learning*

Experiential level	***Metacognitive level***
Game	
Develop: • Personal gaming experience • Competence with surface structure • Gaming environment	• *Address restraining factors and personality tendencies in gaming* • *Identify game features that promote interactions with domain.* • *Control T&POIs showing acquisition of gaming skills.*
• Develop competence with 'deep structure' • Promote communication and sharing tools extending interaction in affinity spaces	*Promote reflection about:* • *Degree of 'sharability'* • *Perceived competence facilitation* • *Interaction between real and virtual identities* *Monitor T&POIs showing sharing of gaming competence*
Promote: • Evaluation of game narrative or knowledge structuring & gameplay • Modification / re-designing of game model • Design of 'Mod' or new game • Participation in 'Affinity spaces' dealing with conceptual artefacts.	• *Control T&POIs showing mediation and contribution of gaming expertise.* • *Controlling for interaction patterns when using game as inscriptional, conscriptional & boundary objects*

Figure 4C*: Pedagogical interventions along the Game dimension*

Experiential level	*Metacognitive level*
Domain	
Identify type of knowledge, skills and mode of interaction with domain	*Develop profile of learning outcomes mediated by game. Control TOIs in relation to game profile. Identify domain competence of students. Identify student-game gaps in knowledge or skill*
• Describe and apply domain model. • Practice domain skills. • Use of affinity spaces and game tools to promote sharing	• *Promote reflection 'in' and 'on' action* • *Control T&POIs for sharing* • *Analyse domain model and how it is represented in game* • *Discuss gaming strategy & tactics in relation to typical behaviours in domain*
• Extend • Apply • Evaluate • Re-design domain model • Mentoring • Mediating domain knowledge and skills	• *Control T&POIs for mediating and contributing to domain model* • *Compare game model with that of didactical approaches* • *Promote insight into epistemic model through interaction with domain COP and experts* • *Reflect about mature identity in domain*

Figure 4D: *Pedagogical interventions along the Domain dimension*

Experiential level	***Metacognitive level***
Community	
Organize Group-Based CGBL to develop awareness of group roles and competence in interactions	*Front end analysis of gamers. Control for individual characteristics: personality, gaming competence, gender, attitude to gaming. Control group composition by: gaming, gender, friendship, size.*
• Organize 'Group-Enhanced' CGBL. • Promote negotiation & argumentation • Share: opinion, experience • Challenge group strategy & tendency for sub-grouping • Suggest goals and possible roles	• *Control for group factors that influence participation* • *Monitor socio-emotional climate, adopted roles, level and directionality of interactions, group structure controlling for sub-grouping*
• Organize 'Group-Shared' CGBL. • Promote epistemic model • Promote & monitor interactions between contiguous and virtual groups • Plan and share Conceptual artifacts and creations	• *Evaluate Conceptual artefacts and creations* • *Monitor T&POIs manifesting need satisfaction by contiguous and virtual groups* • *Monitor for excessive competitive comportment* • *Promote reflection about identity in contiguous and virtual communities*

Figure 4E*: Pedagogical interventions along the Community dimension*

This model is intended to help gamers or teachers manage collaborative gaming contexts by providing a framework of specific interventions to address perceptual, experiential and metacognitive aspects of gaming. It also provides a pedagogical strategy based on the evolving gaming and domain competence of a group. The implications of this pedagogical model will be discussed both for designing games that accommodate better CGBL and its use in technology-intensive collaborative learning environments (TICLEs). This chapter ends with a self-assessment of the project and recommendations for future research.

5.1 A pedagogy for collaborative game-based learning

One important outcome of this investigation concerns the need to address gamers' competence when setting up groups for CGBL. For Ryan *et al.* (2006) competence is a fundamental need to be addressed in gaming contexts. It manifests itself as the need for challenge and feelings of effectance (White 1959; Deci 1975) that are enhanced by opportunities to acquire new skills or abilities, to be optimally challenged, or to receive positive feedback. Perceived competence is among the most important satisfactions provided by games, as they represent arenas in which a person can feel accomplishment and control (Ryan *et al.* 2006, 350). This explains the strong correlation obtained in this investigation between gaming competence and attitude to gaming, interactivity and socio-emotional comportment of gamers. The strong influence of competence gaps on interactions in collaborative gaming should be considered as a critical factor when organising groups for gaming.

The best way to deal with competence heterogeneity is to determined gamers' competence using some surveying tool, like the one used in this investigation (Appendix 1). Through such data participants are organised in groups preferably made of three participants matched by their gaming competence. Groups should be categorised into non-gamers, moderate and enthusiastic gamers avoiding the mixed competence condition. Each group will occupy a different level in the community dimension of the proposed pedagogical model. Non-gamers will correspond to the basic, novice acquisition level, moderate gamers correspond to the middle participation level and enthusiastic gamers fit into the highest contribution level. The results also point to the need to differentiate groups according to gender and friendship. The ideal combination would thus be a group of three either males or female participants who have some friendship history. Other combinations would be more challenging and need more monitoring and interventions to build a smooth, efficiently interacting group.

Novice gamers will need apprenticeship, employing the MAPARI approach (de Jong & Sarti 1994) as discussed in Paper 1, to develop skills in the use of hardware and to acquire insight into the surface structure of the proposed game/s. Those who have less experience in

collaborative gaming must be challenged to adopt different gaming roles - leader, executor and participant – avoiding extremes of comportment. Thus for novice gamers sessions in CGBL will be *'Group-based'*, using the group condition as a pedagogical tool to develop competencies through peer support.

More competent gamers, who play a range of game titles and who feel confident about using the proposed games will be organised into a group, the *'Group-enhanced'* condition. They play the game outside class (during breaks or at home) but get organised into CGBL sessions in class to promote the instructional and metacognitive aspect of the gaming experience. The emphasis here is more on developing competence for collaboration in contiguous and virtual communities and on promoting domain learning through the game and supplementary instructional interventions.

Expert gamers, who have a totally different set of needs, will operate more within the confines of the world of ideas and conceptual artefacts, emphasising creative aspects of gaming and how to merge it with domain learning and knowledge building. Therefore these students will do most of the gaming outside the group, but will participate in CGBL to share their expertise in advanced gaming strategies, designing game proposals, evaluation of artefacts or collaborative mentoring in contiguous or virtual communities and affinity spaces. The gaming experience is thus more *'Group-shared'* because the group serves as a place for sharing their experience in mediating different forms of thinking about gaming, domain knowledge and skills. They also share how to merge and enrich different aspects of their expertise in gaming, domain specialisation, programming and on-line resources. The group provides them with the opportunity to mediate this multi-dimensional expertise to other less experienced gamers.

The interventions around these groups with different needs are organised within three pedagogical levels of the proposed model that will be used to organise the discussion. The concentric circles enclose three areas representing the three pedagogical levels. The inner annulus outlines the interventions along the different dimensions targeting the *group-based* condition, including mainly interactions with the physical and social environment characterised by acquisition learning. The middle annulus proposes interventions within the *'Group-enhanced'* situation, including interactions both with World 1 and 3

emphasising participatory learning. This condition addresses the need for relatedness and affiliation with the contiguous group and with online domain and gaming communities. The outer annulus includes proposed interventions with the *'Group-shared'* condition representing the highest level of gaming and domain competence. These interventions promote mainly World 3 interactions characterised by contributory and mediation forms of learning and knowledge building (*mediating* others' learning, Salomon & Perkins 1998) that addresses the need for self-actualisation (Reeve 1997).

The next section discusses the interventions for each of the three identified pedagogical levels. Since a gaming pedagogy may lead to mixed reactions within an educational context ranging from utter resistance and scepticism to conditional compliance, a preliminary section discusses the challenges that need to be addressed in organising the physical and social environment to promote the other levels of the 'gaming experience.'

5.1.1 Level 1: Creating a stimulating gaming environment

The first pedagogical level of the proposed model focuses on promoting the physical gaming experience and those intra-individual aspects that influence this level of gaming. Teachers may face a challenging situation in developing such environment and initiating students into it. Amongst Educational administrators and parents there is a general negative perception about games. At the extreme games are considered as the antithesis to learning, serving solely as devices for alienating young people, disrupting their academic performance and nurturing aggressive behaviours. For others games have very little educational value and thus little relevance to classroom learning. Thus the first challenging step in a pedagogy that promotes learning through gaming has to address these perceptions and feelings about the negative consequences of gaming. Teachers need to be informed by what researchers and expert practitioners say about these issues in order to provide an objective view and model the process of adoption of this engaging way of learning.

Leading researchers and commentators (Papert 1998; Gee 2003; 2007; Prensky 2001, 2007; Selfe & Hawisher 2007; Shaffer 2006;

Leemkuil 2006) emphasise the need to promote a 'gaming culture' in schools amongst teachers, parents, administrators and policy makers that addresses this resistance and apprehension through positive experiences showing how good games can be used in learning. Research shows that, like all other computer applications, games can be beneficial (section 2.1.2) or detrimental (section 2.2.2) depending on how they are used. While some games offer formidable learning experiences others have a more recreational orientation. One must be selective and clear about the objectives when using games.

To develop this positive culture towards games, teachers need to consider a number of measures prior to organising initiatives in CGBL. Teachers and parents must *develop their own gaming literacy and proficiency*, arriving at comfortable working competence with the use of different game genres. Selfe and Hawisher (2007, 115) argue that 'Without some kind of experience with games, we cannot always know how they work or what they offer'. Therefore it is important for the teacher to identify good games that satisfy one's gaming preferences, interests, area of expertise and provide the opportunity to do things and experience situations that are relevant in life. Personal competence and confidence is developed through playing these games and sharing them with students preferably in an informal climate.

The most challenging stage in this process comes when one tries to extend the gaming experience within an institutional set up as discussed in section 2.2.1. The negative impressions and concerns of administrators, colleague teachers and parents have to be addressed. Their fears about addiction, violence and negative impact of gaming on personal health and academic performance have to be externalised and discussed as a precondition to building positive attitudes that lead to acceptance. The teacher's role is crucial in imparting objective information arising from research results and recommendations by experts. Extreme positions about any of the negative effects of games should be challenges pointing to the inconclusive results and open debate that current research sustains. It is also important to raise this discussion to address the 'Intergenerational Disjuncture' (Selfe & Hawisher 2007, 26). The learning and recreational culture of young people is totally different from that of older generations. The learning needs and styles of young people are satisfied through different means. Learning through CGBL resonates more with the way younger people experience life.

While these psychosocial issues are being addressed, it would be necessary to organise resources for *providing a stimulating physical gaming environment* to familiarise users with different games and gaming consoles. The first step to build positive attitudes is to expose users and make them experience different games and gaming consoles. The basic level of the proposed model addresses the need for competence by creating a stimulating environment rich in information about the various aspects of the gaming experience so that novice gamers, participating in 'class-based' gaming sessions, get firsthand experience and acquire the necessary knowledge, skills and attitudes to continue nurturing this gaming experience.

While equipping the classroom as much as possible with gaming hardware and software, teachers need to acknowledge and promote students' experience in this matter. Through surveys and discussions the teacher should get to know students' gaming patterns, getting information about the type of games and consoles used. More insight into the gaming experience of students can be obtained through participation in gaming events organised to make students share their preferred games and gaming consoles. An ideal situation would be to develop a section (preferably in a media room) with different gaming consoles and have competent student assist other students familiarising themselves with them. It is also very effective to organise research groups around major gaming consoles and dedicated games. LAN parties offer another effective possibility for building awareness and enthusiasm about this field.

(a) Addressing restraining factors

Using the information obtained about the gaming patterns of each student, this situation should be exploited to *address various restraining factors* identified by this investigation, mainly underlying gender-related neurocognitive propensities, attitude to gaming, perceived incompetence, apprehension and perceived lack of control.

A two-pronged strategy should be adopted to address gender-related neurocognitive and affective propensities. While orchestrating interventions to accommodate these unconscious natural tendencies, stylistic shortcomings should be challenged by proposing complementary measures. In other words, while appreciating that males are more attracted to games demanding visuo-spatial and navigational

abilities, take more risks and that they are more inclined to adopt command strategies (Rommes 2002) and coalition-based gaming (Pannksepp 1998), at the same time they should be made aware of their avoidance or lack of affinity for games with a linguistic component, or those employing rehearsal strategies and more collegial approaches. Females should be made aware of the need to train their visuo-spatial skills and use more assertive strategies.

In line with the results from this investigation attitude to gaming should be addressed considering both gender and gaming competence. Males tend to show a very positive attitude to gaming while females show a less positive or neutral attitude to gaming. Enthusiastic gamers also tend to show a very positive attitude to gaming, moderate gamers show positive attitude while most non-gamers show neutral or negative attitude to gaming. Attitude can be effectively addressed by considering the affective component, perceived control, perceived usefulness and behavioural aspects.

The first step in addressing the affective component is to identify the source of negative feelings manifested as fear, hesitation and uneasiness experienced before and during gaming. Apprehension arising from perceived incompetence is challenged by providing assurance that difficulties can be mastered and by giving the necessary assistance and encouragement. But this should be complemented with the promotion of positive feelings about games and gaming. Discussion pointing to valid reasons why and how games can be used for learning helps in this rationalisation process which is also enhanced by promoting game-based learning as a stimulating academic activity capable of challenging both process (fluid) and content (crystallised) intelligence (Carroll 1993; Hunt 1999). Examples of good practice should be used to counter act any opinion about gaming as a time wasting activity. Also since attitudinal change is facilitated through reflection about models, it is very important to promote gamers, game designers and researchers as smart, creative and intelligent people.

One of the toughest challenges faced by teachers in promoting games for learning lies in convincing students and adults about the usefulness of games and their potential in mediating different forms of learning. Perceived usefulness has to be addressed by promoting Game-Based Learning (GBL) as an approach that primes learning through the development of positive feelings and moods (Reeve 1997) lead-

ing to a state of 'relaxed alertness' (Caine 1997) that exploits both conscious and unconscious cognitive and affective processes. In this respect GBL complements instructional approaches that are biased towards cognitive aspects of learning. Females need more reinforcement to overcome their scepticism about learning through games. Discussing direct and indirect learning outcomes such as relaxed-alertness, different insight into domains, development of autonomous learning skills, nurturing of a more positive attitude to learning and to digital tools, may lead to the necessary understanding and eventually to change in attitude.

This investigation also found that when negative perceptions were confronted with examples of good practice both sexes came to consider gaming as a more interesting and imaginative way for learning that it is also very efficient and effective. This points to the importance of challenging perceptions and attitudes as an entry step in a gaming pedagogy. It should also encourage teachers to promote both aspects of a gaming pedagogy: learning through designed (off-the-shelf) games and learning by designing games (Kafai & Resnick 1996; Prensky 2006). The fact that both sexes regard games as efficient and effective learning experiences should encourage teachers to include game-based learning in their curriculum and instruction. Besides changes in domain knowledge, the effectiveness and efficiency of this approach should then be assessed through change in attitude and learner engagement that is, assessing if games lead students to undertake more learning tasks to which they dedicate longer time.

Another attitudinal component that has to be addressed at the entry level of a gaming pedagogy is perceived control that includes ability to self-teach gaming skills, acquiring a sense of control over gaming hardware and software, and the extent of reliance on others' help to execute particular tasks. Males feel much more confident in self-teaching anything related to gaming but females lack such confidence. Thus males can be allowed more space to manoeuvre unaided through assigned games. Females overtly expressed their need for guidance and support from a more competent person while playing games. This necessitates interventions from the teacher or other competent colleague to build confidence through developing competence in females. Employing appropriate scaffolding, they are trained how to use hardware for executing different actions and combinations of actions, giving the neces-

sary reassurance through frequent immediate feedback. It also involves grading the gaming experiences starting from less demanding games or game levels and proceeding to more difficult and elaborate tasks. At the same time one has to avoid over-dependence on this support. In collaborative gaming females should be constantly challenged against their tendency to adopt passive, spectator roles. Males should be involved in providing support, giving instructions and modelling gaming actions without patronising game play.

