Stefan De Wannemacker
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Communications in Computer and Information Science 280

Serious Games: The Challenge

ITEC/CIP and T 2011: Joint Conference of the Interdisciplinary Research Group on Technology, Education, and Communication, and the Scientific Network on Critical and Flexible Thinking
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Preface

ITEC & CIP&T 2011, the Second International Conference on Interdisciplinary Research on Technology, Education and Communication was held during October 19–21 as a result of a combined effort of the Scientific Network (WO.002.07N) on "Critical and Flexible Thinking" led by the Center for Instructional Psychology and Technology of the KU Leuven (Belgium) and the interdisciplinary research group on Technology, Education and Communication (ITEC-IBBT-KULeuven) of KU Leuven - Kulak. The conference, held on the KAHO St-Lieven Campus in Ghent, brought together scholars and researchers who study the use of serious games in educational settings from different perspectives, such as instructional design, domain-specific didactics, cognitive and computer science.

We received an excellent number of submissions from which, after a thorough reviewing phase, we accepted 20 contributions. The authors of the accepted papers and posters were invited to present their work at the conference and to submit an extended paper. From these extended papers, 12 were accepted for publication in these proceedings. This has led to proceedings that give the reader an interesting multiperspective view on serious games in education.

The conference program was enriched significantly by keynote presentations of renowned experts in their respective domains. Ton de Jong from the University of Twente, The Netherlands, spoke about "How to Adapt Games for Learning: The Potential Role of Instructional Support," Sigmund Tobias from the University at Albany, State University of New York, gave a presentation on "Learning from Computer Games," and Steve Thorne from the Pennsylvania State University spoke about "Massively Semiotic Ecologies and L2 Development: Gaming Cases and Issues."

We would like to express our gratitude to the authors for submitting their work, to the invited speakers for their broader enrichment, stimulating discussions and further collaborations significantly, and to all the members of the Scientific and Program Committee for their help in the reviewing process. Last but not least, we would like to express our thanks to the organizing team for their technical and non-technical support. The organization of such a successful event would not have been possible without this mostly voluntary work.

March 2012

Stefan De Wannemacker
Sylke Vandercruysse
Geraldine Clarebout

Organization

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How to Adapt Games for Learning: The Potential Role of Instructional Support

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1 Serious Games

Any activity seems to go without effort when you're doing something you like and that gives you fun. Games encompass fun. As a result the hypothesis arises that using games for learning should make learning fun and thus make it easier. Nowadays, the most widespread, influential, and profitable game formats are computer games (Squire, 2003).

Despite earlier developments computer games did not reach mainstream popularity until the 1970s when home computers were introduced in the market and the mass distribution of arcade games such as Atari's 'Pong' started. Nowadays, with over 65% of the American households playing computer games (Tobias & Fletcher, 2011) and with American children, age 8 through 18, playing over 13 hours a week (Gentile, 2009), computer games have a high societal impact. This high impact and the facilities that games offer has lead educators, scientists, and game developers to propose computer games as a potential learning tool. Among other things they have taken interest in the cognitive and social consequences these games have on players and how some of the motivational aspects might be employed to facilitate learning (Squire, 2003).

Games seem to provide ideal circumstances for high quality cognitive learning (Kebritchi & Hirumi, 2008) because they provide an interactive decision making context in which the player is stimulated to analyze the situation and evaluate decision making effects. By providing learners with control (Vogel et al., 2006), feelings of competency (Ryan, Rigby, & Przybylski, 2006) and situatedness (Habgood & Ainsworth, 2011) games arrange for engaging environments that stimulate personal motivation which, in consequence, facilitates learning (Squire, 2005).

The use of (computer)games for other purposes besides entertainment has led to the name 'serious games'. Serious games are games that are developed with other purposes than just entertainment (Susi, Johannesson, & Backlund, 2007). They aim to teach, train, inform, or persuade and seem to be promising to establish cognitive learning, to achieve attitudinal changes, and to enhance motor skills (Wouters, Van der Spek, & Van Oostendorp, 2009).

2 Is Game Based Learning Beneficial?

As it turned out in practical use, however, games do not always assure better learning performances. Recent overviews of the effect of game-based learning on learning

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performance (Kebritchi, Hirumi, & Bai, 2010; Vandercruysse, Vandewaetere, & Clarebout, in press; Wouters, et al., 2009) show that game-based learning has promise but also that outcomes of the studies are ambivalent. Vogel et al. (2006) illustrated that there is no single and clear answer to the question if educational technology in the form of games results in higher cognitive gain for learners. Their meta-analysis showed that compared to traditional methods, games and interactive simulations result in higher cognitive gains and better attitudes towards learning. They also showed that adding moderating variables such as gender creates a more complex and less unequivocal picture. This influence of moderating variables illustrates that inconsistencies between results of game based learning studies may have arisen due to various differences that exist among these studies. Differences between studies can be found between populations, but also between the ways computers were used, between the skills that were to be taught, or between instructional designs (Johnson & Mayer, 2010; Wu, Hsiao, Wu, Lin, & Huang, in press).

The above leads to the assertion that there are specific game-elements that influence learning. Unfortunately there is no univocal or shared framework for classifying educational games. Studies often use incoherent wording and formulations for the games and elements that they have used, and lack exact description of elements (Vandercruysse, et al., in press; Wouters, et al., 2009). This makes it difficult to compare game-studies and relate learning effects to specific game elements. Possible solutions for creating effective game based learning environments might be found in a comparable field of study: The study of simulations.

3 Interactive Simulations

Simulation based learning shows similarities with game based learning (Leemkuil & De Jong, 2011, in press). Both aim to enhance learning through inquiry processes. Both, simulations and games, use visualization, experimentation and include problems that develop critical thinking. Studies on simulation learning demonstrate that though inquiry learning is a successful instructional approach because it fosters elaboration (Eysink & De Jong, in press), learners may have problems with each of the specific learning processes involved (De Jong & Van Joolingen, 1998). This may cause learners to be unsuccessful at selecting the relevant information and thus fail at correctly performing the learning processes (Mayer, 2004). Research on learning with interactive simulations shows that support can prohibit this kind of failure and structure learning (Alfieri, Brooks, Aldrich, & Tenenbaum, 2010; Clark & Mayer, 2011; Kuhn & Dean, 2005). For example, analyses from Alfieri et al. (2010) demonstrated that unassisted inquiry learning does not benefit learners. Inquiry learning combined with elements of support, i.e. feedback, worked examples, scaffolding, elicited explanations, on the other hand were proven to produce learning gain.

Reid, Zhang, and Chen (2003) proposed a triple scheme design of learning support in simulation based environments. They distinguished three conditions that are of influence on the effectiveness of inquiry learning; the meaningfulness of discovery processes, the systematicity and logicality of discovery activities and the reflective generalization over the discovery processes. In accordance with these three conditions they designed three types of learning support. The first type was interpretative support, which should support learners to generate coherent understandings. The second type was experimental support, which should assist learners in constructing and conducting systematic and valid experiments. The last type of support was reflective support. This should aid learners in claiming deeper understanding of the learning material.

4 Support in Games

Because a game environment is comparable, but not identical to a simulation environment, not all forms of support as described by Reid et al. (2003) will be equally relevant, but several examples of similar support in serious games can be found. Examples of interpretative support in games are: providing background information, suggesting relevant variables during assignments, and providing feedback (Leemkuil & De Jong, in press). These kinds of support serve as an aid for players to separate relevant information from the game environment. To develop the information gathered and learn from their actions players need to reflect. An example of reflective support in games is the prompting of reflection on specific aspects of the knowledge that players are supposed to have gained (Leemkuil & De Jong, in press).

Reflection is a very important part of the learning process, but during a game a player reaches a state of flow in which there is normally no room for reflection (Paras & Bizzocchi, 2005). Game-flow is concept from flow theory of Csikszentmihalyi (i.e. Kiili, 2005; Squire, 2005; Sweetser & Wyeth, 2005) and can be described as a state in which the player is so involved in the game that self-consciousness disappears, time becomes distorted, and the player engages in goal directed activity for simply the exhilaration of doing (Squire, 2005). In short, game-flow describes a state of full immersion of the player in the game. Reaching this state of flow is important because it positively influences learning performances (Skadberg & Kimmel, 2004) and can be directly linked to the players enjoyment of the game (Sweetser & Wyeth, 2005).

The above brings us to an impasse, players need reflection to learn and players also need to reach a state of flow to optimally benefit from the game's learning potential. When players reach this state of flow there is no spontaneous reflection which implies that support needs to be built in to the game to stimulate reflection. But the addition of support to a game may disrupt game flow and in consequence may diminish the motivating properties of the game (Johnson & Mayer, 2010).

This interplay between support and flow was nicely demonstrated in a study by Johnson and Mayer (2010). In their study students had to create self-explanations when learning from a game in two different ways: a) by typing in the self-explanation or b) by selecting an explanation from a list of possible explanations. Students who could select the explanation from a list scored better than students who had to create their own self-explanations. According to Johnson and Mayer (2010) this difference is caused by the fact that selecting a self-explanation is less disruptive for game-flow than typing in an explanation. From these findings it can be concluded that though addition of support to games is necessary to provide a beneficial learning environment (Alfieri, et al., 2010), support should be carefully fitted into the environment in order not to disrupt game-flow and thus lose the motivational qualities of the game (Johnson & Mayer, 2010; Sweetser & Wyeth, 2005).

5 Conclusion

Games can provide challenging environments that are suited for inquiry learning. Though it has been shown that inquiry learning has its limitations it is also proven to lead to greater engagement in learning processes in general and more elaborative processes in particular (Eysink & De Jong, in press). The comparable field of studies on simulation-based learning shows us that the addition of support to structure and support inquiry learning processes results in effective learning environments (Alfieri, et al., 2010). From this we inferred that support should also play a considerable role in game-based learning environments. Further research should point out how support can be fitted into game environments without disrupting the game experience.

In conclusion to the above it might be said that games show great promise as an addition to the current educational system. They provide a challenging, motivational and educational setting. It is up to current research and practice to identify the combination of game-elements, support structures, and instructional approaches that is needed to turn games into effective learning environments. Insights in corresponding fields, such as simulation-based learning might point game-based learning research into the right direction.

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Learning from Computer Games: A Research Review

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Our keynote presentation described findings and recommendations drawn from empirical research on the effectiveness of computer games used for instruction. We have monitored this research for some time (Fletcher & Tobias, 2006; Tobias & Fletcher, 2007; Tobias & Fletcher, 2011a; Tobias, Fletcher, Dai, & Wind, 2011). Our presentation and this summary are based on these prior sources, especially the 95 page review, in *Computer Games and Instruction* (Tobias et al., 2011). The rationale for the most salient recommendations are summarized here and in Table 1. Space constraints prevented us from including the rationale for all recommendations here; interested readers may find these in the references listed in Table 1.

Computer games are perhaps the most recent iteration of technological tools applied to improving learning from instruction. Findings indicate that games are very popular educational technology delivery systems (Tobias & Fletcher, 2011b). Research summarized here and in Tobias and Fletcher (2011a) suggests that educators and trainers may want to use games more often to deliver instruction.

1 Transfer

The most critical question about using computer games for instruction is whether capabilities acquired during game play generalize to non-game contexts, such as school, work, and the tasks of everyday life. In other words does game based learning transfer? Two studies with contrasting findings from the 1990s illustrate the transfer issue clearly. Gopher, Weil, and Bareket (1994) used the *Space Fortress II* game, modified by Donchin (1989) from the original (Mane & Donchin, 1989), to simulate the aircraft flight environment. Gopher et al, found that game groups performed significantly better in piloting real aircraft than the control group. The superiority of the game groups was attributed to similarities between game and actual flight in cognitive load and demands for attention.

In contrast Hart and Battiste (1992) found no transfer to piloting aircraft from playing an off-the-shelf game also dealing with flight (*Apache Strike Force*). The differences in results were evidently due to the modifications of *Space Fortress* that simulated cognitive demands of aircraft piloting in the Gopher et al. (1994) study — modifications that were absent from *Apache Strike Force*. We concluded (Tobias & Fletcher, 2007; Tobias et. al., 2011) that both near and far transfer (Barnet & Ceci, 2002) from games may be expected when similar cognitive processes are engaged by games and external tasks. When there is little overlap between the two transfer seems unlikely, despite superficial similarities between game and external task.

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More recent evidence of transfer from computer games has been reported (Kato, Cole, Bradlyn & Pollock, 2008; Greitemeyer & Oswald, 2010; Cannon-Bowers, Bowers & Procci, 2011; Mayer, 2011; Tobias, et al., 2011). These findings suggest that if transfer from games to external contexts is expected, cognitive task analyses (Crandal, Klein, & Hoffman, 2006; Schraagen, Chipman, & Shalin, 2000)) of both the game and external task should be conducted. Available evidence for transfer does not fully justify the current enthusiasm for using games for instruction. Further research is needed. Specific research suggestions to confirm and extend this evidence were summarized in the sources listed above and elsewhere (Tobias & Fletcher, 2011c).

2 Cognitive Processes and Transfer

Some research has found evidence of cognitive improvements attributable to game playing. These findings transcend issues of near or far transfer (Barnet & Ceci, 2002) since overlap in the cognitive processes engaged by games and external tasks is the basis for both types of transfer. Bavelier and her associates (Green & Bavelier, 2003; Anderson & Bavelier, 2011) conducted perhaps the most notable research program in this area, the results of which, along with the research of others, are summarized elsewhere (Tobias et al, 2011; Tobias & Fletcher, 2011c).

Findings suggest that games may lead to improvements in some cognitive and psychomotor processes. Bavelier's research program (Anderson & Bavelier, 2011) suggests that the ability to flexibly alternate between tasks, as demonstrated in Bavelier's research, could lead to improvements in the skills of pilots, as also suggested by the Gopher et al (1994) study. Although the research in Bavelier's laboratory and elsewhere is carefully designed and executed, its findings should be replicated and extended.

These results offer the intriguing possibility of investigating the use of games to train cognitive processes in various populations (Tobias & Fletcher, 2011c). For example, while performance decrements due to aging are unlikely to be reversed, the pace of this decline in older groups may be reduced by games. Games might also be used to improve the cognitive processes contributing to dyslexia, attention deficit disorders, and similar conditions.

3 Guidance and Animated Agents

Guidance is often provided in games to help players navigate through the game. Virvou and Katsionis (2008) found that such guidance was needed by novices to help them use games effectively. Leutner (1993) found that students given system-initiated advice acquired more domain specific concepts but only learned to play the game to a limited degree while other students who requested background information learned to play the game but only acquired minimal domain-specific concepts.

Guidance is often delivered by animated agents, usually cartoon-like characters resembling human or animal figures, to help players use the game. Research findings regarding the use of animated agents have been equivocal (Dehn & van Mulken, 2000; Tobias et al., 2011). Moreno (2005) reviewed the research on animated agents and concluded reasonably enough that, since no studies found that agents interfered with learning or transfer, there seems to be little reason to avoid them – other than the costs to create and include them.

The issue of providing help or guidance is complex. Research reviews (Aleven, Stahl, Schworm, Fischer, & Wallace, 2003; Wittwer & Renkl, 2008) found that help offered in computer displays, not necessarily game based, was seldom used and did not facilitate learning. Furthermore, Wise and O'Neill (2009) report that the term 'guidance' is ambiguous, and often used for explanations, feedback, help, modeling, scaffolding and procedural directions, among others. Perhaps the guidance issue should be re-framed in terms of instructional support (Tobias, 1982, 2009), i.e., any type of assistance, such as explanation, direction, error correction, etc., that helps students learn. The ambiguous findings regarding help or guidance may be clarified by developing a hierarchy of different forms of instructional support and studying the types of support that facilitate different types of game learning.

4 Cost Benefit Analysis

Cost benefit analysis identifies the resources and opportunities that must be sacrificed to take any course of action along with the value or utility to be obtained from it. The following argument for using games in instruction might be stated: (a) Games are compulsively motivating; (b) People will voluntarily persist in playing games longer than they will engage in non-game learning; (c) If the game is instructionally relevant, this engagement will increase time individuals spend in instruction; (d) Increased time in game-based instruction will therefore yield increased learning in terms of both depth and time on task.

A gaming focus on entertainment may dilute the amount learned per unit time, but that may be more than compensated for by the extra time learners spend voluntarily playing the instructional game. Also, as John Dewey, a pillar of American education research and philosophy, observed in 1913, students work harder to make sense of presented material, and therefore learn more deeply, when they are personally interested in the learning task than when they are not. The additional concentration and reflection on learning in games may further compensate for the dilution of concentrated instruction resulting from the addition of entertainment in game-based learning.

In brief, if people persist in playing games, not because they are paid to but because they want to, then they might with equal perseverance play them with instructional material included. This feature is especially important if learners are paid a salary during the period of their instruction, as in military and industrial training. More instructional benefit may therefore be derived from games with little added cost because the game represents a one-time-only investment. This possibility has not been pursued by the research we found, but knowing the return on investment in game-based learning, or its cost-effectiveness compared to other instructional alternatives is of considerable value to decision-makers who must choose among them. More specific discussion of economic analysis in instruction and game-based learning is provided by Fletcher and Chatham (2010) and Fletcher (2011).

5 Affective Outcomes

Does playing games that involve aggressive behavior increase players' aggressiveness? Gentile's (2005) review of this research concluded that, despite major design flaws in some studies, "given the preponderance of evidence from all types of studies (experimental, cross-sectional, longitudinal, and meta-analytic), it seems reasonable to conclude that violent video games do indeed have an effect on aggression" (p. 17). Similar conclusions were reached by others (Anderson, Berkowitz, Donnerstein, Huesmann, Johnson, Linz, et al., 2003; Irwin & Gross, 1995; Anderson & Bushman, 2001). Nevertheless, Ferguson (2007) and his colleagues (Ferguson, Rueda, Cruz, Ferguson, Fritz, & Smith, 2008) dispute these findings, and suggested that if there was an effect it was very small (Ferguson, 2007).

Most advocates of games (Gee, 2011; Squire, 2006) maintain that people learn from them. It seems unreasonable to claim that the only behavior that is not learned from games is aggressive behavior. We recommend that, whenever possible, game developers limit aggression in games and, instead, consider developing games with pro-social themes. Research (Greitemeyer, & Oswald, 2010; Fontana, & Beckerman, 2004) has shown that such games increase outcomes such as conflict resolution and helping reactions. Whether such pro-social behavior also reduces aggression is an interesting, but as yet unanswered, research question.

6 Game Playing Frequency and Relationship to Curriculum and Players' Prior Knowledge

In a random stratified sample of US residents aged 8-18 Gentile (2009) reported that the mean game playing time was 13.2 hours per week; for boys it was 16.4 and for girls 9.2 hours per week. Gentile found that 8.5 % of his sample played a mean of 24.6 hours per week. He labeled them "pathological players" because they manifested six of 11 symptoms of pathology listed in the *Diagnostic & Statistical Manual of Mental Disorders (American Psychiatric Association, 2000).*

There is concern about the many hours students play games because negative relationships have been reported (Gentile, 2011) between game playing and school achievement. These data raise questions about whether and how those long hours may be used to facilitate school related learning. Din and Calao (2001) reported that learning increased when the games played were integrated into the curriculum. Similarly, Henderson, Klemes, and Eshet (2000) stressed the importance of curriculum integration, and Gremmen and Potters (1997) found that lectures supplemented by a game were more effective for teaching economics principles than lectures alone.

Costabile et al. (2003) found that learning from a game increased when students were informed that their game performance would be monitored by teachers. Jackson and McNamara (2011) found that adding game elements improved student engagement and enjoyment in an intelligent tutoring system. Sitzman and Ely (2009) reported that students learned more from games supplemented by other instruction than from games alone, clearly indicating that integration with the curriculum was important. To improve school learning from the long hours spent gaming, Tobias et. al., suggested (2011) research on integrating games into courses of study. Such integration could be facilitated if game developers pose questions requiring players to leave the game and find external resources (books, articles, field or laboratory tasks, materials from the Internet, etc.) to answer them. Re-entry to the game or points awarded for game playing could be made contingent on players' answers. To follow Dewey's (1913) suggestion, research might also study whether interest in games increases interest in their content.

Using games unrelated to courses of study in order to heighten interest in the domain poses some dangers. Research on text processing (Wade & Adams, 1990; Schraw, 1998) has indicated that including "seductive details" unrelated to curricular goals may lead to learning the seductive details at the expense of curricular objectives. It is important that any game introduced into a course of study have a genuine relationship to the purposes of the instruction.

Some findings (Dai & Wind, 2011; Tobias & Fletcher, 2011c) suggest that games may be especially beneficial for students with low domain knowledge, a finding also reported in the field of multimedia learning (Fletcher & Tobias, 2005) and in research on adapting instruction to student characteristics (Tobias, 1976, 1982, 1989, 2009). This is an intriguing possibility deserving further research since learning from games may be one avenue to improve learning from instruction by populations having the greatest difficulty learning in school environments, such as foreign students, or students from lower socio-economic environments.

An interesting and important question is raised by the frequency of game playing data. If there are gains in school related content from game playing, could the learning be attributed to different aspects of games, or merely to the increased time playing games? Fisher and Berliner (1985) have shown that time engaged with instructional material is a powerful predictor of school learning. If games increase school learning by increasing students' persistence that would obviously be important, but it would be equally important to be clear about the processes accounting for such learning.

7 Summary of Recommendations

Table 1 summarizes the recommendations from our literature review. As mentioned

Table 1. Recommendations for Game Design and Research with Supporting References

Recommendation	Supporting Literature
If transfer from games/simulations to external tasks is expected, run cognitive task analyses to: • Identify cognitive & psychomotor processes required by task • Design/buy games/simulations that engage similar processes	Tobias et al. (2011); Gopher et al., (1994); Hart & Battiste (1992); Subrahmanyam & Greenfield, (1994); Greenfield, Camaioni et al., (1994); Ferry & Ponsere, (2001); Cannon-Bowers, Bowers, & Procci, (2011)

Recommendation	Supporting Literature
Improvement in Cognitive Processes	
• Conduct research to determine whether games can improve processes among dyslexic, or aging populations.	Anderson & Bevalier, (2011); Green & Bevalier (2003); Tobias et al. (2011)
Conduct cost benefit analysis to determine value added by games/simulations	Fletcher (2011)
Provide guidance for novices & those who want it	Virvou & Katsionis (2008); Wise & O'Neil (2009); Kirschner, Sweller & Clark (2006); Tobias & Duffy (2009); Rieber (2005)
• Use human, rather than digitized voices	Atkinson, Mayer & Merrill (2005)
• Include first person references to players in games/simulations	Mayer & Moreno (2000, 2004, 2005)
• Include pictorial, rather than verbal, guidance	Mayer, Mautone, & Prothero (2002)
• Use animated instructional agents	(Moreno, 2005; Dehn & van Mulken, 2000; Tobias et al., (2011)

Recommendation	Supporting Literature
• Develop hierarchy of instructional support	Tobias (2009).
Research does not support discovery learning with minimal or no guidance	Tobias & Duffy (2009); Kirschner, Sweller & Clark (2006); Mayer (2009)
Players should reflect about the reasons for correct answers but not incorrect ones	Moreno & Mayer, (2005)
Use worked examples in problem solving • Fade prompts gradually	Jin & Low (2011); Sweller & Cooper (1985); Ward & Sweller, (1990); Renkl & Atkinson (2003)
Games should be integrated into the curriculum, not stand alone	Henderson, Klemes & Eshet, (2000); Miller, Lehman, & Koedlinger, (1999); de Jong & van Joolinger, (1998); Knotts & Keys, (1997); Baker & Delacruz, 2008); Tobias et al. (2011)
Teams needed to develop games • May be more expensive but will have long run pay off in transfer & sales.	Jayakanthan (2002); O'Neil, Wainess, & Baker (2005); Belanich & Orvis (2006); Tobias & Fletcher (2011c)

Recommendation	Supporting Literature
Games *should* lead Ss to curriculum related resources.	
• Game links could direct Ss to Web or printed sources	Tobias et al., (2011)
• Game re-entry could be contingent on having that information	
Reduce aggression in games	Gentile (2005); Anderson, Berkowitz, Donnerstein, Huesmann, Johnson, Linz, et al. (2003); Irwin & Gross (1995); Anderson & Bushman (2001)
• Design pro-social games	Greitemeyer & Oswald (2010); Fontana, & Beckerman (2004)
• Research needed on whether pro-social games reduce aggression	Tobias et al., (2011)
Avoid using games unrelated to instructional purposes	Wade & Adams (1990); Schraw (1998); Tobias et al. (2011)

above, space constraints limit discussion here. Interested readers will find more complete descriptions of the research bases for these recommendations in sources identified within the Table.

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Massively Semiotic Ecologies and L2 Development: Gaming Cases and Issues*

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Abstract. In dialectic tension with the immense growth in digital information and communication media, Internet information and communication technologies have amplified conventional communicative practices in the areas of breadth, impact, and speed and also have enabled the emergence of new communicative, cultural, and cognitive practices. These practices emerge within distinctive cultures-of-use—that is, the process wherein communication tools and the practices they mediate co-evolve (Thorne, 2003). With these aforementioned issues as context, this article begins by describing contradictory appraisals of the perceived value and complexity of new and 'sociable media' (Donath, 2004) environments. This is followed by a discussion of the diverse semiotic ecology comprising the widely played massively multiplayer online game *World of Warcraft* (hereafter WoW), including routine player engagement with written texts and exposure to multiple languages, assessment of the linguistic complexity of texts designated as highly important by players, and consideration of attendant textual and expressive activity occurring outside of the game, with the purpose of better understanding the potential usefulness of online gaming, and WoW in particular, as a setting for language use and learning.

1 Introduction

Computer-assisted language learning (CALL) has an approximately fifty-year history as a sub-field of second language development (SLD) and applied linguistics research (for discussions, see Bax, 2003; Chapelle, 2009; Hubbard, 2009). The preponderance of existing CALL research has focused on in-class or instructionally related uses of technology and many useful and consistently corroborated findings have emerged from this literature (for recent reviews, see Chun, 2008; Kern, Ware, & Warschauer, 2004; Thorne & Payne, 2005; Thorne, 2008a). Expanding out from these earlier

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investigations, the present article explores the potential for language learning in freely chosen 'sociable media' contexts, which, following Donath (2004: n.p.), I define as mediated environments that are specifically engineered to support rich and varied communicative dynamics and the establishment and maintenance of interpersonal connection (see also Thorne, 2009). Online games, especially massively multiplayer games, are here described as a special case sociable media.

The article begins with a demographic contextualization of sociable media and its often polarized academic and popular press reception. This is followed by the presentation of a distributed and ecological systems approach to human action and development which provides a rationale for carefully assessing the social-interactional and linguistic qualities of digitally mediated environments. I then focus on a specific and widely played massively multiplayer online (MMO) game called *World of Warcraft* (Blizzard Entertainment), including discussion of the attendant discourses that have emerged in related online communities. Discussion of the potential efficacy of online gaming worlds for language learning is informed by responses to a cross-national survey of active players in two countries – the Netherlands and the United States, and through analyses of the linguistic complexity of high frequency game-generated and player produced texts associated with this game. The presentation then moves to a general discussion of the resources and potential constraints of participation in gaming environments as these experiences relate to the potential for second language development.

1.1 Mediated Life Activity and Its Valorisation and Condemnation

Assessing the language developmental value of participation in digital environments is no easy task. The sheer number of what might now be termed conventional Internet-mediated tools, such as email, threaded discussion fora and message boards, synchronous chat and video conferencing, textual virtual worlds, and blogging (to present only a selective list) have been joined by highly popular social and community media environments such as twitter, *facebook* and its many language and region specific siblings (such as *Netlog* and *Hyves* in the Low Countries, *V Kontakte* in Russia, *Orkut* in Brazil, *Qzone* in China). The most globally distributed of these social media environments – *facebook* – is impressive in terms of its user populations. In a recent press release (December, 2011), *facebook* reports 845 million monthly active users, 80% of which are outside of the U.S. and Canada, with the average user having connections to 130 'friends' (http://newsroom.fb.com/content/default.aspx?NewsAreaId=22). Given that the global internet user population is estimated to be more than 2.2 billion (as of December, 2011; see internetworldstats.com), these demographical statistics are noteworthy, especially since omnipresent as well as casual users of social media participate of their own volition, arguably because the interactions, sharing, and exchanges that occur there serve important social-relational, psychological, and informational needs.

Online gaming is also immensely popular and arguably constitutes one of the most complex forms of media-based entertainment. The telecommunications researcher Edward Castronova (2005) has estimated that synthetic worlds (his term for online virtual spaces) were appearing at a rate of Moore's Law, or doubling in volume every two years, and that minimally, the global population across all synthetic worlds was 10 million players averaging 20-30 hours of play time per week. Only six years later, in 2011, the single massively multiplayer game *World of Warcraft*, the most widely played online game of its genre at the time of this writing, has had an estimated peak population of approximately 12-13 million active players distributed among servers supporting game play in Chinese, English, French, German, Korean, Russian, Spanish, and other languages. Additionally, non-recreational digital game-based environments have emerged that offer scenario-based management and military training, interactive kiosks for children in museums, and ‘serious’ educational games for use in a wide range of academic subjects. This growing interest in digital games has been accompanied by a rapid proliferation in the types and genres of games being developed (see Purushotma, Thorne, & Wheatley, 2009; Sykes, Reinhardt, & Thorne, 2010).

Importantly, however, immense user populations and high levels of engagement, in and of themselves, answer few questions about linguistic and interactional affordances that new media might provide to language learners. Further, there is considerable public and academic debate regarding the virtues and perils of new media environments. A number of university and industry researchers have argued that some forms of new media, particularly multiplayer genres of online gaming, present rich environments for the learning of specialized literacies, scientific reasoning, and high-level problem solving (e.g., Gee, 2003, 2007; Grimes & Feenberg, 2009; Nardi & Kallinikos, 2010; Steinkuehler & Duncan, 2008), as well as provide dynamic opportunities for the development of leadership abilities (Thomas & Brown, 2009). Recent research has also examined relationships between children’s use of diverse information technologies as they relate to creativity. Among the four types of information technology that were considered, 1) computer use, 2) general Internet use, 3) cell phone use, and 4) video game playing, the results showed that only video game playing was correlated with greater creativity (Jackson et al, in press).

Many commentators and researchers express more negative assessments of the social and/or linguistic qualities of Internet environments and processes (e.g., Carr, 2010). In regard to social media and gaming, Sherry Turkle, who lauded the fluidity of meaningful identity construction opportunities in Internet environments in the mid-1990s (e.g., Turkle, 1995), has more recently critiqued social media for its displacement of face-to-face and voice contact. In her new work, Turkle (2011) argues that immersion in a deluge of social media messages and ‘relationships’ may result in alienation and a sense of increased isolation for some users of these media (though see Steinfield, et al 2008, for a longitudinal study that suggests an opposite effect).

Much more could be said about these debates, and potentially the perceived threat presented by ‘open’ online epistemologies vis-à-vis their high prestige traditional literacy counterparts (i.e., Lankshear & Knobel, 2006), but I conclude this section by suggesting that opinions and generalizations are unnecessary since the complexity of online activity is an issue that can be investigated empirically. To pejoratively label social media or gaming genres of communication on ideological grounds, or because of its divergence from canonical norms of prestige linguistic varieties, can be seen as a form of symbolic violence (in the sense of Bourdieu, 1991) rooted in the imposition of an epistemologically conservative selection bias. The argument developed here is that qualitative shifts in contexts, purposes, and genres of communication associated with new media necessitate a discerning-and-inclusive proactive vision of educational practice, and one that is responsive to the emerging contexts of first and additional language learning and use.

1.2 Theoretical Framing of Human Development and Language Learning

Language acquisition is a contentious field comprised of diverse and competing frameworks, but virtually all approaches acknowledge the importance of the quality of the linguistic environment and opportunities for engagement as primary determiners of developmental outcomes.

To begin with a few preliminary theoretical observations, humans can be seen as open systems, with the implication that development arises as a function of interaction within historically formed, and dynamically changing, social, symbolic, and material ecologies. When viewed this way, individual learning of whatever kind cannot be clearly separated from life experience. Rather, life activity and development form an 'ensemble' process that is enacted along a brain-body-world continuum (e.g., Spivey, 2007). This open system principle includes a number of entailments, one of which is a focus on mediation – that objects and other people in the environment co-produce action and thinking in unison with individual human agents. This perspective is particularly relevant to assessing technology-mediated communicative and cognitive activity since the meditational means at hand – a computationally enabled gaming environment for example, potentially transforms the morphology of human action in ways that affect developmental processes and outcomes.