Lack of confidence in solving game-related problems demands supporting females in identifying source. These can arise from lack of skills in manipulating hardware, undeveloped gaming tactics from limited exposure to games, or inability to link domain knowledge with game model. Individualised support to females can be provided through easily accessible, categorised troubleshooting guides that provide immediate feedback in problem situations. Gaming actions perceived as mistakes causing irreversible consequences should be identified, discussed and rationalised by providing possible ways how to avoid or resolve these problems.

Males consider gaming, not as a subsidiary activity proposed by others, but more as part of their daily routine showing more determination to use games for learning and entertainment during college life. Females need more direct induction into the use of games for learning demanding explicit guidance regarding game availability, instructional advantages and relevance to learning. Given their social orientation in gaming as established by Paper 4, this activity should be promoted with adolescent females as a collaborative activity that promotes socialisation and interaction. They should also be sensitised to their vigilant attitude in allocating time for gaming considering this activity as less compatible with the academic demands of college life.

(b) Games for domain learning

After addressing the different attitudinal components and creating a positive disposition for using games, the next logical step is to promote awareness about game titles by exposing students to a range of games from different genres. Students should develop their own list of game titles from different genres, emphasising educational and instructional aspects. A good mix should be made between titles that appeal to males (involving navigation, use of hand tools, strategy-based, squad-

oriented gaming) and those appealing to females (involving puzzles, language/narrative, action, enactments and human relations). Since in an educational context values matter as much as personal interests, promoting games about important global issues such as famines (*Food Force*) or regional conflicts (*Global conflict: Palestine / Latin America*) ensures relevance and understanding of complex problems considering different perspectives. This effort in promoting a positive culture for games should be extended to colleague teachers and parents making them aware of the evolving class experience, the resources being used and examples of good practice in using games for learning.

Reference should also be made to on-line resources and affinity spaces that promote learning with games (Eg. *Mamamedia.com*) and to other sources that could be employed to learn by designing simple games (Eg. *Scratch.com*). The website Mamamedia.com includes sections dedicated to different aspects of gaming for children and for young people. But most important it promotes the gaming experience with parents and teachers in an attempt to address the gaming gap that exists between the younger and older generations. The website from MIT dedicated to *Scratch* provides examples of good practice both in the design of simple games and more important on thinking about other domains through games, giving ample examples of how different people developed innovative ideas.

The exposure of students to a stimulating physical gaming environment, and their knowledge of the teacher's commitment to promote this experience, creates the best frame-of-mind to proceed to the core of the basic Information level of the proposed model. This involves promoting games as tools for domain learning and integrating the gaming experience with different forms of learning in the particular domain in which the game is embedded. The processes occurring at this level are described well in Kiili's (2005a & b) experiential model. To overcome challenges based on educational objectives, player generates solutions in the ideation loop especially through group interactions. The player then tests solutions in the experience loop observing the outcomes of actions. While testing solutions a player's skill level increases thus achieving more control over the game and the subject matter.

To promote learning along the domain dimension, the game must be embedded in an instructional context that emphasises reflection about the different aspects of the domain and the model used by

the game to organise the content. The game should be explored and played so that the user becomes familiar with the different concepts and domain knowledge organisation.

This gaming experience should be analysed for the type of knowledge, skills and mode of interaction promoted by the game. For example the game *Age of Empires* (*AoE*) integrates a number of concepts related to the domain of history. It was the most acclaimed game by participants during the investigation and obtained the highest ranking on the survey about 'Perceived Competence Facilitation' as described in Paper 8. AoE includes a number of concepts organising the narrative: 'Ages' (Nomad, Discovery, Colonial, Fortress, Industrial, Post-Industrial, Imperial and Post-Imperial, characterised by the level of technological development); the concept of 'Civilisations' (British, Dutch, French, German, Ottoman, Portuguese, Russian, Spanish and a range of native American nations); the concept of major historical 'Events' (Colonial Revolutions, Napoleonic Warfare, Ocean Voyages, Pirates, The Fur Trade, The Industrial Revolution, The Thirty Years War).

Other concepts organise the gameplay: 'Personalities' (Eg. Queen Elizabeth, Napoleon Bonaparte and others); 'Campaign heroes' (Alain, Morgan Black, Sahin and others); and 'Categories' of Military Personnel (cavalry, infantry, mercenaries, native American warriors, categories of civilians (gatherers, healers, special roles). The game environment is also based on a number of concepts including 'Buildings' (Arsenal, Artillery Foundry, Bank, Barracks, Church, Dock, Factory, House, Livestock Pen, Mill, Mosque, Outpost, Plantation, Town Centre, Trading Post and others) and concepts related to 'geography' (Maps, type of terrain, resources). To acquire this knowledge, participants have to learn how to use the knowledge sharing tools integrated in the game. *AoE* has a number of reference tools including an encyclopaedia, timelines, historical and geographical maps and a glossary.

Skills promoted by *Age of Empires* include managerial skills for leading a civilisation, strategic thinking skills for planning lines of action according to the evolving situation, organisational skills for developing a working model that integrates the different components of a system. The game also determines the mode of interaction with the domain according to the roles adopted. In campaign mode the gamer has to think and act in a preset environment to execute a mission. So the gamer experiences a particular role in a particular historical set-

ting. In skirmish mode the gamer has to develop and organise the historical setting that assumes a deeper level of reflection and interaction with the environment considering a more complex system of cause and effect relationships. Since a skirmish is based on an evolving situation, the mode of interaction is much more dynamic and engaging.

In the on-line game *Food Force*, knowledge and skills are integrated in missions. User gets to know more about the complex problem of famines by directly experiencing the expertise of different professionals involved in the distribution of food aid to a fictitious Sheylanese community while helping them to rebuild their life. This expertise is simulated in different missions that a gamer has to undertake. Mission 1 is 'Air surveillance' where gamer has to pilot a helicopter over the crisis zone in Sheylan to locate the hungry. In Mission 2 'Energy Packs', one emulates the expertise of nutritionist creating a balanced diet to feed the local population within the given budget. Mission 3 'Air Drop' and Mission 4 'Locate and Dispatch' contextualise the knowledge and skills involved in bulk buying and transporting food. Mission 5 'Food Run' and Mission 6 'Future Farming' trains users in administrative and managerial skills involved in distributing and production of food.

The game and dedicated website provide different modes of interaction with the domain in question. The game provides direct experience of the knowledge and skills related to the specialised missions. The dedicated website provides two other modes of interaction. It provides menu driven option so that user can interact with real life data and events related to contemporary famines. It also provides user the possibility to interact with the domain by reflecting on how one can contribute in different ways and to the various famine situations found around the globe. Another section provides suggestions to teachers how they can interact with the domain and how they can promote this experience in class.

To maximise the pedagogical value of a game, the gaming experience should serve both as a 'springboard' to further domain elaborations and as a focal point linked to a network of domains, disciplines, ideas, conceptual artefacts and real life situations. The Maltese campaign in *Age of Empires III* can be used as an ideal point of departure for relevant explorations in archaeology, military engineering, politics and technology. Comparison can be made between real and represented

events or artefacts, such as fortifications, military equipment, soldier battle gears, battle strategies and historical figures. The game can be compared to the Great siege of Malta reported so much in detail in renowned history books, documentaries and visual art. An enriching anchoring experience can be created through virtual tours or development of itineraries for an onsite real life tour by linking game to online historical sites or to real time simulations like Google Earth.

The game *Food Force* is an elegant example of a conscriptional device that integrates gaming, instruction and reflection in a harmonious way. To design and develop CGBL experiences around such games an initial analysis should identify instructional elements in the game model and peripheral tools, together with others that promote individual and collective reflection. A *game learning profile* should be developed for the game to be used in CGBL detailing underlying concepts and the model that organises them, the skills promoted by the game and themes that could be used for reflection. At a more advanced level the profile should include an epistemic frame that integrates all the skills, knowledge, identities, values and epistemology encouraged by the game, how these are organised and developed while gaming.

From an organisational perspective this game learning profile serves as an instrument for front end analysis of students by comparing what the game offers with students' level of understanding so that experience and competence gaps can be identified. Through the tools integrated in the game (time-lines, glossaries, encyclopaedias or additional documentation), on-line resources and books, students update their understanding of the game and the organizing domain. But the profile serves also as a gaming analysis tool against which Task-oriented interactions observed during gaming can be compared to identify the interactional gap i.e. what the game provides and what the gamers are experiencing and manifesting.

This analysis will serve to develop the best pedagogical strategy relevant for the type of interaction exhibited. With less competent gamers, who are still in the phase of developing basic awareness and competences, emphasis will be more on gaming to identify surface structure and basic gaming gestalts. With more competent groups a more appropriate strategy would be to have a gaming session followed by an instructional activity. This may include debriefing and consultation about the approach to be used, whether gaming should precede

instructional interventions and reflection or if gaming should alternate with instruction and reflection.

One important outcome of the collaborative gaming experience is to bring about attitudinal change regarding the domain. For this purpose instructional intervention at this level attempts to make members aware of the importance of monitoring and controlling their affective and cognitive tendencies in relation to the domain (game theme). Gamers should appreciate how cognitive style influences gameplay determining one's preferred approach to acquire and process information. Gamers should be made aware to control and balance natural tendencies in processing information. Thus in the Real Time Strategy (RTS) games, where many factors should be monitored and controlled simultaneously, focussing continuously on one factor, such as gathering resources (and maybe just one type of resource) without continuing to explore surrounding terrain, proves to be detrimental at the end. The skill of parallel thinking and multi-tasking must be developed. Through imitation the group should facilitate the acquisition of these skills providing novice gamers the context for identifying, imitating and practicing basic gameplay gestalts.

Gamers should also appreciate how these strategies directly influence the use of tools in acquiring domain-related knowledge. Focussing just on one tool such as glossary without referring to actual historical data or timelines will not develop a comprehensive understanding of historical context of the game. One should also control for beliefs and attitudes about history and how to learn it, adopting an open attitude that gaming may provide a totally different experience. Thus at this stage it is important for one to develop a good conception of the game and identifies useful domain-related tools to promote a positive feeling on gaming.

One important aspect of cognitive style is risk taking. Since high performance demands risks, hesitant users should be encouraged to practice informed risk taking and experimentation driven by the principle that professionals learn innovative thinking by reflecting on success and failures and the reasons for them.

The ultimate pedagogical benefit of a game occurs when gamers become competent in adopting self-directed approaches to explore themes and situations through organised research. History games lead to further research about historical eras, personalities, events and

themes. *Spore* leads to further investigation into evolutionary mechanisms, the development and criticism of theories of evolution, to an in depth understanding of life forms and their adaptation to the environment. *Food Force* opens up research and discussion on world famines, food and wealth distribution amongst nations. During the course of this investigation many similar experiences were encountered. *Need for Speed* led students to discuss car physics, elaborating on aerodynamics, braking systems, engine adaptations to maximise power generation and computerisations of all control systems. Through *'The SIMS'* group discussions centred around personal value systems, conceptualisations of the ideal family, relationship between career and personal development, challenging cultural models and reflection about possible identities.

Games are excellent tools to promote reflection about 'Prospective Mature identity'. Thematic games like *Food Force, SIMS, Full Spectrum Warrior, Global Conflict: Palestine* and a range of managerial games that demand the adoption of different roles promote awareness, discussion and experimentation with different identities and contexts where expertise is practiced. In fact the greatest advantage of games lies in embodying experience (Gee 2007; Shaffer 2006) which gives a totally different perspective to the discussion about the type of identity a game encourages together with its evaluation in comparison to other identities found in the game or beyond.

Familiarisation with the stimulating gaming environment together with the support and modelling of more competent colleagues, inexperienced gamers should develop basic game management and game playing skills. These may range from practice in effecting basic game and hardware settings, identifying and using basic gaming tools displayed on the game interface and developing an understanding of the game narrative and underlying domain model. Once gamers develop working competence with the domain model, the group activity can be shifted from acquisition of domain knowledge to participation and contribution in knowledge building by moving to the 'Classroom-enhanced' condition. The next two levels in the proposed pedagogical model will elaborate how this basic level of competence serves to extend the gaming experience into a social experience involving affinity spaces and gaming communities. It also explains how to use the gaming experience for the highest form of learning – using the game to create other conceptual artefacts.

5.1.2 Level 2: Managing the social experience

The first level of the proposed model, discussed in the previous section, emphasises the development of personal competence through interaction within a group. The next level of this model focuses on developing competence at a social level in the process of becoming an efficient participant in the contiguous gaming group and in 'Communities of Practice' related both to the particular game being used and to the domain related to the game's theme. At the task level learning shifts from acquisition to participation, that is learning WITH others through communication and sharing the collaborative gaming experience, as elaborated in Paper 1 section 3.2 (Salomon & Perkins 1998). Beyond the task level this social process addresses the need for relatedness, affiliation and intimacy (Reeve 1997) manifested as different degrees of interpersonal interaction.

Different patterns of participation are evident in the diverse competence-based groups. Groups of less competent gamers in the 'class-based' condition tend to engage with the game at a rather superficial level due to their inexperience in interacting with the various levels and aspects of the game. Consequently they should be offered support to get engaged at a deeper level with the game, especially by challenging each participant to adopt and experience different gaming roles in the group. They should be encouraged to take leading roles suggesting what others have to do, executing roles controlling the game according to others' suggestions and also supporting roles providing feedback and suggestions to others acting as leaders or executors. At this point participants should be made aware of how this exercise in experiencing different roles is influenced by their social propensities, controlling for personality factors that determine their approach or withdrawal behaviours (Davidson 1995). They should be made aware of extrovert tendencies that make participants communicate more and in a much directed person-to-person mode.

On the other hand introverts tend to communicate much less and they do so in an anonymous way, speaking to all, rarely directing their contribution specifically to other participants. Both personality types should be encouraged to use the collaborative gaming situation to develop compensatory strategies to their shortcomings. Extroverts should be encouraged to be more task assertive developing game

mastery by relying more on their own experience and on available task resources to answer questions and solve problems, controlling for their tendency to adopt a supporting role. Introverts have to be more person-oriented and socially assertive making more effort on developing in-game relationship by communicating in a more personal way with leaders and executors avoiding being anonymous and adopting spectator roles.

Teachers or gaming managers (a more competent gamer assigned to oversee the collaborative gaming process focussing on participants' interaction) need to oversee participation considering group-based gender-related propensities. Male groups should control their task-oriented tendency by focussing more on Person-Oriented Interactions (POIs) avoiding being anonymous in their interpersonal interactions. They should also be more tolerant to others' opinions and gaming strategies. Female groups should be guided to adopt a more assertive game-oriented approach with different members adopting alternating leading roles. They should be assisted to control their tendency to engage superficially with games and by focussing more on TOIs train themselves in adopting a deep and more critical approach. They should also control in-group formations arising from exclusive patterns of interaction by avoiding frequent one-to-one interactions, opening up to more colleagues and habitually addressing the whole group.

If the situation dictates the setting up of mixed gender groups, participants should be made aware of possible underlying contrasting cognitive processes, attitudes and tactical approaches to gaming. Once they rationalise gender-related differences in approaching the collaborative gaming context, a gaming strategy that capitalises and integrates both tendencies should be developed. These groups should make more effort to develop an affective socio-emotional climate by providing positive feedback and complimenting each other while controlling their tendency to sub-group with same sex members.