An additional dimension to learning that is often salient in dialogically rich digital environments is that cognition, action, and communication are inherently distributed across individuals, artifacts, environments, and time periods (Lemke, 2000). In relation to cognition and also communication, it should be noted that the principle of distribution is not meant to suggest symmetry or equal division, but rather serves as a reminder that thinking is not "brain bound" (Clark, 2008, p. xxvii, in Cowley & Steffensen, 2010). Rather, the insight is that cognitive density can shift from brains to bodies and to a range of physical and representational media in the flow of activity. In this way, learning is also distributed in the sense that a cognitive event is co-created by agents working with culturally shaped digital environments (Thorne, 2003; Zheng, Young, Wagner, & Brewer, 2009). This idea has been expressed within the second language development literature as the 'inseparability principle' – that cognition/action and the social-material world share an ecology (Atkinson, 2010; see also Van Lier, 2004). Phrased in a more philosophical way, Shotter (2003) reminds us that "we live in surroundings that are also living" (p. 10), an observation that seems particularly applicable to the rapid and shifting nature of life activity in and through sociable media.

In research that is more closely focused on language acquisition, usage-based investigations (e.g., Goldberg, 2006; Tomasello, 2003) have underscored the importance of the quality of the social and linguistic environment as it relates to development trajectories. Characteristics such as input frequencies, linguistic complexity, and language-mediated opportunities for joint attention and meaningful engagement are understood as foundational to language learning. As Tomasello has described it, "all linguistic knowledge … derives in the first instance from the comprehension and production of specific utterances on specific occasions of use" (2000, p. 237-8), where each 'occasion of use' is situated in a particular cultural-material context.

A usage-based and ecological approach to language development emphasizes the importance of social and linguistic environments as primary catalysts for language development. In the sections that follow, we (myself and Ingrid Fischer, co-author of a few in-press articles on this topic) explore the cultural-material contexts comprising the online gaming environment *World of Warcraft*, with a view toward its usefulness as a setting for language exposure, use and learning. We develop our analysis using two forms of evidence, 1) elicited descriptions of players' experience provided through questionnaires distributed to, and interviews with, Dutch and American gamers, 2) an assessment of the linguistic complexity of high frequency game-presented and player-generated texts, including strategy websites.

1.3 MMO Gaming (and Attendant Discourses)

World of Warcraft (hereafter WoW) is a commercially designed, avatar-based, persistent virtual world within which thousands of players simultaneously interact, collaborate, and compete. Game play is guided by goal-oriented tasks (called 'quests') that increase in difficulty as players progress. Players advance their characters and improve their skills and abilities by completing quests, collecting and making items and resources, and buying and selling goods and services in an in-world economies (which are sometimes linked to global capital markets).

Game play involves controlling a digital avatar and requires navigation of challenging landscapes, hypothesis testing and strategy development, collaboration and communication with other players (e.g., Thorne, 2008b), and research into the consequences of subtle choices regarding character development (Nardi, Ly, & Harris, 2007). For most participants, hundreds of hours of playtime are required to access advanced levels of game content. There is considerable repetition in the types of challenges presented, but there is also a gradual complexification of scenarios and a concomitant expansion of tools and strategies that support continued progress. As Gee (2003, 2007) has argued, games are designed to provide developmentally productive processes that bring together pleasure and learning through a focus on difficult and engaging goal-directed activity.

1.3.1 Elicited Accounts of Player Experience in World of Warcraft

In order to contribute to an empirically based assessment of the quotidian practices and experiences of WoW gamers, in the Spring of 2011, I and colleagues (Thorne & Fischer, forthcoming) created a questionnaire with the aim of getting a clearer picture of how and/or if WoW players come into contact with multiple languages and how and with whom they play the game. The questionnaire was targeted toward Dutch and American players and was distributed through various social networks and posted to online WoW community sites with the encouragement for initial respondents to redistribute the questionnaire to other players.

Dutch and English versions of the questionnaire were made available and there were an equal number of Dutch (N=32, 16 females, 16 males) and American (N=32, 11 females, 21 males) respondents. The Dutch and American groups were statistically equally experienced in playing MMOs. In both groups, most participants had been playing for more than 3 years, between 1 and 4 times a week, for an average of 3 hours at a time.

The questionnaire consisted of 40 questions covering demographics and background (e.g., age, gender, education, nationality), frequency of play, exposure to and use of different languages, use of external websites and resources, the nature of their specific WoW experience and play preferences (e.g., official language realm, membership in guilds, the balance of solo to collaborative play), patterns of socializing and communication, and preferred communication tools (see Fischer, 2011, for details). These topics were then further explored through follow-up interviews with ten self-selected volunteer individuals who offered to talk with us further. Only a subset of themes will be addressed here, namely players' reported exposure to languages and their use of strategy and information websites that are external to the game.

The player responses regarding the use of external websites was used to identify and inform the selection of texts that were subsequently analysed for their linguistic complexity. This primarily descriptive research addresses the need for empirical investigation of texts present in online commercially available games and aims to finely characterize the linguistic complexity of game-presented texts (or 'quest texts') as well as game-external informational and communicative resources that are widely used by players.

1.3.2 Exposure to Languages and Language Use

All of the Dutch participants speak Dutch as their L1 and English as their L2, of which 93% indicated they speak English at an advanced level. Additionally, German (75%) and French (53%) were also spoken by many of the Dutch of the participants. All but one of the Americans reported speaking English as an L1, 40% reported speaking some Spanish as an L2, and single individuals indicated some competence in nine other languages.

The Dutch participants play on European realms (i.e., servers) and the American group on North American realms. On the European realms, the WoW user interface is available in multiple languages: English, German, French, Spanish, and Russian, whereas on the North American realms, the user interface options are restricted to English or Spanish. In both groups, all participants reported that the official language of their realm was English.

The Dutch participants reported encountering many languages other than English, and that this happened with great frequency. The main languages that were mentioned by the Dutch participants included Dutch, Swedish, Italian, German, Norwegian, Finnish, Danish, French, Russian, Polish, Greek, Spanish, Turkish, Portuguese, Bulgarian, and Croatian. Only languages that were mentioned in the survey and/or interviews by more than one player have been noted in this list. Americans reported encountering fewer non-English languages and with much less frequency than their Dutch counterparts. A list of the main languages that were mentioned by the American participants include Spanish, French, German, Portuguese, and 'Internet' linguistic varieties, sometimes called 'l33t speak', which comprise an alpha-numeric 'supervernacular' (see Blommaert, 2011) that is widely used in a variety of mobile phone as well as Internet-mediated speech communities. Multiple American participants answered 'none' to the question of encountering non-English languages.

We also asked the participants which languages they used while playing the game. All Dutch participants used their L2 of English, 78% reported also using Dutch, and 2 Dutch players (6.3%) reported using Swedish, while regular use of additional languages was reported by only single participants (see Table 1, below).

The majority of the American participants used English only, though three participants also reported using Spanish. Table 1, below, lists languages that were actively used by the questionnaire respondents.

Table 1. Overview of foreign languages used in WoW by the Dutch and American participants. Note: Several participants gave more than 1 answer to this question, thus the combined percentages reported here exceed 100.

Dutch participants			**American participants**		
Language	**Number**	**Percentage**	**Language**	**Number**	**Percentage**
English	32	100%	English	32	100%
Dutch	25	78%	Spanish	3	9.4%
Swedish	2	6.3%	French	1	3.1%
German	1	3.1%	Internet/l33t	1	3.1%
Norwegian	1	3.1%			
French	1	3.1%			
Portuguese	1	3.1%			

The English-specified European realms include players of many different nationalities. We earlier noted the many reports of individuals choosing to play WoW on various L2 realms in order to learn other languages (discussed above, see also Thorne, 2008b, 2010); however, none of our participants reported playing WoW explicitly for this purpose. The expectation that on a European realm communication will occur in numerous languages is, for the majority of the Dutch participants in this study, largely reduced to the use of only two languages – English and Dutch.

1.3.3 Use of Game-External Websites

For both the Dutch and American groups, the questionnaire and interview data indicates that game-external sites having to do with WoW are used often and by all respondents. WoW players look up information on the background story of the game, how to complete certain assignments, how to optimise their characters, for assistance with strategy, and much more. Interestingly, all questionnaire respondents mentioned viewing the external sites in English, despite the fact that WoW strategy and information websites are available in a wide number of additional languages. All of this study's participants reported that they use external websites before, during, and/or after the gaming session. For this reason, we propose that external websites are an integral part of the WoW gaming experience. This observation is born out in the following transcribed portions of the interviews (Note that all names are pseudonyms generated using the name generating function within WoW).

Moonpunisher

"I use quite a few external websites, and I have all of them open while I am playing the game, so that when I need to I can immediately look stuff up." [translated from Dutch]

Glakela
"I never play full screen, I always play in a way so that I can just reach my desktop and can immediately access my browser. I will just put myself in a safe town, so nothing can happen and then I will calmly start reading and looking up things." [translated from Dutch]

Based on the more in-depth follow-up interviews, it is clear that using external websites is not only a preparatory or post-play evaluative process, but also part of the in-process gaming experience. In this sense, regular WoW play involves the use of a complex and articulated set of semiotic resources and tiered discourses that include the texts and interactions of the game itself as well as game-external websites, topical blogs, and community forum sites.

In terms of the generalizability of the questionnaire findings, there are limitations to this research, namely the relatively modest subject pool of sixty-four participants restricted to two geographical regions – the Netherlands and the United States. Additionally, the respondents, on average, were highly skilled gamers whose experience may not represent that of novices. The applicability of the questionnaire results to other populations, therefore, should be understood as tentative.

1.3.4 Linguistic Complexity of Game-Presented and Game-External Semiotic Resources

In the prior sections, we described player reports of the languages they are exposed to or use and what game external semiotic resources they attend to and utilize with greatest frequency. The question asked here is, what is the linguistic nature of these texts? To our knowledge, a descriptive linguistic analysis of the high frequency text types that MMO players are exposed to has not been carried out. The following section briefly reports on prior research (Thorne et al., in press) that assessed the linguistic complexity of 1) game-generated 'quest' texts that guide player actions, and 2) the game-external texts that were designated by players as central to game play. All texts examined here were in English, with the presumption that this information would be relevant for L2 learners of English and potentially would be also be generalizable to analogous texts in other languages.

Linguistic complexity can be broadly defined as the range and sophistication of language forms and structures (e.g., Ortega, 2003). Thorne et al (in press) assessed the linguistic complexity of multiple corpora of WoW-related texts using four measurement types: 1) readability, 2) lexical sophistication, 3) lexical diversity, and 4) syntactic complexity (see Lu, 2009). Each of these measures come with certain limitations, particularly as a result of conflating sentential variability to mean scores, but each also provides a useful vantage point from which to conceptualize and analyze complexity. A synoptic account of the findings are that representative samples of quest texts and external websites, analysed at the level of individual sentences, reveal mean average complexity measures that approximate a secondary school reading level suitable for students aged 13-17 years. Closer analysis, however, revealed a polarized distribution of sentences that clustered in two areas – those that are short and syntactically simple, and those that are longer and highly complex. The graphical representation of the distribution of sentences for each corpus type showed a right skewed (or complexity weighted) "U" pattern. This indicates that there is considerable variation in sentence complexity levels within the texts, with the most complex levels of sentences occurring with greatest frequency. This secondary distributional analysis illustrated that in quotidian game play, gamers read a high proportion of lexically, syntactically and structurally complex sentences (interested parties are encouraged to see Thorne et al, in press, which describes the methodologies, corpora examined, and findings in exhaustive detail).

Within second language development research, numerous studies have indicated the importance of reading and frequency of input for the acquisition of linguistic structures, vocabulary, and genre-specific text conventions (e.g., Ellis, 2002; Hyland, 2002; Nation, 2004; Pigada & Schmitt, 2006). The linguistic complexity research focusing on WoW-related texts sought to better understand which texts are most important to players and to submit these player-designated high frequency texts to thorough linguistic analysis. Game presented and game-external texts that are central to game play and illustrate multiple genres, include a high proportion of both complex structures as well as interactive and interpersonally engaged (e.g., 2nd person address) discourse. Especially in combination with player-to-player communication, which is beyond the scope of this article to discuss, WoW would seem to present a diverse and linguistically complex environment for L2 learners of English. Presumably, the same would hold true for the available versions of WoW in other languages. While debate exists concerning the effects of frequency and the quality of linguistic environments as they relate to language development (e.g., between Ellis, 2002, and Gass & Mackey, 2002), there is no disagreement about the need for exposure to the semiotic systems and signifying practices one wishes to learn.

More broadly, it is also relevant to note that related research focusing on the cognitive content of strategy and game-play websites is rhetorically and logically complex. To take one example, Steinkuehler & Duncan (2008) have demonstrated that WoW discussion forums foster "scientific habits of mind." Analyses of nearly 2,000 WoW-related forum posts indicate that 86% of the entries displayed "social knowledge construction," 65% treated knowledge "as an open-ended process of evaluation and argument," more than half of the posts included evidence of systems based reasoning, and 10% showed scientifically precise model-based reasoning (Steinkuehler & Duncan, 2008, p. 539). In related research, in an assessment of games such as Yu-Gi-Oh and Pokéman, Jim Gee has argued that players routinely engage in "oral and written language of a specialist sort, a key skill for specialist domains, including academic ones at school" (2007, p. 112). In the strategy websites associated with WoW, and in addition to their linguistic complexity, the cognitive and reasoning content has been shown to support scientifically oriented forms of play within the context of a high sociability environment.

2 Conclusion

World of Warcraft is a recreational MMO that was not designed for language learning. But then families, neighborhoods, communities, and workplaces, are not engineered environments for language learning either. This is to say that people have the potential to learn in many activity setting (though efficiency, economies of scale, and developmental outcomes may differ). Formal schooling can be a powerful contributor to development, but so too can lived experiences such as those described as informal learning (Sawchuk, 2003), interaction in online affinity spaces (Gee, 2005), and via language socialization in a wide range of sociable media environments (e.g., Reinhardt & Zander, 2011; Thorne, 2011; Thorne, Black, & Sykes, 2009). If a player wishes to use or learn an L2, the evidence reported here suggests that online gaming, as a form of sociable media, presents a rich and diverse semiotic and social ecology within which to do so. However, the amount of exposure to, and interaction in, the L2 will strongly depend on what the player wishes to do and to achieve in the game.

To revisit the essential message of Internet pioneer Tim Berners-Lee (1998), the Internet is less a technological fact than a social fact, and one that has been accompanied by the massive proliferation of communicative genres that are substantially different from pre-digital epistolary conventions (e.g., Crystal 2001; Danet & Herring, 2007; Jenkins, 2006; Lankshear & Knobel, 2006; Sykes, Oskoz, & Thorne, 2008; Thorne & Black, 2007). The implication for language education is that mastery of conventional literacy and genre norms *as well as* emerging and evolving sociable media communicative and cognitive practices are developmentally useful, and perhaps also necessary, for achieving full participation in many educational, professional, and recreational settings.

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A Game-Based Working Memory Intervention for Deaf Children

Terezinha Nunes, Rossana Barros, Deborah Evans, and Diana Burman

1 Introduction

Working memory (WM) is the ability to keep information in mind and use this information to guide behavior in the absence of external cues. This ability is required in a variety of school tasks and is therefore an important cognitive skill for educational success. Children who have difficulties in learning mathematics in primary school have lower scores in WM tasks (Gathercole & Pickering, 2000; Pickering & Gathercole, 2001; Passolunghi & Siegel, 2003; Barrouillet & Lépine, 2005). WM is a longitudinal predictor of children's difficulties in learning mathematics (Geary et al, 2000; Fuchs et al., 2005) even after controlling for children's general intelligence (Nunes et al, 2007; Nunes, Bryant, Barros, & Sylva, 2011).

Research has consistently shown that deaf children have lower scores in WM tasks than hearing children of the same chronological age (e.g. Harris & Moreno, 2004). Even after cochlear implantation, deaf children continue to show lower scores in WM measures than hearing children (Fagan, Pisoni, Horn, & Dillon, 2007). We carried out a recent, still unpublished study, in which we assessed deaf (N=96) and hearing children's (109) WM when they were in their first two years of school (Nunes. Evans, Barros, & Burman, in preparation). We used in this study an adaptation of Counting Recall, a subtest of the WM Battery for Children (Pickering & Gathercole, 2001). In this assessment, children are asked to count dots on a series of pages, and then recall the result of each count. Their WM span is based on the number of pages for which the children recalled correctly the number of dots in the order in which the pages appeared. After controlling for the children's age and an estimate of their non-verbal intelligence (assessed by the matrices sub-test of the British Abilities Scale, Elliot, Smith, & McCulloch, 1997), deaf children's WM scores were still significantly lower than those of the hearing counterparts. There is, thus, a clear need for interventions to support the development of deaf children's WM.

In order to design a WM program for deaf children, one should consider what might explain their low WM scores. There are two possible explanations for difficulties in WM tasks. One explanation would relate WM problems to automatic attention responses and the second would suggest that WM problems relate to the inability to use rehearsal efficiently. These are not mutually exclusive explanations because deaf children's poor performance in WM tasks might depend on either or both sorts of problems. We explore here briefly each of these possible explanations and their implications for WM training for deaf children.

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1.1 Basic Attention Problems

Children who have poor WM may have attention problems at a basic level of task orientation, which involves implicit processing (Klingberg, 2010). Duncan (2006) suggested that WM is largely related to attention, defined as a process that involves the selective description of information that is relevant to current thought or behavior. According to him, the brain establishes task relevance through a cumulative process; for example, in a test or experiment, the process starts with receipt of instructions and is further elaborated as a full task representation is constructed during the initial trials. This process, which can be documented in animals as well as humans, is not related to the use of rehearsal to control attention during the task. It involves the pre-activation of brain cells in response to the selection of attention targets. In a WM task, children must be able to select the relevant information, which usually involves form (e.g. which digit was displayed) or quantity (e.g. how many dots were displayed) and the order of stimuli (stimuli must be recalled in the order of appearance or reverse order). Mitchell and Quittner (1996) studied deaf children's performance in a computerized visual attention task and compared their performance with hearing children's performance. They found that an average of 71% of the deaf children scored in the borderline/abnormal range in this task, in comparison to only 9% of the normal-hearing sample. This finding suggests that deaf children's problems with WM could result from their difficulties in selective attention to the information that is relevant for task execution. Quittner, Leibach, and Marciel (2004) argued that deaf children's attention problems may stem from their very inability to orient to sound from an early age, and therefore their WM problems could result from difficulties in attention orientation. Therefore, a program designed to promote deaf children's WM should contain an element of orientation training.

Performance on any task requires attention orientation because any task takes place in an environment where there are other objects and people. Competition for attention interferes with performance; this is well documented in dual task performance, when someone has to attend to two messages at the same time (e.g. Bourke, Duncan, & Nimmo-Smith, 1996; McLeod & Posner, 1984). However, biased competition, which takes place when the participant in an experiment is instructed to report targets and ignore non-target stimuli, can strengthen orientation. When people are asked to report letters in a visual field, their performance deteriorates as a result of competition if the number of letters increases. However, if people are asked to report white and ignore black letters, this biased competition produces improvements in performance when the number of letters is held constant, because some of the letters are no longer targets and can be ignored (Duncan, 2006). The implication of these findings may appear, at first sight, paradoxical: children who have orientation difficulties should benefit from practice in tasks where there is competition for attention, but the competition is biased. Because competition increases when the number of stimuli increases and when the similarity between targets and non-targets increase (Duncan, 2006), a sensible training strategy is to increase the number of stimuli and the similarity of targets and non-targets throughout training. This scheme renders the task progressively more difficult while implicit orientation is reinforced through biased competition.

Research with hearing children has shown that WM can be improved among typically developing children and children with attention disorders by repeated performance on WM tasks when the level of task difficulty is augmented by increasing the amount of information to be recalled (Holmes, Gathercole, E., & Dunning, 2009; Klingberg, Fernell, Olesen, Johnson, Gustafsson, Dahlström et al., 2005; Tamm, Hughes, Ames, Pickering, Silver, Stavinoha, et al., 2010; Thorell, Lindqvist, Nutley, Bohlin, & Klingberg, 2009). This sort of progressively more challenging program was shown to be effective, whereas comparable amounts of on-task training in non-challenging tasks was not effective. This successful training of WM in hearing children with attention problems indicates that a similar approach, involving implicit training with progressively more difficult tasks, could be beneficial also for deaf children.

1.2 Effective Rehearsal and WM

A review of factors that explain deaf students' recall in WM tasks (Bebko & Metcalfe-Haggert, 1997) suggests that rehearsal plays an important role: deaf students show less evidence of using rehearsal, either in oral or signed form, than hearing students. Oral rehearsal is negatively affected by lower fluency among deaf people (Marschark & Bebko, 1997) and sign span is consistently lower than word span in deaf people (Gozzi, Geraci, Cecchetto, Perugini, & Papagno, 2010). MacSweeney, Campbell and Donlan (1996) observed that visually based rehearsal strategies are effective for deaf adolescents, a result that suggests that visual rehearsal strategies may be difficult to acquire but can be effective, if implemented. Thus, a lack of tendency to rehearse, fluency problems in oral language and the late emergence of visual rehearsal strategies may affect deaf children's performance in WM tasks.

There is evidence with hearing children and adults that training that seeks to engage the participants' metacognitive skills in controlling attention and rehearsal during a task can lead to improvements in tasks that require attention control, such as WM and executive function tasks. Positive results have been obtained in studies with adults (MacNamara, & Scott, 2001; Turley-Ames, & Whitfield, 2003) and young children: Kloo and Perner (2003) used a measure of executive function in their study, a process which is closely associated with WM, and Nunes et al. (2008) used measures of WM from the WM Battery for Children (Pickering & Gathercole, 2001).

The implication of these findings for training deaf students' WM is that deaf children should benefit from rehearsal training that engages their meta-cognitive skills and that attempts should be made during training to develop verbal as well as visual rehearsal strategies.

In summary, there are two possible explanations for deaf children's poorer performance in WM task than hearing children's: difficulties in implicit attention orientation and lack or inefficiency of rehearsal strategies. With these hypotheses in mind, we designed a WM intervention program for deaf children that includes guided use of visual and verbal rehearsal strategies combined with unguided practice in computer games, which aimed at developing implicit orientation processes in biased attention tasks. The guided attention games were played with the support of a teacher or teaching assistant and the unguided computer games were played on the web without a tutor.

2 Method

Participants were 80 children in a comparison group and 73 in an intervention group, recruited through their teachers who volunteered to participate in response to an advert in a magazine for teachers of the deaf. Their mean age at the start of the study was 8y5m (SD=1.5 years); the range was from 5 years to 12 years.

The intervention was delivered by the teachers but the children were assessed by the researchers. The children were pre- and post-tested in three WM tasks. Two of WM assessments were adapted from the WM Battery for Children (Pickering and Gathercole, 2000); the adaptation consisted of modifications in the instructions, which were found in a pilot study to be more effective for deaf children. A third assessment, Picture Recall, was developed for this study. The assessments load on a single factor, and the factor loadings of each assessment are above .8. The average interval between the pre- and post-test was 5.8 months (SD:1.4 months).

All games used in the training were designed to parallel the demands of WM measures. There were six games in total, three teacher-led and three unguided training games, which are described in the subsequent paragraphs.

Teachers participated in a full-day of professional development before the start of the intervention. All games were delivered by means of computerized presentations; the teachers' role in the teacher-led games was to guide the children's rehearsal by rehearsing alongside the children until the children started to use rehearsal spontaneously. In the teacher led-games, the stimuli were displayed by a slide show controlled by the teacher. There were slides that prompted the children to rehearse at the start of games with a higher level of difficulty.

2.1 Listening Recall

The children were presented with a sentence in their usual language of instruction, oral or signed, and asked to judge whether it was true or false of a picture on the screen; the children had to recall the last word in the sentence; the number of sentences increased over trials. Verbal or sign rehearsal of the last word was encouraged, depending of the child's preferred language. Visual rehearsal of the number of words to be recalled was encouraged by showing the child that each word or sign could be paired with a finger (on the passive hand, if the child was signing) in order to keep track of how many things they had to recall.

2.2 Color Recall

The children were presented with a color strip and learned the positions of the colors (as in a rainbow) on the strip; next, a blank strip appeared and then two colors appeared in sequence in their positions; when they disappeared, the child was asked to name them in the reverse order of appearance. The number of colors to be recalled increased over time. Visual rehearsal was encouraged by asking the child to point to the positions of the colors that had appeared as they named or signed the colors. Figure 1 illustrates a sequence of slides in this game.

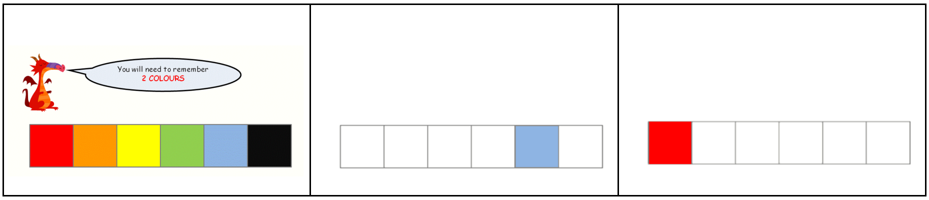

Fig. 1. A sequence of the slides presented at the start of the color recall game. The children were then shown a blank strip and asked to name or sign the colors that had appeared in the previous slides.

2.3 Digit Recall

The children saw series of digit strings and named the digits; at random places in a series, the last string appeared again with the last digits missing, which the children had to recall. The number of digits to be recalled increased over time. Verbal rehearsal was encouraged.

The teachers moved the children to the next level of difficulty in the game when the children met a criterion (4 trials correct out of 9). In each game session directed by an adult, the children were expected to play the same game a few times, attaining new levels of performance, but the teacher could move then on to a different game if they became discouraged by their own lack of progress.

There were three web-based games. For each game, the child was directed to a higher difficulty level when a criterion was attained.

2.4 Counting Recall

The children counted different animals on sequences of screen presentations. At the end, the children recalled and entered the number of each type of animal into the computer. The task was made more difficult by adding distracters, defined as non-targets, in order to create a biased attention task. On alternative games, recall was in the order of presentation or the reverse order. The number of animal types to be recalled increased over trials. Figure 2 presents a series of slides in this game.

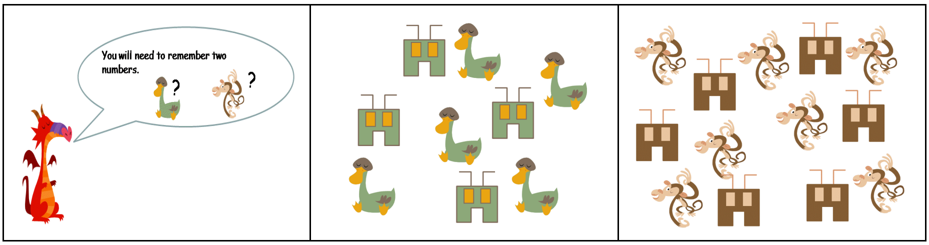

Fig. 2. A series of slides that appear in the web game Counting Animals. The game becomes progressively more difficult as the number of different animals to be counted increases and the distracters become more similar to the targets.

2.5 Backward Digit Recall

The children learned the position of the 9 digits on a 3x3 matrix. During the game, digits appeared sequentially in their place in the matrix on the screen. The children had to type the digits in the reverse order of appearance. The number of digits to be recalled increased over time.

2.6 Letter Recall

The procedure was similar to the previous game but the letters A to I were used instead of digits.

The children's participation in the web games was automatically recorded and they received a certificate of proficiency when they mastered a new level on each game. The average time between pre- and post-test was between four and five months.

3 Results

The effectiveness of the training program was analyzed by a comparison between the intervention and comparison groups. An analysis of covariance was carried out, in which the children's age, non-verbal ability and pre-test WM factor score were controlled for; the dependent variable was the post-test WM factor score. In order to render the scores more easily interpretable, we added five to all scores, therefore converting all scores into positive values. The children's age and their estimated non-verbal ability were not significant covariates; their pre-test WM score was significant (r=.82; p<.001). The adjusted mean score (controlling for age, non-verbal ability and pre-test score) for the children in the comparison group in the post-test was 4.87 and the mean for the intervention group was 5.14. The intervention group had an advantage of 0.27 points in comparison to the baseline group. This difference between the groups was significant (p<.001). Cohen's d effect size was 0.26.

There was a huge variation in the number of web-based games that the children played during the intervention. Some teachers seemed to focus mostly on the teacher led games and the children had no time to access the web for independent practice. Unfortunately, the teachers did not keep good records of how many games the children played with them but we had an automatic record of the number of games that the children played on the web as they had to login in order to play the games. The mean number of web-based games played by the children was between 16 and 17, but some children played more than 80 games. This allowed us to investigate the effect of the web-based game on the children's post-test scores. Figure 3 displays the intervention children's mean scores at post-test by the number of games played on the web.

The figure clearly shows the effects of practice on the post-test scores. In the intervention group, the correlations between the levels achieved by the children in the different web-based games were moderate to high (between .49 and .71) and significant (p<.001). Two measures of the children's practice in the web games were correlated with the post-test factor scores: the mean level attained by the children in the different games and the number of games they played. The correlations between each of these measures and the post-test scores were modest - .31 and .33, respectively, but significant (p<.01). These analyses support the conclusion that the WM gains were due to the intervention.

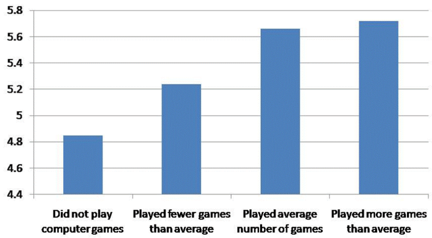

Fig. 3. WM score at post-test by number of web-games played

4 Conclusions and Discussion

WM is hypothesized by many researchers to be a cognitive resource that has an impact on learning. Gathercole (2006) has convincingly argued that it is an important factor for word learning, Cain et al (2001) demonstrated that it plays a role in reading comprehension and Nunes et al. (2007; 2011) showed that it is important for mathematical achievement, even after controlling for the children's intelligence and their numerical skills. Contrary to what was previously thought, it is now accepted by WM is plastic and can be enhanced by training (Klingberg, 2010).

Some training studies have relied on meta-cognitive skills whereas others have relied on automatic processes. Because deaf children are thought to require support in developing automatic attention as well as their meta-cognitive abilities, this project developed resources for supporting deaf children in the development of both processes. The effectiveness of this mixed program is encouraging but also underscores the need for further research. Future research should aim to analyze the relative importance of each of these elements for the development of deaf children's WM.

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Serious Gaming and Vocabulary Growth
Research into the Effectiveness of a Serious Game upon Receptive Vocabulary

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Serious games claim to be both entertaining and instructive [17]. However, research into the actual effects of serious games is rare. This paper presents an effect study that was conducted in 2010 in order to evaluate the learning effects of the serious game Mijn naam is Haas (My name is Haas) upon vocabulary growth in children in grade 1 and grade 2 (age 4 – 7).

1 Introduction

The educational computer game Mijn Naam is Haas (My name is Haas) provides a playful learning environment for children aged 3 to 7. Within the online serious game children create their own interactive story by drawing the world of character Haas. Sometimes they have to move this character around and the child can also draw solutions to problems and add elements, like trees, birds, mushrooms and insects, by drawing them right into the virtual landscape. These elements then become part of the story and may even change the plot. In addition to the online game there are CD-ROM's and picture books, some of them with circular stories. Currently products are used at home and in the classroom in the Netherlands. A distinction has been made between formal and informal learning [16] and the conclusion seems to be that the main difference between the two is in the environment: at school or at home. One might argue that due to serious games like Mijn naam is Haas the threshold between formal and informal learning is diminishing.

In 2009 the developers of the serious game My name is Haas asked Radboud university Nijmegen for advice on the language use within the game to be developed. We especially focused upon the selection of target words, that is: words to be captured by the children. We decided not to make use of word frequency as a selection criterion as this does not seem to be a fruitful approach, neither in instructional design nor in estimating productive vocabulary size [11]. Instead use was made of the Streeflijst Woordenschat [15]: this list reflects teachers´ judgments upon the necessity of a receptive knowledge of the words involved by children in grade 1 up to grade 4. From this Streeflijst we assigned words from different levels to be used in the serious game Mijn naam is Haas. Deliberately words were chosen in such a way that the misunderstanding of a particular word would not hamper the understanding of the game adventure as a whole.

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One of the assumptions of the designers of My name is Haas is that the game will increase young children's vocabulary. Beside that the game is supposed to stimulate children's story comprehension and to challenge their problem solving skills. The latter is triggered by means of confronting the child with situations that need some kind of solution. For instance, when Haas is walking through the woods he arrives at a river. The question is how to get to the other side. It's the child's role to come up with an answer, for instance by drawing a bridge or a little boat. The object that the child has drawn determines the way the story continues, so the game adapts itself to the input of the current user. In this way the learning environment is really interactive and it stimulates the child to come up with some kind of solution. Largest effects however were expected within vocabulary. In order to explain this I will highlight some major implications derived from international literature on Vocabulary Acquisition.