Group history and level of friendship are important criteria for setting up and managing groups. Friendly groups should be advised to emphasise TOIs along with the more frequent POIs. It is not recommended to set up groups where newcomers are introduced to other participants who already show an established friendly relationship. This tends to lead to sub-grouping that evolves into a negative and restraining climate with severe impact on task and group processes.

With non-friendly groups a gaming manager should be delegated to challenge the emotionally inert and disengaging climate and use the game context as an 'ice breaker' for promoting interpersonal communication and ultimately a friendly atmosphere within the group. This process can be enhanced by referring to previous relevant gaming experiences and by making participants aware of their approach or withdrawal tendencies that need to be controlled. When communication is established and the group is interacting efficiently then the role of the game changes to a 'learning object'. This harmonised group activity will stimulate effective interactions that will definitely develop participants' gaming competence. When gaming competence improves to a level that they can be assigned gaming tasks on their own, then the *'Group-enhanced'* approach should be adopted.

The focus now shifts onto the social participatory aspect of gaming, managing the group experience to develop competence for collaborating in contiguous and virtual gaming communities and to promote domain learning through the group processes of negotiation and argumentation (Dillenbourg *et al.* 1996). The main role of the teacher or gaming manager at this level is to instigate discussion and encourage personal contribution by having participants share their opinions and experiences about the particular game being used.

Paper 8 established a direct link between game type and the socio-emotional climate developed during gaming. This implies that group involvement, cohesion and needs satisfaction can be assessed from the type of body language, facial expressions and the level of communication as manifested by the type, frequency and directionality of interactions. Hence the evolution of group structure in the different competence-based groups can be monitored and managed according to the manifested task and person-oriented interactions.

Specific interventions should be identified for different groups challenging their strategy, suggesting different goals and possible roles. Since more competent groups tend to sub-group as a result of overt or tacit competence contention, they may require an external gaming manager to stimulate a cooperative attitude and to give support in establishing common goals, enhance communication among subgroups and ensure frequent rotation of roles.

Non-competent gaming groups will need guidance from a gaming manager to ensure group coherence. This is achieved by assign-

ing roles and proposing lines of action while encouraging participants to be more adventurous and pro-active. Capitalising on the positive socio-emotional climate prevalent in such groups, s/he should provide support through detailed task descriptions. The gaming manager should motivate and support participants in adopting leading and guiding roles. These constant interventions are needed to create an efficiently interacting group with an organised structure that controls for the prevalent incoherent approach.

If it is not possible to avoid the mixed competence condition, these groups need external help to manage gaps in competence by facilitating apprenticeship between more and less competent members, primarily by modelling this process. The same principle applies for managing evolving collective gaming strategies and friendship combinations. The dynamics of a leader-led group are different from those of collaborative groups with distributed leadership, or exploratory groups with no group structure. Teachers and gaming managers should try to establish a balance in leadership roles. While excess coercion exerted by a leader leads to passivity, lack of leadership or guidance lead to inefficient and superficial interaction. At the socio-emotional level, managing friendship combinations is very important to develop an efficient climate for interactions.

At this point it is important to distinguish between a game leader and a gaming manager. A game leader is a member of the gaming group who takes a more pro-active role in guiding others and deciding gaming actions. A gaming manager is a more competent gamer external to the group whose role would be to animate the group by encouraging the participation of all and trying to nurture a positive socio-emotional climate that enhances interactivity both at the task and personal level. While challenging passive comportment or detachment from group, this manager should not contest more competent participants acting as leaders and thus interfere with the established group decision-taking process (Reeve 1997, 149).

Regarding the gaming task, this participatory level extends awareness and skills related to the 'deep' structure of the game involving user-to-user interactions mediated by the game. The group provides individual participants the optimal environment to reflect about and practice advanced gaming skills. Their solitary gaming experience away from the group develops queries and difficulties that they bring to the

group looking for a solution. They discuss narrative, problem types and gaming skills and observe other advanced gaming gestalts (Lindley 2002). This group-based interaction is extended through built-in tools that provide communication and knowledge sharing facilities that are linked to affinity spaces. According to Gee (2007, 87) these are spaces in which people interact, rather than form membership in a community. These on-line portals extending interactions and knowledge sharing amongst gaming affinity groups through chat, fora, FAQs (Frequently Asked Questions about technical and tactical support) and through facilities for exchanging or selling game related artefacts (Gee 2007).

Familiarisation with the deep structure (Gredler 1996) of the game and related affinity spaces should promote reflection in the group about the degree of 'sharability' offered by a game, perceived competence facilitation (Ryan *et al.* 2006) and the mutual interaction between real and virtual identities (Shaffer 2006; Gee 2007; Selfe & Hawisher 2007). The group should be trained to assess the type, frequency and directionality of interactions promoted by game and related on-line environments to appreciate the various levels of interplay between participants. These range from sharing simple to complex gameplay gestalts, sharing gameplay geographically as in multi-user games or temporal sharing of roles that are intentionally changed during a gaming session. Group reflection about the degree of interactiveness of a game should address individual perceptions about competence facilitation by a game.

Paper 8 discussed how games are perceived to promote competences along the three dimensions of the proposed pedagogical model. The group experience helps participants in collaborative gaming to evaluate the degree a game develops domain knowledge and skills, the extent it helps in developing interactional skills for sharing one's gaming experience with the contiguous group and on-line communities and the extent it improves gaming skills. The investigation established that the history games *Empire Earth, Age of Empires* and *Civilisation* were perceived by frequent gamers to promote domain-related competences. *Need for Speed* was perceived to promote gaming skills, while *Age of Empires* was considered very effective in developing community management competences. Such evaluation should lead to a higher level of pedagogical control. One can determine the compe-

tences intended to be developed by a gaming session and select the appropriate game accordingly. An important outcome of this schematisation of the deep structure of games in a collaborative context is intense reflection about one's identity both in contiguous and on-line communities. The interactional possibilities offered by a game facilitate the adoption of different roles. These range from playing different game characters, adopting different roles in contiguous groups (leader, executor, supporter, spectator) or experimenting with different projective identities (Gee 2007; Steinkuehler 2006) in game-related virtual communities.

Beyond learning through direct experience with the game, the group process stimulates learning along the domain through the discourse processes of negotiation and argumentation. Participants arrive at a deeper understanding of the underlying domain model and what characterises a domain expert. The game serves as a tool and context to develop deeper understanding of the domain model, practice the skills characterising that domain and apply the domain model to other situations. *AoE3* and other history games are developed on an evolutionary model starting with a simple colony that develops into an entire civilisation through skilful management of environmental resources and threats. *Spore* uses the same approach, though with a more scientific orientation to the natural sciences. Starting with simple units, primitive organisms are created and managed to establish a colony that can be develop further into a civilisation.

Using the game experience and information from affinity spaces, domain model conceptualisations are elaborated by schematising important features into reconstructions of authentic contexts. The process of developing these reconstructions and simulating key processes serve to acquire further insight into the domain making the knowledge and experience more transferable to similar situations. In other words, playing Spore and obtaining information from dedicated websites helps the player to arrive at new perspectives about evolution and to understand better the principles of emergence and natural selection which are then transferred and applied to other situations involving different organisms or natural environments. History games give different insights into the domain when compared to traditional 'tell-test' approaches. These more robust conceptualisations are transferred and used in situations where other history-related dilemmas are met.

At this stage the objective of instructional intervention should be to assist participants in schematising the main features of the underlying domain model and identify any shortcomings both in narration and contextual representation. For example, the Maltese campaign in *AoE II* is an oversimplification of the real event. The same campaign in *AoE III*, though more elaborate, still lacks many salient details and reconstructions. This should be exploited pedagogically serving as a point of instructional intervention involving both evaluative and developmental approaches.

The gaming experience should also serve as an initiation into domain expertise, that is, facilitates understanding through role play what it means to be a political leader, an explorer, a biologist or any other major game character. Participants should appreciate what type of questions experts ask, what problems they face, how do they solve them and what methods they use to increase their competence and affiliation in these domains (Wagner 1999; Shaffer 2006; Gee 2007). It is a concrete opportunity to practice domain skills. The major outcome of playing a game is the empowerment experienced by a gamer to reflect 'in' and 'on' action. The effect from the game is the ability to describe in a more comprehensive way domain organisation, expertise and its representation in the game compared to that in real life.

As an extrapolation of 'reflection-on-action', the domain model proposed by a game should be compared with other instructional experiences. The history model as proposed by AoE3 is fundamentally different from that proposed in classroom situations. It enables the revisiting of historical situations from different perspectives – Ages, Civilisation, Events and Personalities – which definitely increase one's insight into domain. The teaching approach and the game model about history or biology are actually very complementary putting the user in a better position to understand history or biology through these two contrasting experiences. Through group discourse users should evaluate how much they perceive the game as capable of developing competences in relation to domain. Comparing it to classroom instruction they should assess if after playing the game a better understanding of the game theme is developed, if they are better equipped to acquire, share and mediate domain knowledge and skills. Positive perception about competence facilitation by a game can be achieved if gamer is able to appreciate different modes of interaction with domain knowl-

edge provided by the game and feels more confident in using the various game options to interact with the domain in different ways.

Thus at this level it is very important to follow the type of task and person-oriented interactions occurring in a group. The type of discourse and the roles that evolve in a group disclose the degree of influence the domain and gaming model had on the group in addressing perceived competence facilitation by a game and the promotion of post play interactions with the domain as an extension of the gaming experience. Improving one's sense of competence, both at the task and social level, develops more positive attitudes about the collaborative gaming experience that prepares the way for further exploration into the domain and related expertise.

5.1.3 Level 3: Facilitating contribution and knowledge building

The third level of the proposed pedagogical model focuses on how participants in the 'Group-shared' condition use the collaborative gaming context to develop and refine their mediational and contributory skills. This 'wisdom' level is concerned with the ability to use knowledge for motivating and helping less competent others understand and develop gaming and domain-related competences. As a consequence of their expertise, new knowledge is generated either as an extension of existing conceptual artefacts or in the creation of new ones. This level combines the technology-intensive expertise of participating students with innovative scenarios for educational practice. Designing games and developing domain-related game-based learning are practical instances of Bereiter's (2002) claim for innovative approach in formal education. He recommends a complementary dimension in future education based on the creative use of digital technologies in knowledge building and inquiry-based learning. Learning is considered as understanding leading to further understanding which is achieved through the use of conceptual artefacts that lead to the generation of further artefacts.

Through these mediational and generative activities experienced gamers satisfy the higher order needs for relatedness, affiliation and self-actualisation in contiguous and virtual communities. Their task and person-oriented interactions are an expression of leading and guiding roles. Their insight into gaming and domain models puts them in a

position to anticipate game-related behaviours, quickly evaluate them and propose relevant guiding or corrective measures. On an individual level they may challenge negative impressions and beliefs, model game play, provide tips as guidance, support and encourage members lacking in confidence and challenging them to take more active roles. On a collective level their role is to nurture group affinity by addressing both task-related processes and the socio-emotional climate of the group. Through their analysis of the group gaming goals and the prevalent interaction patterns, they will be able to guide group strategy, challenge inefficient approaches and suggest alternative group structure through change of roles.

One of the most important metacognitive activities along the community dimension concerns how the contiguous group or virtual community promotes reflection about a participant's evolving identity. Collaborative gaming stimulates reflection about a mature gaming identity that motivates a participant to identify a strategy for upgrading various competences to bridge the gap between current and a more evolved identity (Leont'ev 1978; Vygotsky 1978). Experienced gamers should mediate this process by continually challenging less competent participants to adopt more active group roles thus shifting from a spectator or participant status to a more leading and contributing one, both in the contiguous group and also in on-line communities and affinity spaces.

The group process should be used to promote reflection and awareness in expert gamers about the relationship between their evolving identity and self-actualisation by comparing their role and relationship in different groups. Their role may fluctuate between that of a participant, leader or contributor depending on the level of competence of a particular group. For example, while in less competent groups they may adopt a leading or managing role satisfying their need for self-actualisation, yet with more experienced gamers their role may change from a managerial to a participatory one that satisfies more their need for relatedness and affiliation. Thus at this level of expertise collaborative gaming should serve as a pedagogical tool to facilitate experimentation with different identities as part of the process for achieving mature ones.

One common problem in highly competent groups concerns conflict of identities leading to excessive competitive comportment man-

ifested as diverging and contrasting reactions that may easily lead to polarisation of behaviours. There is a tendency for a group to split into members practicing solitary play while others detach or form non-communicating sub-groups (Paper 7). A subtle competitive spirit may exert strong influence on interactions in such groups with the consequence of restraining sharing of expertise. External support would be needed to develop a more collaborative comportment and an attitude of sensitivity to the contribution and opinion of others. Normally this involves actively resisting non-cooperative tendencies such as the inclination to start interacting in sub-groups or consciously detaching from group with the intention of denigrating the performance of other participants. Group members should be encouraged to contribute in developing a positive socio-emotional atmosphere by providing positive feedback and complimenting other's suggestions and achievements. They should also be enticed to take the role of a group manager in turns to promote interaction and communication amongst all group members and as a way to integrate those who tend to disengage from the group.

The group experience developed by a particular game provides competent participants the opportunity to elaborate the gaming experience through suggestions how to improve both the game and the domain models, by modifying existing or designing new ones. There is mutual influence between the game and domain models, such that modification in one would definitely lead to changes and elaboration in the other. But this is not an impossible feat for enthusiastic gamers equipped with insight into a range of game genres and considering that many may be very acquainted or specialised in one or more genres. Many game companies actually encourage and promote these user-generated games by providing various game design tools together with on-line promotion and support facilities.

Paper 8 established that when enthusiastic gamers were placed in a constructionist context, asking them how a game they played inspired them to design a new one, a number of features were identified as useful to enhance the gaming experience. These features introduce new processes in the gaming experience or elaborate existing ones. To have a game interacting in space and time with the external environment, a version of the game should be developed for a portable gaming device, equipped with wireless networking facilities capable of accessing con-

text sensitive interactive system. To enhance interpersonal communication an instant messaging tool bar was proposed to be included.

To promote learning by designing games a game editor for creating 'Mods' (modified versions of the game) was proposed to be integrated in the game. This creative process could be enhanced also through a 'Simulation mode' option that uses the game environment as a tool and context for integrating individual creations. The priming effect of the game used on this generative activity varied as a function of the underlying gaming and domain models. The games *EE*, *AoE* and *SIMS* triggered more elaborations of existing models and tend to develop game conceptualisations that were perceived more attractive as they provided a more interesting gaming and learning experience by giving users more control over the game and the peripheral activity. The models underlying *Civ* and *NfS* inspired less generative activity.

Enthusiastic gamers bring this personal generative experience to the group and using the game as a conscriptional device or conversational focus (Paper 1), they enter into a process of cooperative development through which game conceptualizations are refined. In the group they plan, share and evaluate elaborations of the game narrative, underlying knowledge structure and gameplay. There is also the possibility of developing new game conceptualizations inspired by the collaborative gaming experience and subsequent collective reflection-on-action. This leads to an iterative process of solitary and collaborative design and development. The game serves as an inscriptional device in solitary design moments and as a conscriptional device when the personal constructions are analyzed and criticized by the group (McGinn & Roth 1999).

Designing and developing games is a complex process demanding familiarisation and working competence with a number of tools. At the planning stage when developing the game content, flowchart tools are indispensable conscriptional devices. Tools for interactive story writing (woven stories), like LOOM (Nuutinen 2006), serve the same function for developing the narrative of a game. Various commercially available storyboarding tools can be used when developing and refining prototype game characters and environments.