2 Theoretical Background

The question arises: How do children learn the meaning of words? When arriving at grade 1 children bring in a vocabulary of about 4.000 words. Apparently the principles that guide the vocabulary growth in the younger years are very effective. In this acquisition process three main principles can be distinguished [1, 13]: labeling, categorizing and network building.

Labeling seems to be a natural behavior for parents as they keep on talking to their children during the day while going out shopping with the children, feeding them, bathing them and putting them to bed. There is a one to one-relationship between the words, the labels they are using and the persons, objects, activities that are in the context of this language use. By labeling the adult language users make clear the relationship between words and objects. At the same time a *categorization* of objects and labels is necessary in order to get grip on the world. While comparing objects such as a couch at home, a wooden chair at Kindergarten or maybe even a desk chair, a child may notice that despite big differences there is one important similarity: all three objects are meant to sit on. A categorization of objects and activities in the world surrounding and in the words we use for labeling them, will lead to the *building of a network.* Children notice there is a relationship between *a pan* where French fries are fried in and a *plate* where the food will be eaten from. Distinctive features are used in order to decide whether a word belongs to one category or another, for instance which piece of furniture belongs to the category home, school or office, and to decide upon the relationship between (groups of) words such as *a dog*, *a duck* or maybe *an egg*.

Discovery of these relationships, both in content and in the syntactic field - that is: network building - is considered to be necessary for acquiring deep word knowledge. Just labeling an object will result in a shallow understanding of the concept [2, 9]. All kinds of criteria are being used by language learners to build up these vocabulary networks: shape, color, function and other distinctive features of the object that is labeled as well as syntactic and semantic characteristics of the word (see [4], Chapter 6 for an overview of studies). We do not know on what basis this labeling is most effective in what situation. However we do know that categorizing and network building is a powerful reinforcement to vocabulary growth.

On the basis of these theoretical insights five basic principles are generally considered to be essential for the stimulation of solid vocabulary growth [6, 21, 22]:

1. The use of a rich learning environment that is challenging for the language learner to learn in a functional and meaningful context.
2. Repeated input of target words: in order to be captured a new target word should be presented several times and in different contexts.
3. In order to build a network several distinctive features of a new target word should be presented, both syntactic possibilities, semantic aspects and the context in which the word is being used.
4. Target words should be presented in an interactive context: just like young children learn the meaning of words while playing and interacting in an verbal way with each other, elementary school pupils profit most from language input in a social environment with a lot of interaction going on. Within a serious game it's possible to reconstruct such an interactive environment.
5. Last but not least active participation: giving language input is necessary but stimulating the language learner to use the new words makes the acquisition process much more effective. In a serious game this is possible without creating anxiety or fear as is the case with more introvert children in classroom situations.

In general one can conclude that serious gaming is suitable in helping building a semantic network, especially when stories are used in which the child is participating actively [12, 17, 23]. Nevertheless, there are few empirical studies. For this reason it is stated that "Nothing much can be said about the effectiveness and efficiency of using educational games" in classroom settings [3]. Focusing on Mijn naam is Haas again it is easily demonstrated that within the game important conditions for effective vocabulary growth [4, 7] are met, including:

- target words that are carefully selected from Streeflijst Woordenschat [15];
- presentation of words in a functional context offering different cues in order to derive word meaning;
- multi-channel presentation: children can hear how the specific target words are being used and they can see the context in which the target words are used;
- target words are presented several times within one play session;
- as stated earlier: the child can participate actively within the context in which the word is being used.

Within the game these principles are operationalized in a nondescript way to the user: the player's attention will be with the game itself, not with the target words that are presented. On this basis the following hypothesis can be formulated: *vocabulary growth will be faster in classrooms where Mijn naam is Haas is used than in classrooms where no use is made of a serious game.*

3 Method

Using funds of the M&ICT program in The Netherlands research could be conducted into the effects of this serious game upon vocabulary growth within 4- 6 years old children. This research was carried out in the autumn of 2010; 12 schools at primary level were involved and test results of 412 children were taken into analysis.

In each of the 12 primary schools one class was allowed to play the game twice a week during 6 weeks (the experimental group). Two themes of the game were presented to the children using the online environment (theme *Creativity* and theme *Food and Drinks*). In the background use was made of the educational method Schatkist; during the experimental phase the pupils were not allowed to use the computer version of Schatkist.

The control group consisted of 12 parallel classes at the same elementary schools. The control group did make use of Schatkist, an exhaustive curriculum that incorporates 16 themes including stories, learning activities and computer games. In order to guarantee that the target words were presented in the control groups as well as in the experimental condition, illustrated short stories containing the target words were presented twice a week in the control group. Moreover, teachers of the control group were instructed as how to present these stories to the children in an interactive way. In order to optimise language input in the control group the interactive reading-instruction was based upon insights in the best practices in reading aloud to young children [6, 18, 22], including the repetition of words, paraphrasing sentences, asking open questions to the children, modeling and elaborating the children's responses and giving positive feedback to reactions of the children.

In both conditions teachers took note of the classroom activities during the experiment. Specifically for this experiment an intervention-related receptive vocabulary test was designed containing 28 multiple choice items related to target words derived from the two themes used in Mijn naam is Haas. In this receptive vocabulary test each test item consists of three picture alternatives while the target word is presented through audio within a sentence. The test was constructed after having pretested several items in June 2010 (mean p-score = 70.5 ; coefficient Alpha = .79). This intervention-related vocabulary test was presented to all children involved before and after the experimental intervention. As an external criterion a second receptive vocabulary test was used, derived from a standardized test set [20]. In fact we used a pretest posttest design that allows for within subject analysis. Data of children that missed one of the test sessions were deleted pairwise.

4 Results

Scores on pretest and posttest are represented in Table 1:

Table 1. Test scores per condition on pretest and posttest

	pretest		posttest		
Condition	mean	St.dev.	mean	St.dev.	n
Control group	20,53	3,695	21,73	3,658	205
Experimental group	21,24	3,755	23,04	3,236	207
Total	20,89	3,738	22,39	3,510	412

The log books of the group of teachers showed that in the experimental condition per child 12 to 20 minutes a week was spent playing the serious game My name is Haas. Within the control group in 4 out of 12 schools a double amount of time was spent reading aloud the stories to the children, discussing word meanings and doing related vocabulary exercises. Nevertheless, using the SPSS Repeated Measurement General Linear Model, the difference in vocabulary growth was significant in favour of the experimental condition. Within this model pretest scores on the TAK test [20] were used as a covariate in order to neutralize small, non-significant group differences at the pretest. Interaction between the variables Vocabulary and Condition turns out to be significant (F = 8,541, df = 1, p = .00), indicating that differences in vocabulary growth were highly dependent on the condition a child was in. As gains in the experimental group were higher the hypothesis is confirmed.

Effect size in vocabulary growth per condition was calculated using formula (1)

$$E = \frac{\mu_2 - \mu_1}{\sigma_1} \tag{1}$$

As a result effect sizes per group could be calculated (see Table 2):

Table 2. Effect sizes per condition

Condition	Means and standard deviations	Effect size
Posttest / pretest for the control group	21,73 – 20,53 / 3,695	0,32
Posttest / pretest for the experimental	23,04 – 21,24 / 3,755	0,48
Posttest data for both groups	23,04 – 21,73 / 3,658	0,36

The results show that vocabulary growth differs significantly in both groups. Table 2 indicates that growth was larger in the experimental group, effect size being 150% of the effect size in the control group.

5 Discussion and Conclusions

What can be concluded on the basis of the results reported? First of all, vocabulary growth was observed in both conditions. The conclusion might be that education - that is: our specific treatment - does at least have some effect. Secondly, there was a significant interaction between Condition and Vocabulary with a positive result in the experimental group. Our hypothesis has been confirmed.

Some further remarks need to be made. The first conclusion was that education does have effect. In fact, we are not sure about this. We didn't make use of a null-condition without any treatment: especially at a younger age informal language input, from outside of the school is a dominant factor in language acquisition. Though the target words used in our experiment were not very frequent, it might be possible that these words were captured in informal settings we didn´t control.

The reported effect sizes are moderate [5]: although effective, the results of the treatment were not very spectacular. However, with regard to the double amount of time spent in the control group in comparison with the experimental group, the serious game might have generated much more positive results. As ceiling effects may play a role further data analysis could be carried out on the basis of a differentiation in starting level (e.g. low, medium, high).

In this experiment we did not test deep word knowledge [14] and we didn´t get insight in the quality of the mental semantic network that was built by the children [cf. 8]; as a consequence we do not know much about the persistence of the learning results. In addition we did not use a vocabulary test that generates an indication or estimate of growth in receptive vocabulary as a whole (cf. [21].

To broaden the perspective: it is challenging to find out more about the characteristics in gaming that lead to positive learning effects. It might be possible to look for effects in areas that are less obvious and maybe a little more difficult to explore, for instance in the area of problem solving skills or ict-skills. Both more complicated and more interesting will be research focussing on the interaction between learning effects and characteristics of the serious game; game characteristics may be derived from available descriptive studies, cf. [10, 19]. In the long term it might be possible to create games with built-in tests: not merely tests in order to determine game levels that are best suitable, but formative tests that give insight in educational gains or even diagnostic tests that make clear what a pupil has achieved and what elements of the curriculum still need some attention - with or without a serious game.

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Gaming Behavior of Flemish Students and Their Willingness for Using Games in Education

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1 Introduction

Together with the globalization and the new global economy can the digitalization – the meeting of a variety of mediums (word, consonance, and image) on one bearer – be considered as an important recent social development (Castells, 1997). Playing videogames seems to be an important component of this digitalization. Moreover, the last decades games are increasingly considered as heaving a powerful potential to facilitate learning (Gee, 2003; Squire, 2003; Prensky, 2001; Shaffer; 2007; Steinkeuhler, 2006) and there exist a growing effort to design serious games that teach academic content (Dede & Barab, 2009; Rosenbaum, Klopfer, & Perry, 2007; Squire & Jan, 2007; etc.). Scholars are discussing a variety of motives that plead in the advantage of using games in education. It would increase motivation, creativity, the connection with living environment of students and pupils, fun while learning, independent learning, collaborative inquiry learning, etc. On the other hand, arguments which tackle these positive motives are plenty: the evocation of aggression, playing is not the same as learning, difficulty of controlling learning results, containment of wrong information, games being too expensive, etc. This paper doesn't investigate the scientific propriety of these arguments but examines whether these arguments are held in the perception of pupils of Flemish secondary education, students of a Flemish Education College, and students of a Flemish Engineering College. Moreover, it examines whether gender and gaming experience influences these perceptions. Investigating the perceptions held by the targeted public and the mediating role of gender and gaming experience, can provide insight in the way games can be implemented in education.

2 Method

The data were gathered using an online questionnaire, created with Lime Survey. The survey was in Dutch and comprised the following parts: (1) Socio-demographic data (gender, age, educational type), (2) Self-assessment of ICT-level (expert, good, mean, beginner, non-user), (3) Gaming behavior (frequency of playing games a week, preference playing platform, game genre, playing modus), (4) willingness for using games in education (3-point Lickert scale), and (5) motives for (non-)usability of games in education.

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The respondents have been recruited using snowball sampling. The chain started with inviting by mail all Flemish school management teams of GROUP T database to fill in the questionnaire and to distribute the link to the survey among their students and staff. At the same time, mailing was done to all GROUP T students of both Education College and Engineering College. These latter two groups were also given the opportunity to fill in the survey during classes. The uniqueness of every respondent was checked by comparing the filled in e-mail addresses within the survey (95% did so) and to include only fully completed surveys. Using snowball sampling implies a rather non-randomized selection of respondents, challenging the validity of generalizations. Adding the fill-in opportunity for both colleges of GROUP T, starting with a huge chain, and checking for the distribution in socio-demographic data and variance in answers, the survey nevertheless can provide reasonable strong statements on population level.

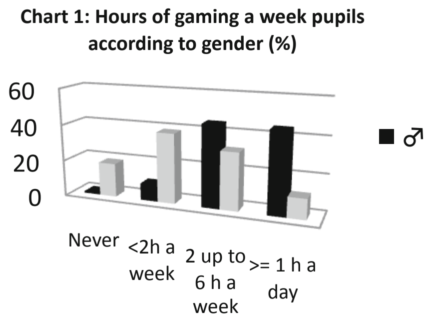
487 pupils from Flemisch Secondary education (♀38,4%, ♂61,6%; 58% ASO[1], 23% TSO, 6% BSO, 13% KSO), 298 students from GROUP T – Leuven Education College (♀ 60%, ♂40%), and 289 students of GROUP T – Leuven Engineering College (♀10%, ♂90%) fully completed the questionnaire. The distribution among gender and educational type were in line with the real population.

3 Results

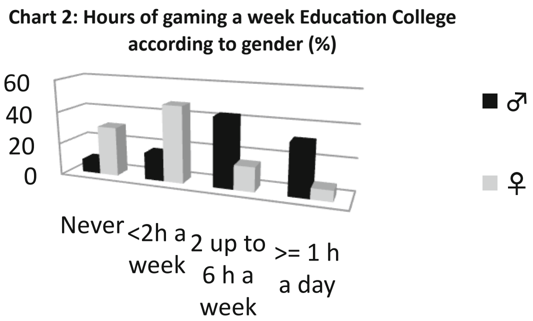
This section starts with a presentation of the results concerning the gaming behavior of the three groups of students. The second part will focus on the willingness of students of using games in education. Finally, an identification of the most selected motives for the (non-)usability of games in education will be presented.

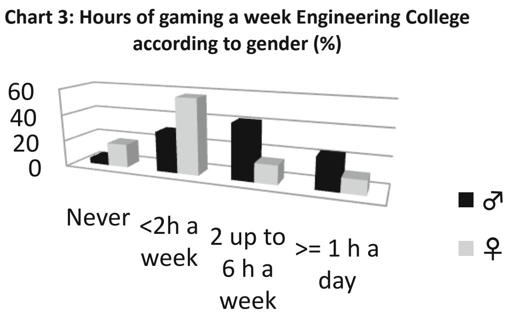
3.1 Gaming Behavior

When considering 'gaming frequency' of the three groups of respondents, significant differences can be found between and within the three groups. In the groups of pupils and students from Education College, females are gaming less frequently than their male colleagues. Further, pupils are gaming significantly more than students (ρ=0,00) and the biggest difference can be found between pupils and the students from Education College.



[1] ASO(General Secondary Education), TSO (Technical Secondary Education), BSO (Professional Secondary Education),KSO (Artistic Secondary Education).

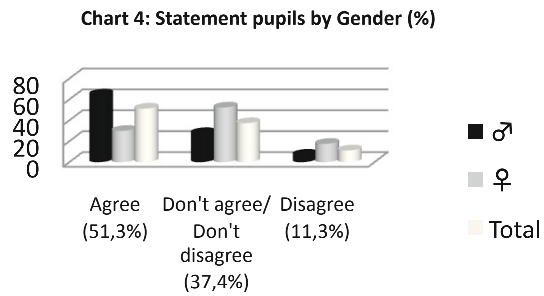




The personal computer (PC) is for all groups and for both genders the most used platform to play games. Second in line is for all males in the three groups the console and for females the mobile phone and/or Smartphone. A related phenomenon can be observed in preferred game genre of both genders. Without a significant difference between the three groups, females are playing most of the time Card& Boardgames, Simulation games, and Social games. In contrast, males prefer First Person Shooters, Racing- and Sportgames, and Strategygames. The fact that Card&Boardgames are often provided on mobile phones and/or Smartphones can explain the difference in the secondly most used gaming platform between males and females. Considering the playing modus, a significant difference between males and females in the group of pupils and students from the education college can be found. In these two groups males are playing more in a multiplayer online modus. This difference cannot be observed in the group of engineering students.

3.2 Willingness for Games in Education

In the survey the respondents had to judge the following statement: 'The use of digital games in education can be valuable' on a 3-point Lickert scale (Agree, Don't Agree/Don't Disagree, Disagree).



With respect to pupils' and students' willingness to use digital games in education, we observed that the percentage of respondents in all groups valuing this statement in a negative manner is rather low

(11,3%;10,4%;11,1%). The majority of both pupils and students value the statement as positive (51%;51%;57%). The results of a Kruskal-Wallis test show that there is no significant difference between the three groups (ρ=0,423).

Nevertheless, within the groups of pupils and students of Education College a gender difference can be observed; females are valuing the statement less positive than their male peers. This gender difference cannot be observed in the group of Engineering Students (ρ=0,845).

When investigating the influence of game experience on pupils' and students' willingness to use digital games in education, a significant negative Kendall's tau between gaming frequency and the statement in the group of students of education college (ρ -,266; p=0,01) indicates that the more students play digital games, the more they have positive opinions about the potential value of games in education. In the group of students from Engineering College the correlation is somewhat weaker but still significant negative (ρ -,212; p=0,01). In the group of pupils the correlation is even bigger than in the two other groups (ρ-,351: p=0,00).

Chart 5: Statement Education College by Gender (%)

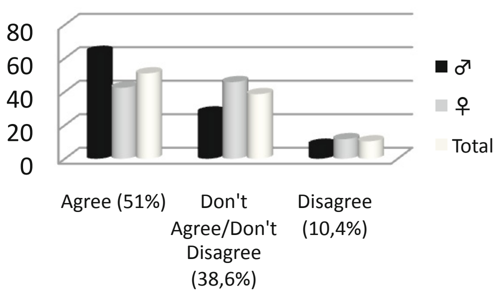
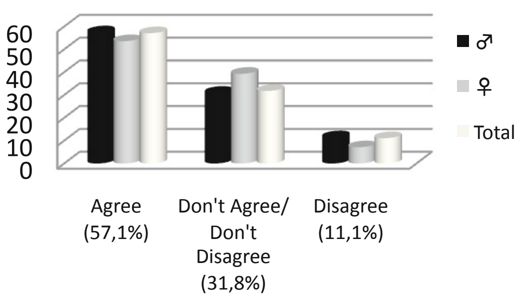


Chart 6: Statement Engineering College by Gender (%)



Knowing that males are gaming significantly more in the group of pupils and students of Education College, this can explain the difference in valuing the statement between males and females in these two groups. Nevertheless, on grounds of the observation that pupils are significantly gaming more than the group of Education College students, a difference in appreciation on the statement between these two groups could be expected, but did not appeared. It seems that students of Education College are taking into account the perspective of their future audience (pupils) when asked to score the statement.

3.3 Motives in Favor and against Using Games in Education

In the survey, respondents were asked to select within a list the motive(s) they thought to be a reason to use or not to use games in education. The two lists of motives were selected from common-sense opinions expressed in several lectures given by the author and cannot be considered as exhaustive. The respondents also had the opportunity to add other motives.

Considering the motives in favor of using digital games in education, the four most selected motives from the given list are the same in all three groups: increase of motivation, increase of fun while learning, increase of creativity, and an increase in connection between the living environment and school environment. While students of the education college select the latter motive the most, pupils and students of Engineering College select this motive as fourth one.

When considering the motives selected that plead against the use of games in education, significant gender differences in all groups can be observed. Females in all groups fear the evocation of aggression significantly more than their male peers. Males in all groups select the difficult integration of games in educational curricula as the most important hindering argument to use games in education.

When investigating the influence of game experience on pupils' and students' selected motives significant correlations can be found. The more experienced they are in playing games, the more the respondents select the difficult integration of games in schools curricula and the limited availability of good educational games, as hindering motives.

4 Discussion

Egenfeldt-Nielsen (2007, p.149) describes three categories of barriers when using games in education: 'Practical/structural barriers' (technical limitations, the limited space, time slots for lessons, etc.), 'Game- related barriers' (learning how to play the game, the complexity of the game, the balance between playing/learning and the integration of computer games with teaching), and the 'expectations and culture barrier' (the students' and teachers' initial way of thinking about computer games, learning and teaching, and learning content). The results of this survey provide us with indications that some of these barriers will influence a good implementation of games in Flemish education.

The results of the survey make clear that the gaming behavior differs severely between genders and between pupils and the two groups of students. Males are gaming more frequently and engage in other kind of games than their female peers. In general, the group of pupils plays more frequently in comparison with the other two groups of students. Especially the difference in gaming frequency between pupils and the teachers in training can hinder a good implementation of games in education because they are the most important stakeholders for the future implementation of games in education. These observations deal with 'game-related barriers'. Knowing that the more experienced persons are in playing games, the bigger the learning effect will be (Egenfeldt-Nielsen, 2007), the observations indicate that especially females and students of the education college will need more training in gaming literacy to gain even learning effects. Also the type of games they are experienced in will be affecting the learning results. Females will be more experienced in card-and board games then males who are much more experienced in strategy games for example.

Considering the 'expectations and culture barrier', the observations show that the amount of respondents from all groups clearly rejecting the educational potential of games is rather low. There exists openness for considering the educational value of games and this perception increases with a growing gaming experience. Interesting to notice is that the perception of teachers in training is not different than that of the pupils, although there are gaming significantly less than their future audience. Possibly, they are taking into account the perspective of the pupils in their judgments.

Concerning the selected motives that plead against the use of games in education, a growing of gaming experience shifts the motives from originating in some kind of moral panic (‘the evocation of aggression’) towards more ‘practical/structural barriers’, like the difficult integration of games in schools’ curricula and the limited availability of good educational games.

In sum, measurement to increase both the willingness to use games in education ánd the eventual learning effect of educational gaming should be aiming at tackling all three barriers, but not in a simple straightforward manner in which all stakeholders are conceived as holding the same barriers in an equal amount.

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Effects of Mini-Games for Enhancing Multiplicative Abilities: A First Exploration

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1 Introduction

Developing knowledge and understanding of multiplicative relations is a main goal of primary school mathematics education. It is important that students consolidate basic multiplication table facts as well as learn how to flexibly apply this knowledge in more complex multiplicative problems [e.g., 1, 2]. Mathematical computer games are considered to contribute to attaining both these learning goals [e.g., 3]. However, as recent review articles have pointed out, clear empirical evidence of the effects of educational computer games is sparse, and in-class longitudinal studies are needed [e.g., 4, 5]. In the BRXXX study we use a large-scale longitudinal design to provide evidence for the domain of multiplication and division. Moreover, our study goes beyond the use of computer games in class and also includes playing games at home. We investigate the effects of multiplication and division mini-games from the popular website RekenWeb (www.rekenweb.nl).

Our research questions are: 1) What are the effects of playing multiplicative mini-games on students' multiplicative abilities?; and 2) In what setting are multiplicative mini-games most effective? In this paper we present the preliminary results of the first year of the study.

2 Method

The research questions are answered by a repeated measures control-group design containing three experimental conditions (E1, E2, and E3) and one control condition (C):

- **E1** Playing multiplicative games at school, embedded in a lesson
- **E2** Playing multiplicative games at home, with minimal attention at school (the students are just told that they may play the games at home)
- **E3** Playing multiplicative games at home, followed by a class discussion
- **C** Pseudo-intervention: Playing games on other mathematics topics at school, embedded in a lesson.

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Comparing the experimental conditions (E) to the control condition (C) allows us to measure the effects of the multiplicative games (research question 1). With the pseudo-intervention in the control group, we control for the positive effects that participating in an experimental intervention might have by itself (Hawthorne effect). The three experimental conditions are meant to compare different settings of playing the games (research question 2): in school, at home, and at home with a class discussion.

Time schedule	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Grade 1 (2009/2010)										Test 1
Grade 2 (2010/2011)	Intervention 1					Intervention 2				Test 2
Grade 3 (2011/2012)	Intervention 3					Intervention 4				Test 3
Grade 4 (2012/2013)										Test 4

Fig. 1. Time schedule of the BRXXX-project

Figure 1 displays the time schedule of the BRXXX-project. In each of the four interventions, the students are offered eight online games. The experimental groups are offered games on practice and understanding of multiplicative relations (see examples in Figure 2). The control group is offered a number of alternative games, mostly on spatial orientation. In all four conditions, teacher manuals are presented to the teachers, describing how the games are supposed to be offered to the children. In the conditions including lessons or class discussions (C, E1, and E3), detailed instructions are given on the contents, procedures and duration of these lessons or class discussions. For the conditions in which the games are played at school (C and E1), the amount of time children are supposed to spend on the games is specified (two times 10 minutes a week). In the playing-at-home conditions (E2 and E3), no duration is specified; the children are just given the opportunity to play the games. The teachers are asked to keep the amount of in-class time spent on different mathematics topics the same as when they would not be participating in the project. Game-play data are collected through monitoring software.

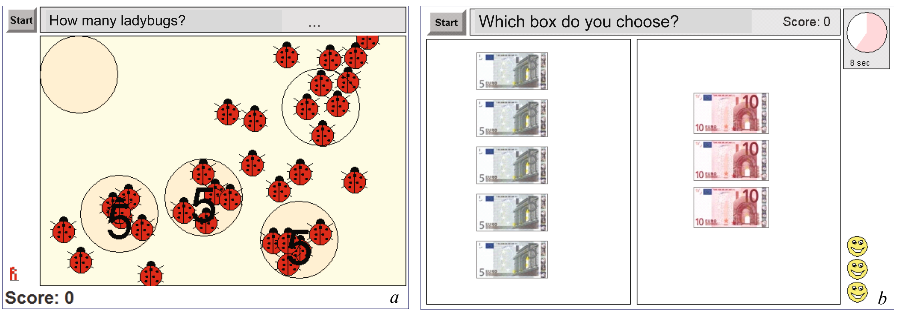

Fig. 2. Screenshots of games in the BRXXX study: a. "Catching"; b. "Choose an amount" (© Freudenthal Institute)

In the study, 58 classes of 54 regular primary schools participate (*n* = 1197). The schools were randomly assigned to one of the four conditions. The students' performance in solving multiplicative problems is measured by the BRXXX Multiplicative Ability test, an online test administered at school. In the different grades different test versions are used, which are linked through anchor items. The test consists of multiplicative items and distractor items. The multiplicative items are partly context items, bare number items, and items that measure the flexible application of knowledge of multiplicative relations. To control for order effects, each test version is administered in four different item orders. Test 1 contained 28 multiplicative items and Test 2 contained 50 multiplicative items (including 16 anchor items).

In our preliminary analysis of the effects of Interventions 1 and 2 (Grade 2), we included only the students who made both Test 1 and Test 2 (*n* = 885). Student's scale scores (weighted likelihood estimates) were computed using IRT, assuming equal item difficulties of anchor items. Linear regression models were employed with gain scores (Test 2 – Test 1) as the dependent variable. Because of the clustered data (students nested within schools) cluster robust standard errors were utilized [6].

3 Results

Table 1 displays the gain score descriptives per condition, and the regression coefficients of the comparison of the experimental conditions to the control condition. In Figure 3, the gains from Test 1 to Test 2 are illustrated in a graph.

Table 1. Gain score descriptives and regression coefficients per condition

		Gain Score[a]			Comparison of E to C			
Condition	*n*	*M*	*SD*	*d*[b]	*B*[c]	*SE*	*p*	*d*[d]
C total	314	2.30	1.17	1.70				
E total	571	2.45	1.30	1.81	0.15	0.15	0.16	0.11
E1	181	2.36	1.26	1.74	0.06	0.24	0.40	0.04
E2	234	2.34	1.32	1.73	0.04	0.19	0.41	0.03
E3	156	2.71	1.30	2.00	0.41	0.21	0.02*	0.30
Total	885	2.40	1.26	1.77				

[a]Test 2 – Test 1. [b]*M* divided by the standard deviation of Test 1 scores (*SD* = 1.36). [c]Regression coefficient.
[d]*B* divided by the standard deviation of Test 1 scores (*SD* = 1.36).
**p* <.05, one-tailed.

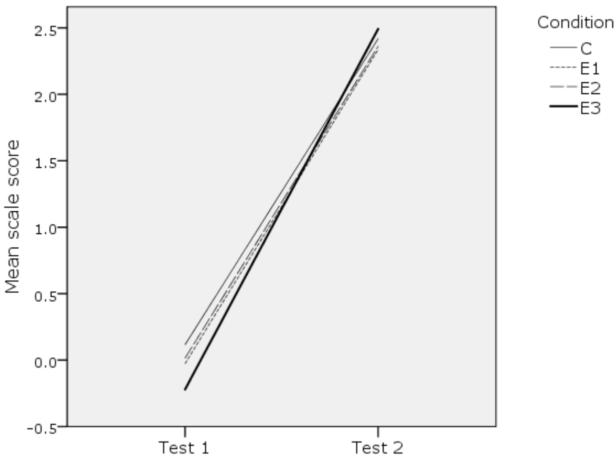

Fig. 3. Mean Test 1 and Test 2 scores per condition

4 Discussion

The preliminary results of this study show that using mini-games for developing knowledge and understanding of multiplicative relations (E) is not necessarily more effective than regular instruction without multiplicative mini-games (C). The way in which the mini-games are deployed in education turned out to be crucial. Playing multiplicative mini-games was only effective when they were played at home and discussed in school afterwards (E3). However, the effective ingredient of the E3 intervention is not just the playing at home, as is shown by the non-significant difference between E2 and C. Apparently, it is the combination of this playing at home and the discussion afterwards in class that works. This may be explained by the possibility that the in-class discussion promotes deeper understanding of the concepts encountered in the games. Furthermore, when comparing E3 with E1, the in-class discussion in E3 can be considered to be more fruitful than the lesson in E1 because of the richer experience gained from the free home playing. Moreover, in the E3 condition, the children may have spontaneously spent more time on practicing multiplicative problems. Further analyses will be carried out to get a better understanding of the effects of playing multiplicative mini-games and the role time-on-task plays in these effects.

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A Look into the Future of Serious Games Technology

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1 Introduction

Serious games often lack detail and graphical polish when compared with commercial games. While there has been an impressive evolution in the graphical technology of AAA games, serious games often lag behind in the adoption of these new technologies. However, adopting these technologies may be beneficial for the player's enjoyment of the game, the immersion effect they can achieve, and the market value of the final product. This lack of detail is often caused by two reasons. Firstly, the budgets allocated for serious games are often lower and the time spent in production time is usually shorter. Secondly, the teams developing serious game content usually consist of educators who are less experienced in the game development process.

However, recently there have been new developments in game technology which may help to alleviate this. In this abstract we will give a short overview of upcoming technologies and how they may benefit serious game creators.

2 Intelligent Tools

Traditionally, games are produced by experienced and skilled development teams using technical and specialized software packages. While these packages are very flexible, they also present the user with a high learning curve. Usually a large team of developers is responsible for adding all content to the game. The production tasks are divided over different artists specializing in one area of content creation (e.g. animation, texturing, environment designers…)

It is unlikely that educators will have the skills needed to produce high quality content. However, we see a clear solution in the future where experienced game developers create "template" content which can then be used by many games in different contexts. The non-technical educators will then be able to use intelligent environment creation packages to fill the world with these templates.

For example, the recently introduced Unity Asset Store [1] allows users to purchase basic "assets" (game objects such as 3D furniture models, icons…) from within the editing environment. However, the user still needs to place all the objects in the virtual world by hand. While this may not require highly technical skills, it still requires a lot of time to create large and realistic worlds. However, recent advancements in computer learning and geometrical algorithms [2, 3] allow scenes to be generated semi-automatically. Here the user provides the system with a number of

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sample scenes. The computer then analyses the scenes and learns the relationships between the scene objects. Finally, new scenes can then be automatically generated by the system. This way, the user only has to be in a supervising role and provide high level input to the editing system. This allows the user to focus on other tasks such as creating educational content. Other research [4] has focused on best practices for graphics specific user interfaces which typically arise when creating game content. Results show that novice users can easily create complex datasets such as material and lighting properties used by the visualization without much prior training.

3 Online Collaboration

In the previous section we already mentioned the online Unity 3D assert store. However, this system is very rigid, content creators provide ready-made content on this platform which can then be purchased by customers. In contrast to this, interactive web based systems also play an increasingly important role in game creation. For example, the Infinitex system [5] allows multiple users to edit the same world at one time without using the complex version management systems often used by professional game developers. The system allows multiple users to create texture data in an intuitive and interactive way. It also goes beyond a simple editor, as it incorporates the whole production process from the initial empty environment until the final finished product and addresses all the challenges that arise along the way when creating visually rich games. In particular, it focuses on versioning, management, continuity, and (multi-user) security. Furthermore, this system works on current generation hard- and software.

Such a system could easily be extended in the future to include more tasks than texture creation such as object placement, sound design and gameplay elements. Such online systems will also simplify the life of inexperienced users by automatically completing certain tasks such as asset management and distribution. Together with results mentioned in Sect. 2, this will greatly reduce the time and effort needed to create high quality game content.

Finally, the most important benefit of online systems is that the line between creators, users and players can be blurred. Users and educators can easily contribute new content and this content will immediately be made available to the players without requiring the installation of updates or patches.

4 Conclusions

In this work we have given a short overview of the future of game technology to create compelling educational games in a cost efficient way. Advanced editing technologies will allow inexperienced educators to create new game content and easily make this content available to their users and players.