Once the different components of a game have been designed, different levels of game development can take place. Some games have a built-in game editor for executing modifications. If one intends to

build a simple game from scratch, Flash-based tools (like Swish) can be used. The game design tool 'Scratch' (Fildes 2007) provides a straightforward, 'click-and drag' method to develop simple animations and games. Microsoft XNA Game Studio Express is a game design tool kit available to MS Xbox users. Linked to this, Microsoft offers online game hosting and marketing facilities. An important trend today is casual gaming (Waters 2008) involving games that people can play and complete in minutes rather than hours. The ultimate game design experience for expert gamers is offered by commercially available professional design tools.

Designing a game is definitely a team-based project demanding a distributed management strategy to integrate the varying expertise of participants. Beyond the task level of interactions, skills have to be developed to manage group processes. The evolving game becomes a collective physical and conceptual artefact serving as a 'boundary object' that coordinates work across groups, time, and space. At this level the game serves as a conceptual artefact that provokes different forms of thinking in participants with diverse interests or roles. While the role of the graphical designer would be to evaluate design aspect, the software developer focuses on the programming aspect and the person responsible with the domain model has to interact with both of these to remain faithful with domain exigencies. Thus, besides allowing for multiple and divergent interpretations and meanings, this newly produced artefact serves to engage widely differing discursive and material practices (McGinn & Roth 1999).

From a metacognitive perspective, recognizing the significance of the game's role as an inscriptional, conscriptional and boundary artefact in the different stages of the design process reveals the underlying levels and dimensions of interactions. This enables teachers or group managers to identify and promote the most appropriate skills for the different design situations. When the game serves as an 'Inscriptional' artefact or 'objects to think with' for creative expression according to personal expertise, individual problem solving, monitoring and evaluation skills are demanded. At the level of conscriptions, communication and collaborative working skills are needed. When the evolving artefact serves as a boundary object, then the emphasis shifts on organizational and management skills that demand a complementary shift to social metacognition (Jost, Kruglanski & Nelson 1998).

For these advanced gamers, the group experience together with their interaction in on-line 'affinity spaces' serves to develop further insight into the epistemic model (Shaffer 2006) of the game. They develop elaborate conceptualizations of domain expertise based on a more detailed description of knowledge, behaviours and skills as embodied by domain experts (Gee 2003). In developing such epistemic model, expert gamers have to be guided to perform structural, functional and process analysis of the related domain (Sherry & Trigg 1996). Structural analysis determines the components or elements of a domain mainly, core themes, key concepts, mode of generating and disseminating knowledge. Functional analysis determines how the elements of the domain are related to each other. Process analysis shows typical expert behaviour as determined by a epistemic frames of that particular domain.

The organizing principles for practices include methods for justification and explanation, forms of knowledge representation, strategies for identifying questions, gathering information and evaluating results, together with a description of the behavioural patterns of those engaged in such forms of thinking and ways of acting. Scientists, politicians, historians, engineers and other expert fields have distinct epistemic frames (Shaffer 2006). Developing expertise thus implies developing expertise of some particular kind, from a particular perspective, relative to the ways of knowing of a particular community of practice (Gee 2007). *Food Force* models the expertise of a typical UN aid worker, *Spore* models the epistemic frames of a Biologist, while *Full Spectrum Warrior* simulates the combat behaviour and thinking of a modern expert soldier. The domain model of many games provides islands of expertise in specific fields. Playing a game will familiarize users with the epistemic frame that represents the tight linkage between practices and ways of knowing in a domain.

The role of expert gamers is to understand this model and the underlying epistemic frame and transform these into conceptual artefacts that can be modified, extended, applied and even re-designed. This will equip them with the necessary insight to use the game and peripheral artefacts to mentor others into these epistemic frames and mediate domain knowledge and skills. Through this mediation they facilitate the process for other less competent users or colleagues to incorporate epistemic frames into their identities (or portfolio of potential

identities). This mediational mechanism involving rich experiences in 'technology-supported simulations of real-world practices' may help students deal more effectively with situations in the real world and in authentic experiences linked to school subjects.

At the metacognitive level along the domain dimension, through discussion in the group-shared condition, highly competent gamers have to monitor and control for a number of aspects in the evolving gaming experience. First they must control for discrepancies between the domain model used in the game and the epistemic frames of real life expertise. Their insight into the game model enables them to evaluate it in relation to official domain standard practice. For example history games are compared with the standard practice of historians or explorers and with documented historical facts. Further comparison can be made with the models of other history games.

They should also evaluate and facilitate the interaction of less competent gamers with the domain model by monitoring T&POIs manifested during gameplay, together with negotiation and argumentation in collaborative gaming contexts. Their role in other groups would be to mediate the domain knowledge and skills to less competent member thus facilitating their understanding of the domain model. This is done through guiding negotiation and argumentation of inquisitive members. Under this expert supervision, games are categorised according to design features and according to the types and levels of interaction they provide with the domain. If an expert gamer ascertains that further experience to develop a more comprehensive insight into a particular domain is needed, they may propose game titles according to the identified interactions or competences to be developed. One's expertise may also be considered for proposing games to promote intended domain-related attitudes. Conversely expert gamers may preclude the use of games that may have a negative effect on domain conceptualisations such as those with simplistic domain representations or those that provide limited ways of interacting with domain. Other games may be inappropriate to be used in group situations due to their lack in maintaining group cohesion, in promoting intended interactions or desired socio-emotional climates.

Collective reflection with their highly competent colleagues should explore the difference in interactions mediated by a game's domain model and that underlying other instructional experiences. This means

comparing how a game mediates interactions with the domain compared to the interactions developed during a typical history or biology lesson. Expert gamers should evaluate how each situation mediates the epistemic frames and what are the strengthens and the shortcomings of each. This should also lead to reflection about commonalities and discrepancies in the proposed mature identities by each situation.

The above discussion and the underlying model show the complexity of collaborative game-based learning (CGBL). Managing this activity requires the consideration of various levels and dimensions of the gaming experience. It is not simply an individual process of passing from acquisition to participatory interactions with the game. It involves collective experiences with the physical and social environments, together with experiences in the world of conceptual artefacts that trigger reflection about the intra-individual and collective gaming experience.

This model should be used to assess CGBL for a range of learning outcomes. It can be used to evaluate the evolving group experience in terms of changing roles and contributions both at the task and also at the group management level. One can monitor and assess the changing domain and gaming competence and the intra-individual controls to enhance these. This model also provides a template how the collaborative gaming experience stimulates acquisition, modifications and elaborations of domain-related knowledge structures and skills, together with criteria to identify domain regulatory learning. This elaborate model for the collaborative gaming experience proposes a number of design features that need to be integrated in games with an educational orientation to be used in groups. These will be discussed in the following section.

5.2 Implications for designing games

The Popperian experiential model suggests that collaborative gaming can evolve into a holistic experience if games integrate a number of features that promote the three aspects of gaming: tools that promote physical and social interaction, other features for objectifying and externalising the intra-individual reality and a set of tools that transform the game into a malleable conceptual artefact. Educational games should thus be designed to integrate these three aspects of the

gaming experience, considering both the experiential and the meta-cognitive levels.

The proposed process-oriented model that focuses on identifying interactions along the different dimensions of the gaming experience can be an extremely useful tool in user-centred game design, Kiili 2005a. 'Player-centred game design is not about asking potential players what kind of game they would like to have, but rather a way of providing the design team with information on what the game design can be based upon and inspired by' (Ermi & Mäyrä 2005, 13). Thus instead of adopting a self-reporting approach with the inherent subjectivity, the model proposes a more empirical approach for feeding game designers with objective information about user interaction patterns and quantified behaviours along the domain, technology and community dimensions.

The model assumes that the game itself serves as the main interactive feature, being complemented by a number of tools that extend interactions within the domain, within the gaming community and in relation to other game design tools. Serious Games like *Food Force, Spore* or *Global Conflict: Palestine* are excellent examples of this strategy. Commercially available titles like history games can be further developed to promote the three aspects of the gaming experience.

5.2.1 Designing games that promote direct interactions with the environment

Whether developing new games or upgrading commercially available titles, the educational potential of games can be greatly enhanced through tools that promote interactions with the physical environment represented in the game environment. For example the game *Food Force* simulates the direct experience with the various physical working environments of an aide worker. The six missions - Air Surveillance, Energy Pacs, Air Drop, Locate and Dispatch, Food Run and Future Farming - serve as enactments of different context-specific problem-solving situations. This game is also embedded within a virtual learning environment that incorporates menu-driven options with links to various media-based first hand experiences highlighting famines and humanitarian aide work. Other options include a section with resources for teachers and one with proposals for user contribu-

tions to help UN 'World Food Program' fight hunger. Several links are also available to promote communities involved in this humanitarian activity such as press, blogs, teacher's communities and game design communities.

The principle of extending the physical experience through the game should be applied to commercially available games like *Age of Empires*. This particular game was chosen to structure this discussion for two main reasons. The first is the fact that it was one of the most acclaimed games by the experimental groups. Secondly, it includes an oversimplified simulation of the 1565 Great siege of Malta as one of its options. The first act of the single-player campaign begins with the player in the role of Morgan Black leading the Knights of Saint John to defend the last stronghold on Malta from Sahin "The Falcon" of the Ottoman Empire. The true location where the major military and naval operations took place is the Grand Harbour adjacent to the city of Valletta. The direct experience with this authentic environment can be further enhanced through a range of media artefacts related to this historical event including representations and re-presentations of historical sites, arms, archives, military maps, paintings of the time and other sources.

This direct experience can be promoted in a number of ways by the game. The game environment may be designed to integrate links to these resources. For example double clicking on the wall of the city in the game gives user a real life picture of the bastions of Fort St Angelo where the actual battles were fought. Double clicking on a musketeer, a canon or a galley leads user to authentic representations or animated re-presentations. Another possibility is to have menu driven options providing lists of authentic experiences in the form of audio-visual documentaries or video-based enactments of highlights from historical events or about historical settings. These may also include panoramic views of relevant sites, 3D animated walk-through of historical sites or animated demos of artefacts. These could also form part of the built-in reward regime that are activated on task completion. The game may also be linked to external geographical simulation tools like Google Earth. Using the information in the game the student has to use Google Earth to arrive at sources of information beyond the game. For example student may be asked to develop an itinerary for organising a walking tour following the Great siege trail. The tutoring sys-

tem within the game helps by providing an interactive environment with strategic 'clickable' points that show panoramic scenes of past and present historical sites.

At a more intricate level ambient games integrate real with virtual environments, creating networks of players socially interacting in time and space. Games have to be specifically designed for portable gaming consoles that are equipped with wireless networking facilities, capable to interact with 'hotspots' in the physical environment and also with other gamers utilising the same network. The possibilities offered by this technology are infinite. It creates dynamic interaction with the domain, with the physical environment, with technology and with the social environment. While one gamer plays the game in Fort St Angelo, the actual site where Grandmaster La Vallette led the knights and Maltese during the Great Siege, another gamer plays the role of Dragut (the true historical figure leading the invading Turks). Through the network of 'hotspots' the game leads one gamer to the exact location where Dragut placed the canon batteries when bombarding Fort St Angelo giving him on site information about geographical, topographical and important military intelligence regarding opponents. The other gamer playing the role of La Vallette will be given relevant geographical, topographical and military information about enemy formations. This demands that the game has to integrate in its intelligence all possible actions taken by gamers.

The game may provide other ambient sensitive gaming modes providing role play of different historical figures or management of events. One may play 'on site' the role of different categories of invading Turkish soldiers or the role of defending Knights. The game may offer the possibility of playing the role of a Spaniard feudal lord in the pre-knights era exploring the barren peninsula on which Valletta city was built later. While the character moves to different locations on the peninsula the game gives 'on site' detailed simulations of the different parts of the land in its virgin state. The game may provide users the option to play the role of La Vallette entering Valletta as a barren piece of land surrounded by the newly built bastions, or as a grandmaster in the later stages of knight era entering the fully built and decorated city. Other scenarios would simulate Napoleon taking over the city from the knights, or a British governor inspecting the devastation caused by bombing from German air forces during World War II. In

any of these scenarios, the game integrates historical facts, simulated artefacts and authentic locations. Actually this links to the other more engaging aspect of the gaming experience – using games as conceptual artefacts for knowledge building and deeper understanding. The versatility of ambient gaming lies in merging physical with conceptual artefacts, a combination that boosts enormously the pedagogical potential of this technology.

5.2.2 Designing games that address the intra-individual experience

An important dimension of this study was how to promote reflection about the domain, gameplay and community as an integral part of the personal gaming experience. Different aspects of this metacognitive activity have already been discussed in the various published papers. Here discussion focuses on the implications for designing games with tools that serve various individual and collective metacognitive functions.

The strong gender effect manifested in neurocognitive propensities, attitude to gaming and individual gaming competence demands serious consideration when designing games. A gender-related design option should be integrated for the beginner and intermediate levels in educational games. During the log-in process a male or female option should be provided and the selection of either of these activates the relevant adaptive tutoring system. This investigation established that females feel less competent in managing resources to acquire knowledge or skills demanded by the gaming context. They overtly expressed the need for support from a guide to build confidence and competence. Considering also the fact that females are more relation-oriented, compared to male task-orientation, the 'female option' should activate a customisable Game Personal Assistant (GPA) that provides continuous formative dialogue and feedback.

When the male option is selected, feedback would be less frequent, giving only salient task-related information through a problem-solving approach. If the female option is selected a more elaborated support system will be activated that provides task-related information through animated tutorials, proposing solutions related to hardware or game settings problems, gaming tactics or domain knowledge in a stepwise

manner. The GPA should also have a metacognitive role especially at the end of the gaming session when female users decided to quit the game. To entice them to use more games for learning the GPA may propose other serious games through promos, demos, links to dedicated websites and instructional sections in affinity spaces.

From a process-oriented perspective, games should also provide tools both for promoting and monitoring interactions. Interactions processing systems, discussed in more detail in the next section, provide empirical data that could be used for modelling behaviours and thus develop adaptive tutoring to gamers. Gamers can be guided during playing on basis of the frequency and directionality of task and person oriented interactions pointing to patterns of interactions or lack of them. Games should also integrate a number of tools to facilitate 'beyond' the game interactions. In multiplayer games, task-oriented tools, such as text-based instant messaging and dedicated task-related icons (directions to move, actions to do, tools to use etc), will enable players and supporting colleagues to exchange information, provide encouragement and task-related feedback. Person-oriented communication tools should include a live video window showing facial expressions of other participants integrated with on-line video conferencing, an activity meter giving graphical statistical information about frequency of interventions by gamers and a wide range of emoticons for expressing positive and negative feelings or encouraging and challenging colleagues.

5.2.3 Designing games that support knowledge building

Games should not only be included in pedagogical approaches that promote learning by acquisition and participation but most important in innovative future educational scenarios that focus on learning by contribution through technology-intensive creativity support systems. The role of games as conceptual artefacts will be to generate new artefacts in the form of elaboration of existing games, development of new games or the promotion of innovative domain-related conceptual artefacts. This implies that games need to include or link to design and knowledge building tools.

Since most game developing companies promote user-generated content, they are designing games equipped with game editors or com-

patible game design tools. This enables experienced gamers to extend game features and functionalities creating their own 'Mod' – a modified version of the entire or part of the game. The oversimplified Malta campaign in *Age of Empires* can be elaborated by expert gamers helped by colleagues who are competent in Maltese history to develop a gaming experience that is more faithful to the real event.