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One Mini-Game Is Not Like the Other: Different Opportunities to Learn Multiplication Tables

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1 Mini-Games in Mathematics Education

Computer games are a powerful medium to learn mathematics [1]. They are used in several mathematical domains and in particular for the learning of basic skills in the domain of number. In this field, very often so-called 'mini-games' are used. In general, these games consist of small, focused activities, which students play for fun and in which they are engaged for a short period of time [2]. Mini-games can be part of textbook materials or can be textbook-independent. The RekenWeb mini-games (http://www.rekenweb.nl) belong to the latter category.

2 Identifying Learning-Supportive Characteristics

Although different mini-games intended, for example, for supporting students' knowledge of the multiplication tables may look very similar at first, for informed educational decision making, it is necessary to have a deeper understanding of their learning-supportive characteristics [3]. In the study reported here we developed a framework for identifying these characteristics. In this paper we discuss what this framework reveals about the opportunities to learn multiplication tables in two mini-games: Playing cards (Game 1) and Making groups (Game 2) (see Figure 1).

3 Framework

Based on a literature review, we identified a number of often mentioned learning-supportive game characteristics [4]. Following Garris, Ahlers, and Driskell [5], we made a distinction between general and domain-specific characteristics.

A. General Learning-Supportive Characteristics:

1. Challenge: e.g., the game includes possibilities for competition; offers problems with which students are not familiar.
2. Feedback: e.g., the game shows whether an answer or solution is correct or wrong

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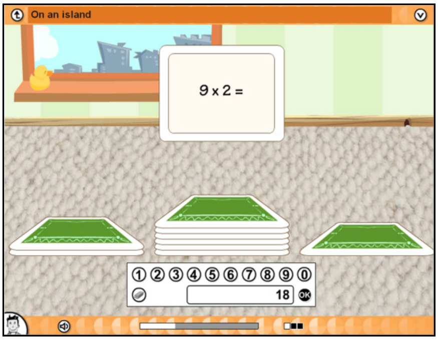
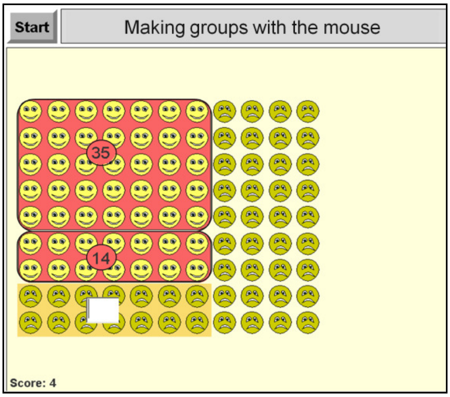
3. Reward: e.g., the game presents the student's increasing score, an approving text or a visual or acoustic bonus.
4. Learner control: e.g., the student can decide which problems to solve; when to stop with the game, because there is no programmed end.
5. Practice: e.g., the game has a structure in which problems show up repeatedly.

B. Domain-Specific Learning-Supportive Characteristics:

6. Conceptual understanding: the game
   a) shows connections between different multiplication problems.
   b) presents different representations of multiplication problems.
   c) enables different calculation strategies (recall of multiplication facts, repeated addition, counting).
   d) gives access to multiplication properties (commutative, distributive, associative).
   e) supplies models for understanding multiplication: group structure, number line, rectangular array.



'Playing cards'
(© Malmberg, Textbook 'Plusplunt', grade 2)



'Making groups' (© Freudenthal Institute)

Fig. 1. Game 1 (left) and Game 2 (right)

4 Results

For the categories Challenge and Reward the two games are rather similar (see Figure 2). With respect to Practice, Game 1 clearly offers students the opportunity to practice the recall of multiplication facts. The game ends when all problems have been answered correctly. In contrast with Game 1, Game 2 is targeted less towards just the memorization of number facts. Instead, this game focuses more on conceptual understanding. The game offers opportunities for connecting different multiplication problems and different representations, and applying different calculation strategies. Moreover, Game 2 gives the students access to the commutative and distributive property and supplies them with a rectangular array as a model. Another salient characteristic of this game is learner control. The students can choose themselves which problems to solve and can determine the duration of play. There is no programmed end in the game.

5 Discussion

The comparison of the two mini-games revealed considerable differences. While Game 2 clearly offers the opportunities to trigger a deeper understanding, Game 1 evidently contributes to memorizing multiplication facts. The latter could also be the case in Game 2, due to the many multiplications problems that the students can solve in this endless game. However, this game still allows the students to count and add instead of recalling a multiplication fact. This analysis shows that one mini-game is not like the other. Mini-games can offer different learning opportunities. Which game is most suitable and is chosen for a learning activity depends on the learning goal.

Characteristic		**Game 1**	**Game 2**
General learning-supportive characteristics	1. Challenge	- Staying within the time limit - Entering the next level	- Covering the complete field - Making all faces smile
	2. Feedback	- Showing whether answer is correct or wrong - Showing progress	- Showing whether solution is correct or wrong
	3. Reward	- Getting a pile of correctly solved cards - Getting an approving text - Getting applause - Reaching next level	- Getting smiling faces - Getting an approving text - Having the score increased
	4. Learner control		- Choice of multiplication problem by size and shape of rectangle - Choice of duration of the game
	5. Practice	- Practicing specific multiplication facts - Limitation: after solving a problem no further practice	- Practicing self-selected problems - No limitation in practice
Domain-specific learning supportive characteristics	6a. Connections between multiplication problems	-	- Connections between different multiplication problems: double of it, half of it; one more, one less
	6b. Different representations	-	- Use of the representations array and the connecting bare multiplication problem
	6c. Calculation strategies	-	- Enabling the calculation strategies counting, repeated addition, and recall of multiplication facts
	6d. Multiplication properties	-	- Access to the commutative property (e.g., 5 x 3 = 3 x 5) and distributive property (e.g., 7 x 5 = (5 x 5) + (2 x 5))
	6e. Models	-	- The rectangular array as a model

Fig. 2. Learning-supportive characteristics of Game 1 and Game 2

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Towards a Framework for Unraveling the Hidden Curriculum in Military Training Simulators

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1 Introduction

Armies increasing rely on modern training simulators. Training simulators offer training experiences that are often not feasible without them. How can a tactical tank battle be executed without a large training area? How to perform complex navy sea operations without a large fleet? Of course, 'real' training exercises in the physical world are still necessary, but mostly in the final phase of the training program after many runs in training simulators.

Despite these advantages, concerns have emerged among professionals and academics. Few scholars express their discontent with simulation in education as clearly as Turkle [1]. She argues that simulation has become embedded in the way we practice science in research and education so much that we might forget that simulations are built by human beings and offer a certain perspective to the world. The most challenging aspect of simulation is in her opinion that simulation 'wants immersion'. Immersion makes it very hard for participants to reflect on their experience and to distance one.

Hence, to counterbalance this phenomenon, we are interested in hidden, maybe unintended, effects of training simulators. A hidden curriculum is a somewhat infamous concept in curriculum studies. It has connotations with Marxist curriculum studies in which power relationships were investigated, often revealing hidden processes of indoctrination. Later the concept was used for a more practical reason: making visible the implicit processes that are counter-effective to the desired learning-outcome [2, 3]. The concept of hidden curriculum helps to make these effects explicit, thereby offering enhanced opportunities for (meta) learning at the organizational and individual level.

The objective of this paper is to develop a framework for structuring research on training simulators. This objective connects with the multi-disciplinary field Science and Technology Studies where the relation between human and non-human actors is scrutinized and political effects of technology are revealed [4]. The notion that technology is more than 'just a tool' is often demonstrated in case studies [5, 6].

This paper is structured as follows. In the next paragraph we explain the concept of hidden curriculum and related key concepts. Then the generic structure of training simulators (and games) is outlined and interpreted through the concept of hidden curriculum. In the fourth paragraph a small example is described. And finally, opportunities for future research are discussed.

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2 Analyzing the (Hidden) Curriculum

Marsh and Willis define a curriculum as "an interrelated set of plans and experiences that a student undertakes under the guidance of the school." [7] This definition allows for different views on curricula and learning. Marsh and Willis distinguish – also on the basis of work of others – four types of curricula: the planned curriculum, the enacted curriculum, the experienced curriculum and the hidden curriculum. The four types will be related to the practice of training simulators.

First, the documented intentions of schools or operational units are called the *planned curriculum*. This curriculum is written down in reports, web pages, policies and other documents, for example the 'Guideline for Education and Training' of the Dutch Army [8]. Plans are written down (and therefore typically represent explicit information), and serve as a means for communication, management and alignment. The notion of a planned curriculum shows the reach of ideas, intentions and curriculum development.

Second, the *enacted curriculum* is about what happens in the classroom. Trainers interpret the planned curriculum on their own right – as all human beings do with information being presented. They translate it to their courses, instructions, assignments, and activities. The enacted curriculum is also about the communication between trainer and trainee. The trainer is the actor who brings the planned curriculum 'alive'. The notion of an enacted curriculum stresses the importance of curriculum implementation and managing change processes [9].

Third, the *experienced curriculum* is about what trainees actually perceive while being immersed in training. Experience is about how trainees communicate and use course material and how they grasp the contents of the course. The trainees observe the behaviour of trainers, read the course material, complete the assignments and follow the program. On the basis of these activities they construct ideas about the intentions, aims and content of the study, subjects and profession. Of course their knowledge grows and skills are developed, but for every trainee it will be a different set of skills depending on their learning style, personal condition, and response to the learning environment. The experienced curriculum is beyond the scope of the planned and enacted curriculum. Experiences are typically the private domain of the trainee, concerning their tacit knowledge processes.

Fourth, a final type of curriculum is the *hidden curriculum*. It is about "those parts of the environment that influence the experience of students but that are either not accounted for or cannot be accounted for in curriculum planning" [7]. The term was introduced by Jackson and became the conceptual instrument for many curriculum studies [10]. The term is especially useful for 'discovering' mechanisms underlying the experiences of the trainees. Portelli explains that the term 'hidden' is not the same as hiding: the factors that influence the experiences are not intentional [11]. The concept challenges the achievements of lectures, assessments, workshops, courses and programs. That is, echoing progress in communication and knowledge theory [12, 13], relationships between planning, enacting and experiencing a curriculum are not straightforward. The hidden curriculum is mostly about invisible socialization processes and becoming part of a (professional) culture.

Marsh and Willis' four types of curricula illustrate the dynamics of an on going process of curriculum development, resulting in intentions (planned curriculum), events (enacted curriculum), encounters (experienced curriculum) and complex relationships between curriculum elements (hidden curriculum). This distinction can be useful according to Marsh & Willis: *"We are well aware that some authors contend that a curriculum consists of a structured series of intended learning outcomes and that instruction is the means by which these ends are realized. While separating ends and means is part of the logic employed in technical work, readers should clearly understand that we do not regard the process of curriculum planning and development as inherently technical. In fact, viewing it as technical has been historically (and currently) one of the greatest causes of confusion and frustration for people engaged in it."* [7]

The classification of the types of curricula emphasizes the complexity of a curriculum development process. It is not just as a problem of alignment (knowledge transfer) but also of co-existence of different worlds. These worlds can only partly be bridged by extensive communication between all people involved (knowledge construction). By definition the worlds are separated because they are the domains of different actors with their own 'praxis' (Table 1).

Table 1. Classifying curricula

	Explanation	**Actors and Praxis**
Planned curriculum (intentions)	What is explicit, documented, in formal plans?	Policy makers, curriculum planners, managers, etc.--
Enacted curriculum (events)	What contributes to evoke learning?	Teachers, trainers, staff, coaches, course leaders, instructors, examiners, observers, etc.--
Experienced curriculum (encounters)	What do trainees receive and grasp?	Trainees --
Hidden curriculum (Socialization)	What elements are not accounted for?	Classroom, building, technology, equipment, tests, etc.--

Different actors can be identified that are involved in delivering a learning experience for and with trainees. Anderson [14] - based on the work of Ahola [15] and Bergenhenegouwen [16] - develops a method for making the hidden curriculum of a university explicit. According to Anderson learning is a process that consists of four stages: (1) Learning to learn; (2) Learning the profession; (3) Learning to be expert and (4) Learning the game. Students have to struggle to complete University education successfully. He concludes that the 'day-to-day university' of students contrasts enormously with the 'ideal university' of the official policy makers. The empirical data (interviews with students and teachers) made it clear how this gap can prevail. Whereas teachers talk about the quality of learning, true knowledge, critical thinking and so on, students tell stories on coping strategies, scattered knowledge, loneliness, hurry, and poor quality. This gap in interests, intentions and experiences can only be investigated by analysing the stories of the actors involved and focussing on the discrepancies and controversies. The analyses can be considered as making the hidden curriculum (more) explicit.

3 Hidden Curriculum and Military Training Simulators

Nowadays, all sorts of military training simulators are available. They support training for operating complex weapon systems, driving tanks, flying F-16s, simulating large battles, performing medical operations and making tactical assessments. To illustrate this point: the handbook *Jane's simulation and training systems* lists more than 700 companies that develop military training systems. The industry of (military) training simulators is changing rapidly. A key reason is the wide spread use of games like America's Army and Virtual Battle Space 2 in military training [17]. Despite differences in military training simulators they share a common logic. Simulation is considered cheaper than a regular military training exercise since it does not involve physical reality. This saves time to set up; simulation doesn't require petrol, demands less training grounds; and opposing forces can be simulated . A wider variety of skills can be trained, for example driving in snow, storm, rain and sunshine – all in just one day. Training sessions within the simulator have less impact on the environment and are considered physically safe. Finally, the training process that comes with a simulator is comparable to a regular training: one receives instructions, executes a scenario and evaluates the actual behavior.

If one opens the black box (cf [18]) of the training simulator, a generic structure and specific types of actors can be identified. In general the following actors are involved: software developers for the representation of the (virtual) world and behavioral models for the 'realistic' behavior of the (virtual) objects and subjects, controllers that set-up specific training scenario's, trainers that evaluate the activities of the trainee, the trainee who is executing the scenario, and of course other trainees (peers) that are also involved via the computer network. Each actor plays a part in the training simulator. See figure 1 for a graphical sketch of the elements (adapted from [19]).

The configuration of these elements is the architecture of a training simulator. Mostly these six elements are present and can be understood in terms of the vocabulary of the hidden curriculum. The trainee is experiencing the training (experienced curriculum), and the training is set-up by the controller (planned curriculum) and evaluated by the trainer (enacted curriculum). The software and hardware are built according to software engineering standards, but with many assumptions about the virtual world [20]: how the (semi) represented physical reality should look like, and behavior of virtual objects and opponents [21]. One could say that these pre-conditions are part of the hidden curriculum.

Ethnographical research methods should be applied to map experiences, interpretations, assumptions and aims of each actor [22]. What matters is that different actors bring in their skills, ideas and work into the training at different levels. The sum of these ideas creates a learning environment that offers a certain perspective of the world. Uncover the unintended or hidden aspects of the curriculum in training are an important part of this environment. Yet current studies seldom focus on these aspects.

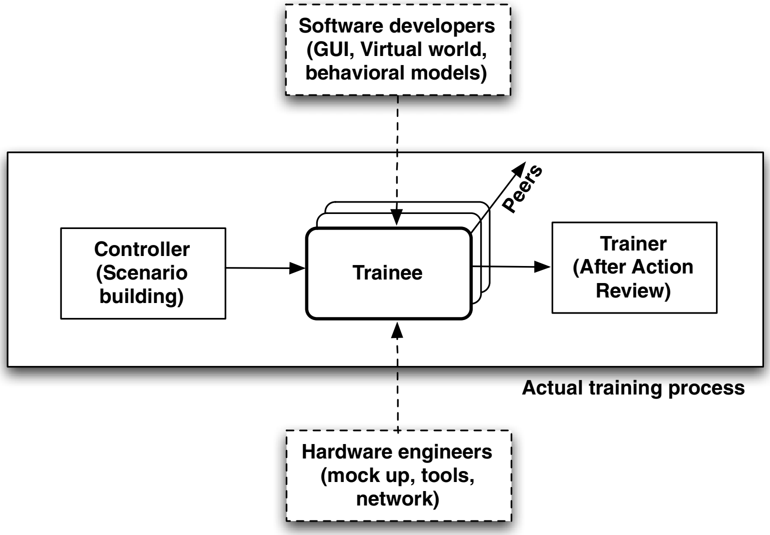

Fig. 1. Generic model of a Military Training Simulator

4 Illustrative Case: America's Army

How could one make the hidden curriculum of a training simulator explicit? Many papers in game studies offer valuable lessons (see for example [23-26]). This paper takes a popular training tool America's Army as example and explores its hidden curriculum.