Another important design functionality to be included in games is the option enabling the game to switch to simulation mode. The game environment and characters can be manipulated to design new artefacts, include elaborations of the storyline and incorporate new ways of interacting with the domain. Having this simulation mode in *Age of Empires* one could create a simulation of the historical site during the siege era, anecdotal moments of historical figures or other important personalities, accurate 3D models of fortifications, arms, ships, transport vehicles, land and naval battle strategies and formations. The game should also be capable of linking to external design tools so that any digital artefact such as animations, simulations, 3D models and other creations could be imported into the game.

One of the most important aspects in developing knowledge building skills is providing apprenticeship both in the use of design tools and in domain content conceptualisations. In practical terms creations developed by students have to be assessed and compared to expert conceptualisations and interpretations. Expert models and simulations are provided as part of the ancillary tools in the game or dedicated affinity space. This provides two levels of analysis. Standard game features (characters, tools, artefacts, environment etc) can be compared with expert versions to make user aware of possible adaptations and simplifications. But these can be also used to analyse user creations when these are imported into the game or affinity space. In both situations, the system will provide assessment through animated commentaries that compare gamer propositions with actual events, documents, sites or artefacts. Actually this is an instance of the player-centred game design approach proposed by Ermi and Mäyrä (2005), Sotamaa *et al.* (2005) and Sotamaa 2007.

The inclusion of these proposed tools would definitely enhance the educational potential of games thus increasing the chance of being integrated into the formal educational process by innovative teachers. A gaming pedagogy is only possible if the games used address a range

of student and teacher needs. Games must be designed to address different levels of gaming competence, different aspects of the gaming experience and different modes of learning ranging from acquiring knowledge and skills, to participating and contributing to communities of practice and affinity spaces. In other words games need to be adaptive along the different dimensions and pedagogical levels proposed by the model. Besides being adaptive with regards to domain content, they need to be adaptive to user's personal needs, mainly gaming competence, gender, type of learning in relation to competence and status within the community of practice. The more games with enhanced levels of interactivity and adaptivity are available, the greater will be the possibility for the collaborative game-based pedagogy to become a reality.

5.3 Self-assessment of the investigation

The investigation is evaluated from three different aspects. First the internal validity of the results obtained is discussed commenting on the support for the conclusions that the causal variables caused on the effect variables. The second deals with the validity of the adopted experimental approach commenting on the degree that this investigation supports the intended conclusions drawn from the results. The third perspective involves a general evaluation of the investigation referring to statistical conclusion validity, external validity, transferability, applicability and credibility of the investigation.

5.3.1 Internal validity of results

Capturing group activity through quantified categories of interactions was found to be a more empirically sound approach that reflects better the complexity characterising collaborative gaming activity. At the same time it facilitates management of collaborative learning scenarios by giving control over single components enabling pedagogical interventions at the experiential and metacognitive levels along different dimensions of the gaming experience. It increases objectivity and hence validity when evaluating collaborative contexts by shifting the focus onto external observers and not limiting their evaluation to subjective, self-reporting regimes. The positive feedback received from

reviewers of the published papers, each focusing on a different aspect of the gaming experience, confirms the validity of the approach and of the proposed model.

The discussion about the internal validity of the results is organised around the three aspects of the gaming experience. The results related to the normative aspect of the physical and social gaming experience confirmed those obtained by other researchers where gender influences choice of games, time dedicated to playing games, motivations to play and preferred social context (Paper 2 & 4). Paper 4 also provides empirical evidence how game genre and gender interact to develop different interaction profiles for male and female users.

An important aspect of the physical gaming experience is the perception created in users (especially novice gamers) about the competences that could be developed by a game after evaluating the surface and deep structure of the game. The survey developed to evaluate the perceived competence facilitation needs validation and standardisation with larger user samples and a wider range of game titles. Yet the data collected points to its effectiveness in profiling games according to competence facilitation along the domain, gaming and community dimensions involving acquisition, sharing or mediational forms of learning. Recent research in use of games (Ryan *et al.* 2006) promotes this approach soliciting researchers to explore further the role of perception in preliminary game play evaluation.

Coupled with this approach, consideration should be given to the influence of perceived usefulness of game features on game use. The results showed that perceived usefulness of game features is determined by game genre and that some features are seen to be more suitable with particular type of games than with others. Evaluating games for the way they represent domain knowledge, their degree of vividness and authenticity and the inclusion of a number of support tools helps in rationalising perceptions and customise better the gaming experience.

Another promising line of research deals with how game genre influences the socio-emotional climate that evolves in a group. This was carried out using both separate and clusters of POIs. This proved to be an accurate method for establishing how various features that affect game appeal influence positive or negative feelings, interpersonal communication and eventually the socio-emotional climate that

addressed the need for relatedness. This method of using POIs and expressions of friendship to characterise the contexts developed by different game titles gives the possibility of quantifying the degree of social interaction and collaboration promoted by a game. Research question 5 of Paper 8 uses the same method to explore the influence of user control provided by a game on group interactions.

Instead of POIs, research question 6 in Paper 8 focuses on TOIs and directionality of interactions to establish the level of interactions observed in collaborative gaming contexts that serve as an indicator of the degree of 'sharability' of a game. Data confirmed that more sharable games develop higher levels and variety of interactions, more positive socio-emotional climates and a higher degree of interpersonal interactions. This made it possible to rank games using an index of sharability. This approach of analysing the physical gaming experience and the game itself using this interactions approach is a very valid approach that was highly acclaimed by paper reviewers as it focuses on variables that could be measured empirically and managed pedagogically.

A number of variables making up the intra-individual gaming experience were validated through the proposed interactions approach. The influence of personality, described from the perspective of Cognitive Neuroscience, on collaborative gaming was explored through a triangulation approach. The instrument developed from renowned psychometric instruments used to evaluate personality was used as an indicator of personality type which was then explained through frequency and directionality of interactions. This proved to be a versatile approach that combines empirical aspects with objectivity and comprehensiveness considering task and person-oriented interactions together with adopted gaming roles. This provides a better methodology for characterising personality in technology-intensive environments.

The influence of gender on collaborative gaming was confirmed from different perspectives. Interpreting the influence of gender on game choice from a neurocognitive perspective using profiles of interactions is a very valid approach as it transcends behaviouristic conceptions linking observed behaviours to underlying cognitive and neurobiological mechanisms. The same can be said about the influence of gender on entry attitudes to gaming. The breakdown of attitude into four sub-components each targeting specific cognitive, affective or conative interactions provide an accurate method for profiling gen-

der-related attitude that is empirically measurable and that has extensive pedagogical implications enabling surgical interventions to address specific attitudinal components.

The influence of gender on collective activity was explored through interaction profiles of groups with different gender composition. This gave a very elaborate picture of group dynamics based on the type, frequency and directionality of interactions for male, female and mixed gender groups. Group activity can be differentiated on the basis of task-oriented interactions, person-oriented interactions and the prevailing socio-emotional climate, together with the patterns of interpersonal communication and sub-grouping. These multidimensional group profiles render themselves as an effective tool for managing group processes during collaborative gaming.

Like gender, individual gaming competence (IGC) proved to be a major factor influencing collaborative gaming. A strong correlation was found to exist between IGC and attitude to gaming. The method used is empirically valid as it quantifies both variables using scales that can be easily manipulated both from a methodological and a pedagogical perspective. IGC was also validated from an interactions perspective establishing statistical correlation with T&POIs, directionality of interactions and adopted gaming roles. It was also found to correlate with gender showing that males are predominantly enthusiastic gamers while females tending to be moderate or non-gamers.

IGC was also one of the variables used in setting up experimental groups and was found to be a major factor that influences collaborative gaming. The interactions profiles that emerged for competent, mixed competence and non-competent groups confirm that IGC influences T&POIs, the socio-emotional climate of the group, directionality of interactions, sub-grouping and individual gaming roles adopted in the group. The contrasting and extensive group profiles also show a higher degree of influence on group interactions when compared to all other group factors (gender, friendship level, size). The key role of this group characteristic is acknowledged in the proposed pedagogical model where IGC is used to structure the three pedagogical levels accommodating the different interactions along the different dimensions.

Apart from exploring the influence of single individual characteristics on group interactions, the social experience of collaborative gaming was investigated through three more distributed group char-

acteristics: friendship level, group structure and group size. The level of friendship (friendly, partly friendly and non-friendly) determined T&POIs, the socio-emotional climate characterising the group, directionality of interactions in relation to direct versus anonymous communication and role patterns. Different combinations of friendship led to the development of contrasting interaction profiles manifesting varying degrees of satisfaction regarding the needs for relatedness, affiliation and intimacy. This multidimensional assessment of the socio-emotional climate of a group in relation to underlying needs is a very valid approach for analysing and managing collaborative activity and should be one of the components addressed by any pedagogical template.

The data from this investigation shows that the evolving gaming strategy, or any task execution strategy in technology-intensive collaborative contexts, is another group condition that should be given major consideration. The profiling of groups using T&POIs and directionality patterns according to how they evolve in leader-driven groups, collaborative groups with distributed leadership or exploratory groups with no organised structure is very accurate and beneficial from a group management and pedagogical perspective. Evolving or established patterns of interactions serve as an authentic guide for orchestrating pedagogical interventions to improve group efficiency and productivity. Group size was found to be another important factor that contributes significantly to effective group processes.

Regarding the gaming as an experience with conceptual artefacts based on design approaches to build knowledge, the results obtained by this investigation are indicative of a potentially creative and challenging approach. Users are encouraged to consider games as an evolving experience around an artefact that could lead to different conceptualisations of domains involving new modes of experience and reflection. The ideas about design approaches included in the instrument 'Useful and Appealing Game Features' (Appendix 15) should be further elaborated and refined through research. More reliable results will be obtained if this research approach using the proposed instrument is embedded within a constructionist approach that merges learning with game design.

5.3.2 Evaluating the experimental approach

The aim of this investigation was to gain insight into collaborative gaming and hence propose a process-oriented model how this context could be exploited for learning. The investigation established the complexity of this context identifying various levels and dimensions of interactions. This led to a range of methodological challenges demanding an innovative interactions-oriented approach involving both qualitative and quantitative data capturing methods.

Research is a creative act manifested by the ability to adopt various approaches to explore different aspects of the problem situation. Studying collaborative gaming involves both exploratory and confirmatory methods through which an attempt is made to establish generalisations about certain aspects while considering contextualisation and applicability of the concepts under investigation. Thus this investigation integrated quantitative and qualitative data collection techniques to address different research needs. The exploratory component of this investigation attempts to acquire an in-depth understanding of participants' behaviour and the reasons behind it by investigating the *why* and *how* of decision making, not just *what*, *where*, and *when*. This implied the use of focused experimental groups, rather than large random samples. Information was gathered using various methods including participation of researcher in the experimental setting, direct observation, in depth interviews with participants after gaming sessions, and analysis of surveys and video recordings of gaming sessions. The data obtained was organised into interactions profiles serving as the primary basis for organizing and reporting results.

But certain aspects of the investigation demanded confirmatory methods for measuring a number of trends related to various clearly defined concepts. Employing a systematic approach focussing on a number of hypotheses, clearly defined concepts or trends were measured in an attempt to establish a connection between empirical observation and a mathematical expression of quantitative relationships.

Reflection while reviewing literature and observation from prior investigations led to the formulation of a number of hypotheses or research questions. The first hypothesis was about the observed gender-related difference in the use of games. For this purpose a preliminary survey was developed including sections to measure different

aspects of this trend. The same approach was used when investigating the identified individual, group and game characteristics. Data was collected to support the hypothesised condition or relationship described in the research questions.

But reflection and creative analysis did not feature only during the initial phase preceding the investigation. While carrying out the focused investigations based on pre-structured explanations, other insights grew out of the data or the experimental context. Combining explanations from quantitative measures with these more contextualised insights led to a better understanding of the concepts under investigation. In this way the main factors influencing interactions during collaborative gaming were identified.

The behaviours of participants in collaborative gaming situations were described through various approaches. From a quantitative perspective one aspect of the investigation explored a number of cause-and-effect relationships between identified variables that focus on a single behavioural outcome or few variables making it clear what is influenced by what. Thus individual, group and game characteristics were each described through a number of cause-and-effect relationships involving subsidiary variables. An experimental setting was organised to explore these relationships as defined by research questions. Experimental groups were set up with members having different personal characteristics (personality, gender, attitude to gaming, gaming competence). The group conditions were varied (gender, individual gaming competence, friendship level, size) together with task conditions (different type of games). Individual and group interactions were observed under the different conditions recording the different combinations on video. Analysis of these recordings quantified the type and directionality of interactions. The data was analysed using the above mentioned characteristics as independent variables and frequencies of interactions as the dependent variables.

These theme focussed investigations were complemented with a number of surveys that provide a good blend between quantitative and qualitative research methods. These were used as an alternate source of information for understanding more college students and their gaming experience. Each statement provided a quantitative measure of a particular behaviour or variable and combinations of the variables could lead to the quantification of higher order variables. Thus attitude to

gaming was explored through 28 statements each targeting some specific behaviour or interaction. But these were clustered around four major attitudinal components which in turn were integrated into an overarching general attitude component. But interpretation and integration of these different variables could only be done through an explanation embedded in the experience of college students.

In fact this investigation can be considered as a case-study that evolved into a process comprising theme focussed investigations embedded in a bigger narrative that represents the developmental process in which a range of variables relevant to the collaborative gaming context were identified and integrated in a theoretical and methodological framework. The experimental groups were studied within the bigger context of the pre-university college and the national cohort of 16–18 year olds. Through formal and informal interviews, discussions, observations, analysis of video recordings and reflection, this process focussed more on how to interpret the world and the gaming experience of a typical college student in collaborative gaming contexts. The narrative evolved from a phase of reflection sustained by readings on the gaming experience that was captured in conceptual, methodological and pedagogical models serving as tools for describing and prescribing the collaborative gaming experience in the 'natural' setting of a typical class.

Though this investigation includes a number of theme focussed investigations involving research cycles that are reported in separate published papers, these were always considered as stages in an evolving process. Actually, since the early stages of this investigation, all activity was organised within systemic models to avoid fragmentation of ideas or disjointed experimental approaches. At the conceptual level, the main ideas behind this investigation were organised through the Popperian three world model. This was translated into a pedagogical constructionist model detailing the main processes and needs that will be addressed by the investigations. The results of the investigation were again integrated into an elaborated version of the original model to give a coherent pedagogical template that can be used by researchers and practitioners. Using Salomon's metaphor, the flutes have to be seen within the context of the orchestra, while keeping in mind that the orchestra itself is made of specialised musicians.

5.3.3 General evaluation of the investigation

As part of the evaluation process it is important to acknowledge the strengths and limitations of this investigation considering how these may influence the generalizability, credibility, confirmability, dependability, transferability and applicability of the adopted methodology, the results and the proposed pedagogical model.

This investigation focused on the collaborative gaming experience of college students. Thus the proposed model needs to be validated with other age groups and with students from different academic backgrounds. College students are very much constrained in dedicating time to gaming and to actually enjoy it in a relaxed way. They experience immense academic pressures arising from the intensive two year course and the critical final exams. Thus similar investigations should also be conducted with students following less demanding courses. Though most of the surveys were carried out with large groups of students, the purposeful sample involved in the experimental setting dealing with collaborative gaming comprised only 56 students. The investigation should be repeated and validated with larger student samples. Also the study is based on five identified games and this should be extended to a larger number of games representing the different genres.

The credibility of this investigation arises from a number of factors. The organising models are all based on recommendations from literature pertaining to different fields related to the gaming experience. The methodological approach and related instruments were all developed according to criteria proposed by cutting edge research. These gave rise to a number of versatile data packages giving relevant results that were highly acclaimed by other researchers and reviewers. From the perspective of the participants in the research, there was general consensus that their personal and collective gaming experience was being analysed and described in a very accurate manner. The different surveys used, the video recorded sessions and the formal or informal discussions that formed part of the investigation gave them ample chance to reflect on the different dimensions and levels of their experience. All results were discussed with participants, which they confirmed and commended to extend their experience. When confronted with the proposed pedagogical model there was general agreement that it rep-

resented faithfully their experience and detailed the right approach for adopting a game-based pedagogy.

The adopted research methodology and the proposed pedagogical model can easily transfer to other research or learning contexts. The underlying pedagogical model has already been applied to assess interaction in web-based communities. It is being used in research about interactivity in other Technology-intensive collaborative environments as discussed in section 5.4.3 below. The pedagogical model can easily be used with other student cohorts apart from college students. With minor modifications it can be used to analyse collaboration in technology-intensive contexts. The model is currently being used in undergraduate teacher training courses providing a framework both for research and practice in Educational Technology. At Masters level it is being proposed both as a pedagogical model and as a framework for research methodologies.

Since this investigation has a strong qualitative component implying that researcher brings a unique perspective to the study, confirmability becomes an important issue. Results must be confirmed and corroborated by others. Thus a number of strategies were used to enhance confirmability. The different stages of this investigation were embedded in models that provided frameworks for integrating the different variables with each other and with underlying psycho-social processes. The models were published in papers to be evaluated by other researchers. A detailed description was provided how the models will be translated into the adopted methodology and all the procedures and data collecting instruments were checked and rechecked throughout the study. At the end of each research cycle the theoretical framework, methodology and results were published to obtain criticism about the approach so that the next research cycle will be fine tuned and controlled for any shortcomings or biases. All instruments used are available to other researchers to be used in confirmatory or exploratory research initiatives. In this respect both model and instruments have been passed to other researchers who requested permission to use them in their investigations.

There is also the issue of dependability that emphasizes the need for the researcher to account for the ever-changing context within which research occurs. The theoretical, technological and social contexts change continually and these demand adaptive measures dur-

ing the course of the investigation. At the theoretical level there was a shift in research towards interpreting human behaviour from the perspective of Cognitive Neuroscience. This determined the model and approach that had to be adopted.

The concepts behind technology and technical capabilities change so rapidly that the short life-span of many applications and games affect directly investigations having a relatively long time frame. Games used during the initial stages of the investigations were superseded within a short period of time. Even the nature of the gaming experience changes with time. Gaming evolved from a solitary activity to an extensive collaborative one. Thus the games initially used in this investigation were definitely of a lower level of sophistication and appeal than current games. For example this investigation used early versions of the history-related games *Empire Earth II, Civilization II* and *Age of Empires II*.

In the three years after the experimental sessions during which the data analysis, publication of papers and writing of this thesis were done, more sophisticated versions of these games were published exploiting developments in the underlying technology and the greater experience of the gaming community. Currently *EE III*, *Civilization IV* and *Age of Empires III* are available with many related expansion packs. A similar evolution happened in the *SIMS* and *Need for Speed*. The model should thus be validated with these more evolved versions of the games. Incidentally some of the games already integrate features proposed by this thesis on basis of the results obtained.

Also during the later phase of the investigation more relevant games were released. If the investigation was to be done again one would consider a range of different games like *Food Force, Spore*, a number of titles dedicated to the Nintendo Wii together with recent versions of history games. Future investigations should use the most recent version of a game. Though this may somewhat infringe on the consistency of the experimental conditions, student engagement is determined by preliminary evaluation of the gaming experience. They consider newer versions of games to have more elaborated surface and deep structures thus providing qualitatively richer gaming experiences.

One must also consider contextual constrains that influenced both the course and the content of this investigation. Many times researchers have to adopt a 'defender' role arising from the many social concerns around computer games. For example the main thrust of this

investigation is about the use of games in educational contexts and their pedagogical value. Many circumstances were encountered by the author where this thesis, or any of its major themes, had to be defended in the midst of raging debates about some aspect of the gaming phenomenon. One has to continually insist that there are entertainment-oriented games and others that can provide profound educational experiences. The debate regarding the former should never impede or limit discourse about the latter. Actually this situation sensitized the author to adopt a balanced perspective between over enthusiastic writers glorifying the use of games in the face of sustained social criticism and generalizations from personal experience.

Another relevant observation made by Kirriemuir and McFarlane (2004) is about the fact that games and publication cycles are out of phase. The time taken for peer reviewed articles to reach publication often means that games described as 'current' may be somewhat out of date compared with the rapid and dynamic evolution of more elaborated and sophisticated games. They thus recommend that research into games and learning need to be supplemented by alternative sources, such as on-line dedicated websites, fora, gaming communities, game developers' sites and other sources that are not subject to the same level of expert scrutiny and degree of peer-reviewing as academic publications. In this respect a compromise was reached regarding publication of papers related to this thesis. Papers 1-5 were submitted to the longer but more rigorous reviewing process characterising publications in journals. Paper 6-8 were subjected to the quicker peer-reviewing process provided for conference proceedings.

This evaluation of the results, the adopted methodology and the general organisation of the investigation points to a number of improvements and suggestions that have to be considered in future research. The next section synthesises these recommendations.

5.4 Implications for future research

The range of research possibilities triggered by this investigation for the future will be discussed under three categories: Research about games and gaming, validation of instruments used in this investigation and application of proposed interactions approach and related pedagogical model.

5.4.1 Games and gaming

This investigation serves as a point of departure for further investigation about games and gaming patterns in Malta and thus merits to be extended to include larger experimental groups so that a more standardised empirical base is developed for this field. Longitudinal studies should also be carried out to establish gaming patterns involving different age groups. This research should also be backed with comparative studies from different countries to identify general and local gaming trends and patterns.

Another dimension that needs to be explored is about evaluating the use of the proposed model when introducing game-based learning in formal educational contexts with different age groups. Investigations should also be carried out with adults to identify ways and means how this approach can be applied within the context of life-long and life-wide learning. This approach should also be investigated from the perspective of curricular subjects and different domains of learning. Using the proposed model more focused studies are needed to carry out an in depth analysis of solitary, collaborative and competitive gaming using different genres of commercially available games. The model should also be adopted to investigate the educational benefit and negative effects of gaming from a process-oriented approach.

Regarding gaming as an intra-individual experience the various dimension introduced by this investigation need further exploration. The influence of personality and how it can be interpreted in Technology-Intensive Collaborative Learning Environments (TICLEs), the motivations that drive gaming, gender and gender-adaptive gaming and the influence of prior experience merit further elaboration. More research is also needed to validate the instruments developed for this investigation, mainly the interactions approach used to describe personality, survey about attitude to gaming and the survey about the evaluation of games from the perspective of perceived competence facilitation. A more integrated approach should be adopted where all instruments related to the different major factors are administered to each experimental group. This will enable more coherent statistical analysis and makes empirical modelling possible.

Research should also be carried into the use of games as artefacts for learning and knowledge building. Investigations should be car-

ried out to explore how domain learning can be promoted through games. The lack of learning along the domain dimension was one of the major outcomes of this investigation. Throughout the experimental sessions task-related interactions involving acquisition or sharing of domain knowledge were very scarce. This means that research should focus specifically on how to promote domain learning. Studies should be carried out how games and the group condition could be used to promote acquisition and sharing of domain knowledge as described in the proposed pedagogical interventions along the domain dimension. These should be evaluated to refine the pedagogical process.

'Learning by designing games' as a pedagogical approach should be promoted and validated with various age groups and for different domains. Closely related to this is the approach of simulating expertise in epistemic games. For example a challenging research endeavour would be developing a game oriented to student teachers that simulates teacher expertise. This automatically implies research and collaboration in promoting a culture that advocates game-based learning and knowledge building and in creating the necessary mechanisms for implementing such a vision.

5.4.2 Validation of instruments used in this investigation

The instruments used to gather information about gamer's experience 'My Preferences for Digital Games', 'My Feelings when Playing Digital Games' and 'My Personal Style' (Appendix 1, 7 and 8 respectively) should be administered with larger student samples representing different age bands and from different educational streams. These instruments should be evaluated for test-retest reliability, criterion validity and internal consistency. The same should be done with the instruments used to evaluate games regarding perceived competence facilitation and perceived usefulness in this case using it with a wider representative sample of game genres.

A similar validation process involving criterion validity and inter-rater reliability should be done with the instruments used to record student interactions, mainly the 'Student Interactions Observation Sheet', 'Student Role Observation Sheet' and 'Observation sheet for direction of interactions' (Appendix 3, 4 and 5 respectively).

5.4.3 Interactions model and approach

The positive experience gathered from this investigation acknowledge by recommendations from paper reviewers shows that the proposed model provides a valid approach for designing and evaluating TICLEs. This should be corroborated by further investigations about the use of this model in different TICLEs such as Web-based learning, Mobile Learning, Ubiquitous computing and Technology-intensive creativity support systems.

The adopted methodology involving the capturing of different dimensions and levels of interactions, categorising them by type and direction, and use these to develop interactions profiles has wide implications regarding the design and adaptivity in TICLEs. In contiguous groups using technologies for carrying out identified tasks, interactions can be captured through direct observation using appropriate recording instruments or by recording on video and analysing recorded sessions. Subsequent analysis of recorded data enables the development of data profiles that can be utilised for managing better the social level of learning.

In technology-intensive environments involving people interacting through VLEs, LAN multiplayer environments, Massive Multiplayer On-line Games, ambient gaming or through mobile learning technologies, profiling of interactivity can be done more efficiently through built-in information processing units capable of tracking, recording and analysing interactions by type, frequency and direction. Analysis of this evolving data enables adaptive decision-taking by other processing units in relation to manifested user interactive propensities. The generated meta-data can then be exploited by a pedagogical component of the system to suggest lines of action along different dimensions and appropriate pedagogical levels.

This innovative approach to adaptivity using interactions as empirical data on which behaviour can be modelled will change the way devices evaluate users' preferences. Instead of employing self-report questionnaires prior to task commencement, evolving data and meta-data are utilised as source for decision making, thus eliminating subjectivity and human variability. For example identifying and managing personality type was traditionally done through self-reporting instruments like the ones used in Paper 6 with all the reliability and valid-

ity concerns arising from user's subjectivity. Also there is the problem of how these personality dimensions manifest themselves in online environments, thus challenging again the validity of prescriptive approaches. But by tracking interactions, personality can be expressed as a function of recorded data in the form of an interactions profile.

One of the investigation reported in Paper 6 outlined this approach and established that the interactions profile of extroverts contrasts with that of introverts. Extroverts are oriented to social interaction showing higher degrees of interpersonal interaction manifested as 'Asking', 'Suggesting' and 'Disapproving' in relation to the task at hand. They also show divergent patterns of interaction with larger number of interaction directed individually and collectively to group members. They tend to adopt a supporting role. Introverts tend to be more reserved in social situations being taxed by interactions and thus prefer to adopt a withdrawal strategy, manifested as a 'Passive presence'. Though they may be cognitively very active, collaborative environments put them into a socially and emotionally 'less-interactive' mood. They showed no task or person –oriented interactions with statistical significance and tend to adopt a spectator role. If they interact, their interaction profile is characterised by linear interactions directed to single person/s from the group. These contrasting interaction patterns can easily be picked by a system and adaptive action taken based on pedagogical decisions.

Such profiling method has wide implications and applications for the design and adaptivity of TICLEs including collaborative gaming. The pedagogical potential on both the cognitive and metacognitive level will be extended drastically through interactions processing systems capable of tracking interaction type, frequency and direction built in network software systems or mobile devices equipped with local and distant communication facilities. These integrated systems will then have the possibility to host task and person oriented interaction tools giving participants more interactive options thus empowering them to manage their own learning and enhance contribution and mediation options. Regarding adaptivity, interaction processing systems will change the way devices evaluate users' preferences. Instead of employing self-report questionnaires prior to task commencement, interaction processing systems will analyse and record user initial interactive performance. Reference to this evolving data enables adaptive decision-taking in relation to manifested user interactive propensities.

The generated meta-data can then be exploited by a pedagogical component of the system to suggest lines of action along different levels and dimensions.

Though there are still crucial problems to be solved and further refinement is needed this model and approach offer promising methodologies for modelling behaviour in TICLEs through objective and empirical means. Currently this process-oriented pedagogical model is being investigated at the Department of Computer Science, University of Joensuu, Finland. The objective is to develop a pedagogical agent to be integrated in an intelligent system designed to tutor a TICLE where groups of students using a network of computers design and program educational robots. The roles of the pedagogical agent is to trace, categorise and record interactions, evaluate them against an itemised interactions-based knowledge platform, identifies interactions gaps between individuals and groups, proposes lines of action, records individual and group interactions profiles, and prescribes instructional and group management proposals.

An interactions-based knowledge platform is being developed for the different dimensions of the model proposed by this thesis. The domain dimension will be the 'Programming' component of the project with task-oriented interactions related to the use of statements, data, variables, commands, loops and control structures. The technology dimension involves the building of a robot with task-oriented interactions related to simple movements (flexing and rotating), different types of sensing and control behaviour. The community dimension captures the person-oriented interactions between different group participants (students and tutors) while 'Asking' for acquiring knowledge or competence, 'Reporting' on sharing competence and 'Commenting' on reflection about competence or performance. The directionality of interactions is being categorised into the following possibilities Student-to-Student (S-S), Student-to-Students (S-Ss), Student-to-Group (S–G), Student-to-Groups (S-Gs), Group-to-Group (G–G), Group-to-Groups (G – Gs), Student-to-Teacher (S-T), Student-to-Teachers (S-Ts), Teacher-to-Student (T-S), Teacher-to-Students (T-Ss), Teacher-to-Group (T-G), Teacher-to-Groups (T-Gs), Teacher-to-Teacher (T-T) and Teacher-to-Teachers (T-Ts).

Text-based interactions will be recorded on session logs, while verbal interactions and body language will be captured on video from on-

line video conferencing tools. Digital video camera will be used with contiguous groups sharing a common computer lab. Analysis of the above mentioned categories of interaction will lead to the identification of interaction patterns from which relevant counter profiles will be developed driven by pedagogical or domain exigencies. By time it is proposed that an intelligent tutoring system will be developed that integrates this interactions processing unit with a pedagogical agent capable of analysing incoming interaction patterns, compares them with those of an integrated database and develops appropriate lines of action.

The potential of the process-oriented approach should be explored within TICLEs for developing learner profiles as a tool for formative and summative assessment. This line of research can be extended to explore how this system can be used as a personal profiling system involving personal e-portfolios, 'Mixed e-Portfolios' for integrating personal achievements with collaborative activity and Team-e-Portfolios integrating group problem solving skills, communication and social skills, team working skills, group dynamics, LLL and knowledge building skills.

5.5 Conclusion

This investigation is better described through the game metaphor as a series of challenges that had to be tackled at different stages of its evolution. Yet the game is not over! The next level deals with the challenges proposed to researchers, educationalists and parents. It's about promoting a culture and a pedagogy that resonates with the epistemology of a knowledge society. Gee (2007, 12) uses the pioneers' metaphor to characterise this arduous mission:

"The Wild West and space were seen as new frontiers. Video games and the virtual worlds to which they give birth are, too, a new frontier and we don't know where they will lead. It would be a shame, indeed, not to find out because, like any frontier, they were fraught with risk and the unknown. But then, I have already admitted that all of us in the complex modern world are frightened of risk and the unknown. But that is a disease of the soul that good games can help alleviate, though, of course, not cure."

For many teachers and parents using games for learning in collaborative contexts is a new cultural frontier that needs to be traversed.

They need direction and support in the process to help them appreciate the new possibilities offered. But it is also a pedagogical frontier that demands new insights, new tools and innovative practices. This thesis proposes one possible way ahead to meet the challenges faced by learners in a digital society where teaching, learning and working have been radically transformed and will continue to change. By orchestrating the network of variables that determine how learners interact with technology, with domains of knowledge and with relevant communities, the proposed pedagogical model attempts to create a template that merges learning in schools with that occurring beyond, combines reflection with engagement and blends individual with collaborative experiences.

It proposes ways and means how to cross these cultural and pedagogical frontiers that lead into a new terrain where further explorations and evaluations have to be undertaken. But after all isn't this the essence of the game .... moving on to the next level to explore the unknown!

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APPENDICES

APPENDIX 1:
MY PREFERENCES FOR DIGITAL GAMES

Name: ……..…… Class: …….....
School: ..... Date: …….....

1. Preferred gaming device PC □ Playstation □ Mobile phone □
   Other**……**
2. Insert the time (¼, ½, ¾, 1, 2 hours etc.) that represent sessions you dedicate to playing digital games during a normal school week and a typical week during holidays:

School Week	**Mon**	**Tues**	**Wed**	**Thurs**	**Fri**	**Sat**	**Sun**
before noon							
between noon & 6 p.m							
between 6 p.m. & midnight							
after midnight							

Holidays	**Mon**	**Tues**	**Wed**	**Thurs**	**Fri**	**Sat**	**Sun**
before noon							
between noon & 6 p.m							
between 6 p.m. &midnight							
after midnight							

3. I prefer to play games Alone □
   With: Parents □ My sister/brother □ My best friend □ a group of friends □
4. Go through the following list of game titles. Insert a tick [✔] near your favourite game/s.

Resident Evil		Simcity	
Max Payne		Ultima On-line – Age of Shadows	
Indiana Jones		Shogun Total War	
Everquest		FIFA	
Age of Empires		Alpha Centauri	
Civilisation II		Command and Conquer Generals	
Flight Unlimited III		Battle 1942	
Need for Speed		Roller coaster tycoon	
The SIMS		Supermario	
Theme Hospital		Worms	
Anarchy Online		Solitaire	
WWWII Online		Minesweeper	
Encarta Mindmaze		Hangman	
Starcraft		Snake	
Harry Potter and the Chamber of Secrets		Half Life	

5. My preferred video games are ……..……
   ……..……..……

APPENDIX 2: COMPOSITION OF EXPERIMENTAL GROUPS

Composition of Experimental Groups						
Group No.	**Student Name**	**Gender 1=M 2=F**	**Group Comp./ Gender**	**Group Comp./ Friend-ship**	**Gaming Competence**	
					Individ	**Group**
1	Daniel	1	3	1	1	2
1	Siglio	1	3	1	1	2
1	Clarissa	2	3	1	3	2
1	Ramona	2	3	1	3	2
2	Clayton	1	3	2	1	2
2	Paul B.	1	3	2	3	2
2	Carina	2	3	2	2	2
2	Miriam C	2	3	2	2	2
3	Lydon	1	3	3	1	2
3	Paul A.	1	3	3	1	2
3	Daniela	2	3	3	2	2
3	Svetlana	2	3	3	2	2
3	Tara	2	3	3	3	2
4	Christopher	1	3	1	3	2
4	Yannis	1	3	1	1	2
4	Maria	2	3	1	2	2
4	Melissa	2	3	1	3	2
4	Miriam F	2	3	1	2	2
5	Andrew Joseph	1	3	2	1	2
5	Clint	1	3	2	1	2
5	Simone	2	3	2	2	2
5	Stephanie	2	3	2	3	2
6	Jean Paul	1	3	1	1	1
6	Joseph	1	3	1	1	1
6	Karl	1	3	1	2	1
6	Stephen	1	3	1	1	1
6	Henriette	2	3	1	2	1
6	Veronica	2	3	1	2	1
7	Jean Paul	1	1	1	1	1

7	Joseph	1	1	1	1	1
7	Karl	1	1	1	2	1
7	Stephen	1	1	1	1	1
8	Graziella	2	2	1	3	3
8	Henriette	2	2	1	2	3
8	Ruth	2	2	1	3	3
8	Susan Victoria	2	2	1	3	3
8	Veronica	2	2	1	2	3
9	Fiona	2	2	1	3	2
9	Henriette	2	2	1	2	2
9	Veronica	2	2	1	2	2
10	Peter	1	3	1	2	3
10	Elaine	2	3	1	3	3
10	Maria	2	3	1	3	3
10	Vanessa	2	3	1	3	3
11	Malcolm	1	3	3	1	2
11	Marylin	2	3	3	3	2
11	Stephanie	2	3	3	2	2
12	Michael	1	3	3	2	2
12	Ryan	1	3	3	1	2
12	Mary Claire	2	3	3	2	2
12	Sarah	2	3	3	3	2
13	Olaf	1	3	3	3	3
13	Amy	2	3	3	3	3
13	Miran	2	3	3	3	3
13	Xanthe	2	3	3	3	3
14	Claire	2	2	1	3	3
14	Enrique	2	2	1	3	3
14	Jade	2	2	1	2	3
14	Kyra Domenique	2	2	1	2	3
14	Marika	2	2	1	3	3
14	Maris	2	2	1	3	3
15	Daniela	2	2	1	2	3
15	Nadya	2	2	1	3	3
15	Nathalie	2	2	1	3	3

APPENDIX 3: STUDENT INTERACTIONS OBSERVATION SHEET

Student Interactions Observation Sheet																															
Student Name:													Master Cassette Code:										Session Code:									
Game Used:													Group:										Session date:									
Game Profile:																															
Task-oriented Interactions	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Focused reception																															
Interacting with game																															
Imitating Game actions																															
Ref. Personal Biography																															
Asking for help																															
Giving help																															
Responding																															
Sharing																															
Providing feedback																															
Confirming																															
Suggesting																															
Socio-emotinal Behaviours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Pleased look																															
Neutral look																															
Disagree/ Rejection																															
Jubilant Expressions																															
Approving gestures																															
Disengaged																															
Disapproving																															
Hostile																															
Recommands game																															
Censures game																															

APPENDIX 4:
STUDENT ROLE OBSERVATION SHEET

Student Role Observation Sheet																																		
Student Name:													Master Cassette Code:											Session Code:										
Game Used:													Group:											Session date:										
Game Profile:																																		
Gaming	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30				
Leader																																		
Guide																																		
Follower																																		
Supporter																																		
Spectator																																		
Friendship	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30				
Detached																																		
Solitary																																		
Friendly																																		
Exclusive																																		

APPENDIX 5: OBSERVATION SHEET FOR DIRECTION OF INTERACTIONS

Observation Sheet for Direction of Interactions																															
Student Name:												Master Cassette Code:										Session Code:									
Game Used:												Group:										Session date:									
Game Profile:																															
Addressing	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
All group																														
Addressing	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
All group																														

Summing directionality of interactions									
Male-male		Male-males		Male-female		Male-females		Male-all	
Female-female		Female-females		Female-male		Female-males		Female-all	

APPENDIX 6: COMPUTATION, RESCALING AND RECODING DATA SHEETS FOR SPSS VARIABLS

Master Cassette Code:					Session Code:				Session date:				Group:			
GrpNo	GCmpGn				GCmpFr				GGmCmpt				GmStrat			
Student																
Game																
IGC																
GR																
	C	R	C	R	C	R	C	R	C	R	C	R	C	R	C	R
Task-oriented Interactions																
Fcrc																
Gin																
Gim																
Pbio																
Askh																
Gvnh																
Rspd																
Shrg																
Pvfd																
Conf																
Sug																
Socio-emotional Interactions																
Pslk																
Ntrl																
Dsrj																
Jbln																
Apgs																
Dsng																
Dspr																
Hstl																
Rcmg																
Cnsg																
Individual Gaming Role																
Grldr																
Grgd																
Grflwr																
Grsptr																
Grspct																
Individual Friendship Role																
Fldtcd																
Flsol																
Flfrnd																
Flxcls																

APPENDIX 7:
MY FEELINGS WHEN PLAYING DIGITAL GAMES

Name …… Group …….

	Please indicate whether you agree or disagree with each statement. Try not to think about your answer for too long. This is a survey NOT a test, so there are no 'right' or 'wrong' answers – just answer as honestly as you can. Please tick ONE answer for each statement.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	Given the opportunity to use a Game such as ***Empire Earth*** or ***SIMS***, I am afraid that I might have trouble in navigating through it.					
2	Games help me relax and thus do my work better.					
3	I could probably teach myself most of the things I need to know about Games.					
4	I would avoid learning a topic if it involves Games.					
5	I hesitate to use a Game in case I look stupid.					
6	Games can enhance the learning experience to a degree which justifies the extra effort.					
7	I am not in complete control when I use a computer for Games.					
8	I don't feel uneasy about using a Game.					
9	I can make the computer do what I want it to do while playing a Game.					
10	I only use Games when told to.					
11	I need an experienced person nearby when I'm using a Game.					
12	Playing Games does not scare me at all.					
13	Most things that one can get from a Game can be obtained or arrived at through other means.					
14	I avoid playing Games.					
15	If I get problems using a Game, I can usually solve then one way or the other.					
16	I hesitate to use a computer for playing Games as I'm afraid of making mistakes I can't correct.					
17	Games provide more interesting and imaginative ways for learning.					
18	I will use Games regularly throughout school/college.					
19	I do not need somebody to tell me the best way to use a Game.					
20	Games make me feel uncomfortable.					
21	Games make it possible to learn more productively.					

APPENDIX 8:
MY PERSONAL STYLE

Name: ……...…..Group..……

The table below is divided into four sections. In each section there are five statements. Read all statements in a section and then rank them from 1 to 5 according to the following scheme:

5: Most like me 4: Like me 3: Neutral 2: Not Like me 1: Least Like me

Statements	Rating
Being in a crowded or busy place, like a shopping centre or at a party, makes me feel drained and tired.	
I tend to keep to myself	
I think of myself as being sociable and outgoing	
In social situations, I am usually shy and reserved.	
I find it easier to think in groups than alone.	
I prefer to think of possibilities instead of realities.	
I like authors who use very figurative and fanciful language.	
I am a very down-to-earth person.	
I trust my intuitions when making decisions.	
I have difficulty understanding abstract ideas and concepts.	
People should place more emphasis on reason and less on emotion.	
In making decisions, seeking harmony is more important than seeking objective clarity	
Cold, rational objectivity appeals to me.	
I am a soft-hearted person.	
I am a very romantic person.	
I like to keep my life organised and planned.	
I am always prepared.	
I usually leave things till the last minute.	
I have a very spontaneous personality.	
It usually takes me a long time to make up my mind.	

APPENDIX 9: PERCEIVED COMPETENCES FACILITATED BY A '*NAMED GAME*'

Code:
D = Domain dimension; T = Technology Dimension; C = Community Dimension
A = Acquisition learning; S = Sharing: M = Mediating.

For the game: Empire Earth (EE)

1	Historical eras are represented faithfully along the time-line of EE.	DA1
2	After playing EE, I feel more confident at discussing history games.	GS1
3	EE puts me in a better position to evaluate other history games.	GM1
4	Historical events are represented very accurately in EE by great leaders (Queen Isabella, Napoleon, Frederick the Great, Suleiman ..)	PU1
5	After playing EE, I feel more confident to discuss historical events.	DS1
6	Through EE, I feel so empowered to coach others in history games.	GM2
7	Through EE one learns a lot about historical events and eras.	DA2
8	EE stimulates a lot of discussion amongst gamers.	CS1
9	EE changed the way I look at history.	DA3
10	Through EE, one learns quickly ***basic*** tactics in strategy games.	GA1
11	Through EE, one quickly learns ***advanced*** tactics in strategy games.	GA2
12	I participate regularly in on-line communities (fora, blogs, SIGs) dedicated to history games.	CS2
13	EE helps you understand history through practice.	DA5
14	I find it easy to lead discussions about strategy tactics in EE.	CM1
15	EE is very good at changing one's impressions about history.	GA3
16	EE helps you understand better historical developments.	DA6
17	I participate in LAN parties involving history strategy games.	CS3
18	Changing roles in the game promotes understanding of history.	GM3
19	I like combining history with role-play.	DM1
20	Game scenarios and objects gives insight into the past.	GM4
21	Through EE I made a lot of gaming colleagues and friends.	CA1
22	After playing EE, I real look forward to learn more about history.	DA7
23	Games like EE develop a healthy competitive spirit.	GS2
24	EE is very easy to learn and use.	GA4
25	If I had to design a history game about Malta, playing EE makes me more creative and confident to apply the game model.	DM2
26	Games like EE are a good way of expressing and promoting oneself in a group.	CS4
27	I recommend EE to history students.	CM2
28	Playing EE is very close to enacting historical events.	PU2
29	I find tutorials in EE very helpful.	PU3
30	I find 'Time-lines' in history games very helpful.	PU4
31	I find the 'History' option in EE very helpful	PU5

APPENDIX 10:
EVALUATING *EMPIRE EARTH*

Name ……Group …….

Number of hours per week I dedicate to play games: 0-1 ☐ 2-7 ☐ 8 or more ☐

	Please indicate whether you agree or disagree with the following statements. Try not to think about your answer for too long. This is a survey NOT a test, so there are no 'right' or 'wrong' answers – just answer as honestly as you can. Please tick ONE answer for each statement.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Historical eras are represented faithfully along the time-line of EE.					
2	After playing EE, I feel more confident at discussing history games.					
3	EE puts me in a better position to evaluate other history games.					
4	Historical events are represented very accurately in EE by great leaders (Queen Isabella, Napoleon, Frederick the Great, Suleiman ..)					
5	After playing EE, I feel more confident to discuss historical events.					
6	Through EE, I feel so empowered to coach others in history games.					
7	Through EE one learns a lot about historical events and eras.					
8	EE stimulates a lot of discussion amongst gamers.					
9	EE changed the way I look at history.					
10	Through EE, one learns quickly ***basic*** tactics in strategy games.					
11	Through EE, one quickly learns ***advanced*** tactics in strategy games.					
12	I participate regularly in on-line communities (fora, blogs, SIGs) dedicated to history games.					
13	EE helps you understand history through practice.					
14	I find it easy to lead discussions about strategy tactics in EE.					
15	EE is very good at changing one's impressions about history.					
16	EE helps you understand better historical developments.					
17	I participate in LAN parties involving history strategy games.					
18	Changing roles in the game promotes understanding of history.					
19	I like combining history with role-play.					
20	Game scenarios and objects gives insight into the past.					
21	Through EE I made a lot of gaming colleagues and friends.					
22	After playing EE, I real look forward to learn more about history.					
23	Games like EE develop a healthy competitive spirit.					
24	EE is very easy to learn and use.					
25	If I had to design a history game about Malta, playing EE makes me more creative and confident to apply the game model.					
26	Games like EE are a good way of expressing and promoting oneself in a group.					
27	I recommend EE to history students.					
28	Playing EE is very close to enacting historical events.					
29	I find tutorials in EE very helpful.					
30	I find 'Time-lines' in history games very helpful.					
31	I find the 'History' option in EE very helpful					

The Malta / Valletta Experience: A Smart Mobile Game.

1. Do you consider designing a game about Valletta or history of Malta based on available digital games? Briefly outline your ideas.

.....
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2. Do you consider designing a game as a good way to learn? Why?

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3. A smart game about the History of Valletta (Malta) is being developed with a number of extra features listed below. Give your opinion about each feature using the following statements:
   1. Makes gaming and learning more interesting
   2. Serves to have more control over game
   3. Makes no difference
   4. Makes game more complicated but still playable.
   5. Puts one off from playing game.

Features

a. Game will be available on mobile gaming device E.g. PDA, PSP. (1 2 3 4 5)

b. Integrated WiFi connection. (1 2 3 4 5)

c. Wireless LAN function for multiplayer gaming. (1 2 3 4 5)

d. Connects to 'smart' access points through wireless connections (1 2 3 4 5)

e. Includes a communication toolbar with instant messaging options, Emicons, message templates to encourage, challenge, help others etc. (1 2 3 4 5)

f. Includes design tools to create game 'Mods". (1 2 3 4 5)

g. Includes design tool to design small games (1 2 3 4 5)

h. Changes to 'Simulation' mode to model processes or objects. (1 2 3 4 5)

APPENDIX 11:
EVALUATING *AGE OF EMPIRES*

Name ……...….Group …….

Number of hours per week I dedicate to play games: 0-1 ☐ 2-7 ☐ 8 or more ☐

	Please indicate whether you agree or disagree with the following statements. Try not to think about your answer for too long. This is a survey NOT a test, so there are no 'right' or 'wrong' answers – just answer as honestly as you can. Please tick ONE answer for each statement.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Historical eras are represented faithfully in AoE.					
2	Through AoE, I feel more confident at discussing history games.					
3	AoE puts me in a better position to evaluate other history games.					
4	Historical events are developed very accurately in AoE.					
5	After playing AoE, I feel more confident to discuss historical events.					
6	Through AoE, I feel so empowered to coach others in history games.					
7	Through AoE one learns a lot about historical events and eras.					
8	AoE stimulates a lot of discussion amongst gamers.					
9	AoE changed the way I look at history.					
10	Through AoE, one learns quickly ***basic*** tactics in strategy games.					
11	Through AoE, one quickly learns ***advanced*** tactics in strategy games.					
12	I participate regularly in on-line communities (fora, blogs, SIGs) dedicated to history games.					
13	AoE helps you understand history through practice.					
14	I find it easy to lead discussions about strategy tactics in AoE.					
15	AoE is very good at changing one's impressions about history.					
16	AoE helps you understand better historical developments.					
17	I participate in LAN parties involving history strategy games.					
18	Changing roles in the game promotes understanding of history.					
19	I like combining history with role-play.					
20	Game scenarios and objects give insight into the past.					
21	Through AoE I made a lot of gaming colleagues and friends.					
22	After playing AoE, I look forward to learn more about history.					
23	Games like AoE develop a healthy competitive spirit.					
24	AoE is very easy to learn and use.					
25	If I had to design a history game about Malta, playing AoE makes me more creative and confident to apply the game model.					
26	Games like AoE are good to express and promote oneself in a group.					
27	I recommend AoE to history students.					
28	Playing AoE is very close to enacting historical events.					
29	I find tutorials in AoE very helpful.					
30	'Time-lines' in history games are a very good guide.					
31	Historical documentation included in games add more value.					

The Malta / Valletta Experience: A Smart Mobile Game.

1.Do you consider designing a game about Valletta or history of Malta based on available digital games? Briefly outline your ideas.

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2. Do you consider designing a game as a good way to learn? Why?

……
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……

3. A smart game about the History of Valletta (Malta) is being developed with a number of extra features listed below. Give your opinion about each feature using the following statements:

1. Makes gaming and learning more interesting
2. Serves to have more control over game
3. Makes no difference
4. Makes game more complicated but still playable.
5. Puts one off from playing game.

Features

a. Game will be available on mobile gaming device E.g. PDA, PSP. (1 2 3 4 5)

b. Integrated WiFi connection. (1 2 3 4 5)

c. Wireless LAN function for multiplayer gaming. (1 2 3 4 5)

d. Connects to 'smart' access points through wireless connections (1 2 3 4 5)

e. Includes a communication toolbar with instant messaging options, Emicons, message templates to encourage, challenge, help others etc. (1 2 3 4 5)

f. Includes design tools to create game 'Mods". (1 2 3 4 5)

g. Includes design tool to design small games (1 2 3 4 5)

h. Changes to 'Simulation' mode to model processes or objects. (1 2 3 4 5)

APPENDIX 12: EVALUATING *CIVILISATION*

Name …….Group …….

Number of hours per week I dedicate to play games: 0-1 ☐ 2-7 ☐ 8 or more ☐

	Please indicate whether you agree or disagree with the following statements. Try not to think about your answer for too long. This is a survey NOT a test, so there are no 'right' or 'wrong' answers – just answer as honestly as you can. Please tick ONE answer for each statement.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Civilisations are represented faithfully in this game.					
2	Through ***Civ***, I feel more confident at discussing history games.					
3	***Civ*** puts me in a better position to evaluate other history games.					
4	Historical events are developed very accurately in ***Civ***.					
5	After playing ***Civ***, I feel more confident to discuss historical events.					
6	Through ***Civ***, I feel so empowered to coach others in history games.					
7	Through ***Civ*** one learns a lot about civilisations and eras.					
8	***Civ*** stimulates a lot of discussion amongst gamers.					
9	***Civ*** changed the way I look at history.					
10	Through ***Civ***, one learns quickly ***basic*** tactics in strategy games.					
11	Through ***Civ***, one quickly learns ***advanced*** tactics in strategy games.					
12	I participate regularly in on-line communities (fora, blogs, SIGs) dedicated to history games.					
13	***Civ*** helps you understand history through practice.					
14	I find it easy to lead discussions about strategy tactics in ***Civ***.					
15	***Civ*** is very good at changing one's impressions about history.					
16	***Civ*** helps you understand better historical developments.					
17	I participate in LAN parties involving history strategy games.					
18	Changing roles in the game promotes understanding of history.					
19	I like combining history with role-play.					
20	Game scenarios and objects give insight into the past.					
21	Through ***Civ*** I made a lot of gaming colleagues and friends.					
22	After playing ***Civ***, I look forward to learn more about history.					
23	Games like ***Civ*** develop a healthy competitive spirit.					
24	***Civ*** is very easy to learn and use.					
25	If I had to design a history game about Malta, playing ***Civ*** makes me more creative and confident to apply the game model.					
26	Games like ***Civ*** are good to express and promote oneself in a group.					
27	I recommend ***Civ*** to history students.					
28	Playing ***Civ*** is very close to enacting life in a civilisation.					
29	I find tutorials in ***Civ*** very helpful.					
30	'Time-lines' in history games are a very good guide.					
31	Historical documentation included in games adds more value.					

The Malta / Valletta Experience: A Smart Mobile Game.

1. Do you consider designing a game about Valletta or history of Malta based on available digital games? Briefly outline your ideas.

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2. Do you consider designing a game as a good way to learn? Why?

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3. A smart game about the History of Valletta (Malta) is being developed with a number of extra features listed below. Give your opinion about each feature using the following statements:
   1. Makes gaming and learning more interesting
   2. Serves to have more control over game
   3. Makes no difference
   4. Makes game more complicated but still playable.
   5. Puts one off from playing game.

Features

a. Game will be available on mobile gaming device E.g. PDA, PSP. (1 2 3 4 5)

b. Integrated WiFi connection. (1 2 3 4 5)

c. Wireless LAN function for multiplayer gaming. (1 2 3 4 5)

d. Connects to 'smart' access points through wireless connections (1 2 3 4 5)

e. Includes a communication toolbar with instant messaging options, Emicons, message templates to encourage, challenge, help others etc. (1 2 3 4 5)

f. Includes design tools to create game 'Mods". (1 2 3 4 5)

g. Includes design tool to design small games (1 2 3 4 5)

h. Changes to 'Simulation' mode to model processes or objects. (1 2 3 4 5)

APPENDIX 13:
EVALUATING NEED FOR SPEED

Name ……..……. Group .....…….

Number of hours per week I dedicate to play games: 0-1 ☐ 2-7 ☐ 8 or more ☐

	Please indicate whether you agree or disagree with the following statements. Try not to think about your answer for too long. This is a survey NOT a test, so there are no 'right' or 'wrong' answers – just answer as honestly as you can. Please tick ONE answer for each statement.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Car models are represented faithfully in NFS.					
2	After playing NFS, I feel more confident at discussing racing games.					
3	NFS puts me in a better position to evaluate other car racing games.					
4	Physics principles are applied very accurately in NFS.					
5	After playing NFS, I feel more confident to discuss car physics with friends.					
6	Through NFS, I feel so empowered to coach others in racing games.					
7	Through NFS one learns a lot of technical words regarding car design.					
8	NFS stimulates a lot of discussion amongst gamers.					
9	NFS changed the way I look at car technology and physics.					
10	Through NFS, one learns quickly ***basic*** racing tactics.					
11	Through NFS, one quickly learns ***advanced*** racing tactics.					
12	I participate regularly in on-line communities (fora, blogs, SIGs) dedicated to NFS.					
13	NFS helps you understand car physics through practice.					
14	I find it easy to lead discussions about racing tactics in NFS.					
15	NFS is very good at changing one's impressions about car racing.					
16	NFS helps you understand better car design.					
17	I always participate in LAN parties involving car-racing games.					
18	I recommend NFS in 'Challenge mode' for practicing racing and reflex skills.					
19	I like combining physics with car design.					
20	I recommend NFS in 'Career mode' for practicing design and planning skills.					
21	Through NFS I made a lot of gaming colleagues and friends.					
22	After playing NFS, I real look forward to learn more about car physics.					
23	Games like NFS develop a healthy competitive spirit.					
24	NFS is very easy to learn and use.					
25	I feel more confident to apply principles of physics for designing racing motorcycles / boats.					
26	Games like NFS are a good way of expressing and promoting oneself in a group.					
27	I recommend NFS to physics, science and technology students.					

APPENDIX 14: EVALUATING *SIMS*

Name ……Group ..…….

Number of hours per week I dedicate to play games: 0-1 ☐ 2-7 ☐ 8 or more ☐

	Please indicate whether you agree or disagree with the following statements. Try not to think about your answer for too long. This is a survey NOT a test, so there are no 'right' or 'wrong' answers – just answer as honestly as you can. Please tick ONE answer for each statement.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Human characters and relations are represented faithfully in SIMS.					
2	Through SIMS, I feel more confident at discussing human relations.					
3	SIMS puts me in a better position to evaluate other social games.					
4	Life events are developed very accurately in SIMS.					
5	After playing SIMS, I feel more confident to discuss friendship and family life.					
6	Through SIMS, I feel empowered to coach others in social games.					
7	Through SIMS one learns a lot about human relations.					
8	SIMS stimulates a lot of discussion amongst gamers.					
9	SIMS changed the way I look at society.					
10	Through SIMS, one learns quickly ***basic*** tactics in strategy games.					
11	Through SIMS, one quickly learns ***advanced*** tactics in strategy games.					
12	I participate regularly in on-line communities (chat, fora, blogs, SIGs) dedicated to social games.					
13	SIMS helps you understand social life through practice.					
14	I find it easy to lead discussions about strategy tactics in SIMS.					
15	SIMS is very good at changing one's impressions about social life.					
16	SIMS helps you understand better the dynamics of human relations.					
17	I participate in LAN parties involving social strategy games.					
18	Changing roles in the game makes me understand myself better.					
19	I like combining social life with role-play.					
20	Game scenarios and objects give insight into my future life.					
21	Through SIMS I made a lot of gaming colleagues and friends.					
22	After playing SIMS, I look forward to learn more about relations.					
23	Games like SIMS develop a healthy competitive spirit.					
24	SIMS is very easy to learn and use.					
25	If I had to design a social game in a Maltese context, playing SIMS makes me more creative and confident to do it.					
26	Games like SIMS are good to promote oneself in a group.					
27	I recommend SIMS to be used for PSE activities.					
28	Playing SIMS is very close to enacting real life events.					
29	I find tutorials in SIMS very helpful.					
30	I find the 'Career ladder' in SIMS very motivating.					

The SIMS in Paceville:
A Smart Mobile Game.

1. Do you consider designing a game about Paceville based on the SIMS? Briefly outline your ideas.

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2. Do you consider designing a game as a good way to learn? Why?

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3. A smart game about the Paceville is being developed with a number of extra features listed below. Give your opinion about each feature using the following statements:
   1. Makes gaming and learning more interesting
   2. Serves to have more control over game
   3. Makes no difference
   4. Makes game more complicated but still playable.
   5. Puts one off from playing game.

Features

a. Game will be available on mobile gaming device E.g. PDA, PSP. (1 2 3 4 5)

b. Integrated WiFi connection. (1 2 3 4 5)

c. Wireless LAN function for multiplayer gaming. (1 2 3 4 5)

d. Connects to 'smart' access points through wireless connections (1 2 3 4 5)

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g. Includes design tool to design small games (1 2 3 4 5)

h. Changes to 'Simulation' mode to model processes or objects. (1 2 3 4 5)

APPENDIX 15: USEFUL AND APPEALING GAME FEATURES

1. Useful Features in a Game: *(Integrated in surveys for evaluating specific games)*

Historical events are represented very accurately in EE by great leaders (Queen Isabella, Napoleon, Frederick the Great, Suleiman ..)	PU1
Playing EE is very close to enacting historical events.	PU2
I find tutorials in EE very helpful.	PU3
I find 'Time-lines' in history games very helpful.	PU4
I find the 'History' option in EE very helpful	PU5

2. Do you consider designing a game about Valletta or history of Malta based on available digital games? Briefly outline your ideas.

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……
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3. Do you consider designing a game as a good way to learn? Why?

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4. A smart game about the History of Valletta (Malta) is being developed with a number of extra features listed below. Give your opinion about each feature using the following statements:
   1. Makes gaming and learning more interesting
   2. Serves to have more control over game
   3. Makes no difference
   4. Makes game more complicated but still playable.
   5. Puts one off from playing game.

Features

a. Game will be available on mobile gaming device E.g. PDA, PSP. (1 2 3 4 5)
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APPENDIX 16: INTERVIEW GUIDE FOR 'AGE OF EMPIRES'

1. When you play AoE which are the first strategic steps that you take at the very beginning of the game?

2. How would you proceed to develop a colony? (Consider gathering resources, increasing population, spending resources on buildings, spending resources on military units, challenging rival colonies).

3. Granted you have enough resources how would you attack a rival colony? (Answer: build differentiated army; attack from different directions; first destroy military buildings to stop military build-up; destroy town-centre to stop build up of population;

4. Does the game represent (models) history faithfully?

5. Did the game change the way you look at history?

6. Do you see any similarities between the game model of AoE and present day wars?

7. You are assigned a group of students to teach them a unit about historical eras. Choose your preferred method for using 'Age of Empires' in your instruction:
   - Give history lesson in class and then recommend to students playing the game at home or in computer lab (providing facilities)
   - Students play game and you explain concepts along as they play.
   - Let students play the game. Then you use books and handouts to explain concepts met in game.
   - Let students play the game. Then guide students to continue personal research (creating maps, historical timelines, researching game concepts, drawing parallels to historical or current events, etc.) using books, internet, other games.

3. If you had to design a history-oriented game, what would you change or include?

Designing a (mobile) game about Maltese history

1. Do you consider designing a game about Valletta or history of Malta based on available digital games? Briefly outline your ideas.
2. Do you consider designing a game as a good way to learn? Why?
3. A smart game about the History of Valletta (Malta) is being developed with a number of extra features listed below. Give your opinion about each feature using the following statements:
    1. Makes gaming and learning more interesting
    2. Serves to have more control over game
    3. Makes no difference
    4. Makes game more complicated but still playable
    5. Puts one off from playing game.

Features

a. Game will be available on mobile gaming device E.g. PDA, PSP. (1 2 3 4 5)

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h. Changes to 'Simulation' mode to model processes or objects. (1 2 3 4 5)

PART II - NOT PUBLISHED IN E-VERSION

COLLECTION OF PUBLISHED PAPERS