America's Army is a unique videogame. It is the 'official U.S. Army game' since 2002 and can best be described as an online, multiplayer, squad-based tactical first-person-shooter game. *"The game (…) is developed and maintained under the direct supervision of the U.S. Army. The game's expressed goal is to inform and interact with popular culture rather than to persuade or indoctrinate, and to raise awareness of the U.S. Army brand, rather than to recruit directly."* [27]. The game can be downloaded free of charge from americasarmy.com. Besides marketing purposes the game is used to instruct recruits in the first phase of their military training. Also players who earned enough credits in the game get dispensation for parts of the training program in the (real) Army.

If a learner wants to become a soldier on the virtual battlefields of America's Army he should download and install the game before it can be played - an elaborative process because also software tools Steam and Punkbuster are installed and several logins have to be created (including the selection of an avatar). After that an opening screen appears in which you can enlist into the training program of the virtual Army. A training schedule is presented in which the course and learning aims are specified (planned curriculum). Three phases are identified: phase 1: red 1-3 weeks, phase 2: white: 4-6 weeks and phase 3: blue 5-9 weeks. Phase 1 contains the following description: *'The Army makes sure every recruit is physically and mentally prepared* *to start Basic Training. Upon determining this, recruits are given a haircut, provided with Army uniforms and are ready to start training.'* The first challenge is to 'complete the obstacle course' which will 'unlock Basic Rifle Markmanship'. Trajectories are set out and the recruit is enforced to complete them to become an American soldier. Learning is first about acquiring the right skills to use the keyboard and mouse to be able to run, jump, hide and handle the weapons. After the learner completes this course s/he has to acquire the right values. The America's Army is exceptional in this game genre because you do not only acquire points for killing enemy forces, but also for demonstrating other skills, like achieving objectives, showing teamwork and giving medical treatments [28]. You can also be penalized for violating the rules of engagement (the player may end up in a virtual prison). Learning is about obeying and understanding the rules.

After the learner has become acquainted with the values of America's Army, he can make certain decisions: specialize in types of weapons or learn additional medical skills. Of course, expert behavior is also about gaining points and growing in rank. Expert behavior requires many hours of playing and executing certain courses successfully. But this is not only an individual achievement anymore. One must be able to work in teams. Therefore the game offers a multiplayer environment. Truly good performance is only possible if one is able to cooperate with others and establish a 'clan'. The clan is a team of players who work together regularly to accomplish certain missions. The codes for interacting and working together add a new dimension to the game. This aspect is not explicit accounted for in the game. One must learn it from the other players.

In this short description we have seen that not only content matters. Also the technology itself plays an important role in creating the gaming environment. Software, computer screens, keyboard, internet, they all contribute to the learning experience. Technology makes things possible or impossible. So, beside playing the game and observing what happens, we should also consider into the possibilities of the technology, and the intentions of the developers (for an impression: www.youtube.com/watch?v=SM9_0EetArc) and many other relevant actors. This would probably lead to a kaleidoscopic picture of training with much more depth than what we can produce right now.

5 Discussion and Conclusion

The objective of this paper is to develop a framework for structuring research on training simulators. So, what is the hidden curriculum of a military training simulator? It is a question that must be investigated on a case-by-case basis. The game America's Army reveals a myriad of (new) experiences to the learner. The game 'demands immersion'; in that sense Turkle is worried that it offers no space for reflection. It is surprisingly easy to become involved in the game and to want to achieve better results. Therefore it is important to take a distance and ask questions like: 'What is going on here? What am I learning here?' If the learner doesn't look closer he will not realize that he is fighting opposing forces that see themselves as American soldiers too. Or that almost no blood is visible when a soldier is wounded. There are almost no civilians present on the battlefield [29]. The (small) illustrative case makes it quite clear that the technology itself also plays an influential role. Only by analyzing the game, the technology and the relevant actors (policy makers, developers, trainers, trainees, etc.) one can build a rich picture and reveal the curriculum that is hidden behind the screen.

Soldiers tend to be very positive about the training effects of military training simulators. Michael Macedonia, chief scientist and technical director of the U.S. Army Simulation, Training, and Instrumentation Command (STRICOM), explained the aims of military training eloquently. *"So a lot of what we're trying to do in training is creating memories. Memories that last forever. (…) In the training world, we try to create a virtual reality around the virtual reality program in our head. And I think in a sense games try to do the same thing, not realizing it. It's not intentional. That is, we're trying to mess with that program a little bit, so you can remember long afterward that experience. So that when you're confronted with it in combat, or some other particular situation, you recall that."* [30] One would expect that a lot of effort is put into the understanding of what is going on when learners are playing a scenario. But that is not the case.

The concepts planned, enacted, experienced and hidden curriculum helps to study simulation based training practices more carefully. Our starting point is the idea that not only the content of training matters, but also the technology. Actors who are involved in the development of the training simulator (i.e. technology) have an impact on training effects. Therefore effort should be put into the identification of different actors. Not only the ones that are involved in the training itself, but also the ones that designed the technology and synthetic environment. A training simulator is about the network of people making choices shaping an immersive environment – not only about the learning outcome of the students. We expect that by bringing in ethnographical methods these stories together the interpretations, experiences and interests are becoming visible and therefore negotiable.

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PC-Based Microsimulation Improves Practical Performance in an OSCE

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1 Introduction

When 5th year medical students are trained in emergency medical care, it can often be observed that they are not able to transfer their theoretical knowledge to a real life case scenario with a simulator [5, 10]. In simulation practical performance is often not as good as intended because the step from theory into practice, especially relating to decision making, seems to be more difficult than expected [1, 7]. One reason might be that the acquisition of theoretic knowledge is insufficient for constructing a mental model [4, 9]. To solve that problem we introduced a serious game (MicroSim® from Laerdal, Norway) which simulates an Emergency Department into virtual reality, in which the students have to treat medical emergencies. The idea was to support their decision-making ability by using a structured approach, using this virtual approach. We had observed in the past that this method improved the practical performance in everyday training, but to that point we didn't have any figures to prove this observation.

This brings us to the following research question to verify our observation:

Does MicroSim® improve the practical performance of fifth year medical students in an Objective Structured Clinical Examination (OSCE) though being a theoretical medium?

Does MicroSim® also influence other types of knowledge (besides practical performance; for example procedural, conceptual or strategical knowledge) [8]?

2 Methods

To answer these questions we randomized the participants into three groups (fifth year medical students at Martin-Luther-University Halle-Wittenberg, n = 205) after ethical approval of the institutional review board (IRB) (each n>=65). The participants of this prospective, randomized, controlled and observer-blinded study were given literature on resuscitation, chest pain and dyspnea.

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After an initial Objective Structured Clinical Examination (OSCE – practical exam - as pretest) focused on a standardized approach, the groups either had access to MicroSim (solving a total of 15 virtual case scenarios) or had to write an reflective article about a standardized approach on these topics, which should be close to “normal” learning for developing a mental model. Both methods should be comparable concerning the required time for learning. The third group simply read the literature without further intervention. This group had been introduced for measurement because we assumed a learning effect due to the repetition of the same OSCE.

In a second OSCE (posttest) we evaluated the structured approach again. In addition we asked the students to fill in different standardized questionnaires (as validated instruments) before and after the intervention (e.g. learning preferences, avoidance, time spent on computers, etc.) [4], assuming that the success of learning is influenced by multiple variables. This knowledge is based on the aptitude-treatment-interaction concept [4]. In our opinion there is not just the one best method, but rather an individual preference for different learning methods.

The OSCE results as main outcome variable are the sum of different single items. These also may be combined to aggregated items like structured approach, practical performance, etc.

3 Results

We were able to show a significant improvement in the MicroSim group according to the OSCE scores (difference between pretest and posttest), compared to the other groups (12,0 % vs. 8,4% and 8,2%, $p<0{,}008$, $f=0{,}22$). It seems that this result can be ascribed to the aggregated items concerning a structured approach. No difference in the quality of performance was found.

An explorative data analysis also found interesting results. Depending on group assignment the learning strategies and self-efficacy influenced the performance [4]. Furthermore we found no influence of other types of knowledge on the results.

4 Discussion

This study shows that Microsimulation improves practical performance. Though it is assumed, that simulation changes behavior, so far there is no proof that even theoretical Microsimulation changes performance more than standard theory learning (reading literature), or even the active dealing with the content when creating a summarization of findings.

When repetition is a favored learning style this method suits perfectly to prepare for an OSCE. In education it is well known that high self-efficacy reduces performance. MicroSim® seems to prevent this effect following the mastery learning idea [2, 6], which relies on preventing to stop learning too early. This was not expected, but seems to be a reasonable explanation for the found results.

5 Conclusion

The authors conclude that MicroSim® is valuable for improving practical performance in a blended-learning setting.

Knowing that there is not the one perfect method for all learners, this study also shows what kind of learner with this method improves performance.

Maybe also other interactive e-learning tools can also improve practical performance. However, further research on this topic needs to be conducted – especially concerning the effect of interaction as well as the concept of blended learning. In addition research on the difference between the learners should be improved.

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Lost in La Mancha: A Mobile Serious Game Experience for Language Training

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1 Description

Lost in La Mancha is an online video game designed to help English speakers learn Spanish. It is based on a methodology that combines various learning strategies, such as problem solving and language use in everyday situations, with activities to be completed and access to course content. This educational initiative revolves around and is presented in the format of a serious game based on the adventures of its main character, Collin, who receives a gift from his company to take part in an experimental project that will enable him to learn Spanish and in which he will have to survive in an immersive recreation of the city of Toledo in Castile-La Mancha (hence the game's title).

The video game's content is based on the level-A1 Spanish syllabus taught at the Instituto Cervantes (equivalent to international certification for Spanish as a second language).

In addition to the use of a video game and an immersive world as an educational strategy, this project's value lies in the fact that it has been designed to be accessible via different channels and devices, including the internet and a whole range of mobile devices (iPods, tablets, smartphones, etc.).

2 Pedagogical Design

Educationally speaking, Lost in La Mancha's learning strategy is based on two complementary approaches, namely language immersion, albeit in a simulated 3D immersive world, and active learning, through a carefully developed video game script that leads students into different communicative situations to be resolved. The main activity in the 3D environment (a recreation of the city of Toledo) introduces the video game's other elements, specifically learning activities and content. The result is practical learning contextualised in real situations, in such a way as to allow for the meaningful acquisition of the different skills involved in language learning (listening and reading comprehension, use of vocabulary, grammatical competence, sociocultural knowledge, etc.) and to extend familiarity with the use of Spanish in relation to various themes (greetings and introductions, work and study, family, physical and emotional states, orientation in space and time, food, leisure activities, daily routine, urban life, the media, etc.).

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3 Users and Learning Scenarios

Just as language immersion and active learning are fundamental elements of the resource's learning strategy, entertainment and mobility are essential to encouraging its use and increasing its accessibility, bearing in mind the characteristics of its potential users and the conditions in which they will use it.

Lost in La Mancha is aimed at users accustomed to playing video games and familiar with advanced forms of digital interaction. They will be people who also need to learn enough basic Spanish to enable them to take their first steps in a linguistic context in which the language is dominant. They could be businesspeople, students involved in mobility programmes, academic staff, travelling professionals, etc.

The above entails usage scenarios compatible with the pace and nature of users' day-to-day activities. In all likelihood, that means short periods at different times of day and in different locations (hotels, waiting rooms in offices, airport lounges, cafés, during journeys, etc.). It is thus necessary to keep in mind that the scenarios in which the resource will be used will vary greatly in terms of technological, environmental, emotional and time-related conditions.

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Design of Web-Based Mini-Games for Language Learning: An Evidence-Based and User-Centred Approach

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1 Introduction

This paper reports on an ongoing project which aims to develop and evaluate web-based mini-games for language learning in an evidence-based and user-centred approach. In recent years, a shift is taking place towards more learner-centred learning environments, and designers of Computer Assisted Language Learning (CALL) software have stressed the need for a user-centred design approach (Colpaert, 2010; Hémard, 2003). In general, there is a growing interest in participatory design, in which users are involved in the design process (co-design), marking a move away from traditional design methods characterized by an expert mind-set (Sanders 2008).

Many gaming elements, such as competition, interaction/interactivity, problem solving, scoring, and feedback, are also present in traditional learning and testing environments. Hence, it is conceivable that learners' perceptions of these "gaming elements" determine the reception of a language learning activity as a game to a significant extent, rather than the educational intentions of instructional designers alone (Hubbard, 1991). This warrants empirical research on language learners' perceptions of games for learning, as well as user evaluation studies with operational prototypes.

2 Research Goals

The study was conducted as part of a project which aims to develop and evaluate web-based mini-games for language learning. Mini-games are small and self-contained games which usually take a short amount of time to complete and which focus on a specific topic (Frazer et al., 2007). Educational mini-games for language learning seem to favour and even prioritize the development of formal linguistic accuracy. Arguably, language pedagogies nowadays stress communicative outcomes rather than formal linguistic accuracy, partly for motivational reasons. For instance, in the strong communicative approach of task-based language teaching, what matters from the learners' perspective is the communicative outcome of the task (e.g. having compiled a "a story, a list of differences"), rather than the pedagogical aim (whether learners have actually used or apprehended a linguistic structure) (Ellis, 2003, p. 8).

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Our main concern is how educational games can be designed to cater to the needs of the ‘net generation’ and the ‘digital natives’. Since this target group has grown up in a society that is pervaded by technology, and in which technology is an important catalyst of (collaborative) exploration and creativity, this raises questions with respect to the relation of games as a medium of entertainment with, on the one hand, formal/informal learning contexts, and explicitly educational content on the other hand. For the design of educational games for language learning, therefore, it seems critical that a user-centred approach is conducted.

Although the field of CALL has some tradition in developing and researching educational games (Peterson, 2010), what is needed to create language learning games that are foremost a fun and engaging experience for adolescents remains unclear (Purushotma, Thorne, & Wheatley, 2008). Therefore, we aimed to examine what it is that makes an educational game for language learning engaging and something the learners want to play for the sake of fun alone. Hence, our research question deals with gaining insight into the needs of adolescents concerning fun and engaging educational games for language learning.

We will address this research question from an interdisciplinary perspective that bridges instructional design for second language acquisition with human-computer interaction in order to level sound pedagogy with a coherent, pleasant and meaningful user experience.

3 Methodology

To answer our research question, we organized co-design sessions with14- to 16-year-old pupils from general and technical secondary education in Belgium. In these sessions, the participants created game concepts for language learning. In the setup of the co-design session, the mental mechanisms that steer the process of creativity as a cognitive process were taken into account. Consequently, the co-design sessions were structured in consecutive phases that corresponded with the stages that are typical for a creative process: a preparation stage to immerse into the problem, an inspiration stage to arrive at new creative insights, and a transformation stage of evaluation and elaboration (Boden 2003; Bullinger, Müller-Spahn, and Rössler 1996; Csikszentmihalyi 1997; Weisberg 1986). Additionally, we also stimulated the creation of multiple co-design artefacts to improve the design outcomes, exploration, sharing, and group rapport (Dow et al., 2011).

4 Preliminary Results

The game concepts that were created in the co-design sessions were diverse and demonstrated a range of elaborateness. Two main categories of game concepts could be discerned. On the one hand, there were games concepts in which language was used as a means of communication, while on the other hand, game concepts could be distinguished that focused on formal linguistic learning, e.g. through vocabulary exercises. In contrast with the game concepts in the first category, the concepts in this last category were typical examples of mini-games. This is in line with our expectations that mini-games for language learning seem particularly fit to for the topic of formal linguistic accuracy.

The game concepts will be analysed further in order to examine in more detail which specific aspects of the make them fun and engaging. The results will then feed into a brainstorm and a specification of user requirements, which both will steer the further design process of mini-games for language learning. In each step of the design phase, in which we will gradually evolve from game concept to low- and high-fidelity prototypes, the same target audience will be consulted at regular times to evaluate intermediate results.

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P-III: A Player-Centered, Iterative, Interdisciplinary and Integrated Framework for Serious Game Design and Development

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While reconciling a creative game design process with a complex software engineering process is already a daunting task, serious games add another ingredient to an already volatile mixture: the challenge of crafting an effective learning experience. In order to achieve this strenuous objective, Group T's e-Media Lab and the Centre for User Experience Research, K.U.Leuven, have developed a player-centered, iterative, interdisciplinary and integrated (P-III) framework. This framework has been developed over the course of five years of research on the design and development of serious games. Hence, P-III is built bottom-up, molded and shaped, tested and refined through several research projects [1,9,17,18,19,20,21,22,23]. While P-III also prescribes a specific process, in this paper we limit ourselves to highlighting the four pillars of the P-III framework, and their theoretical underpinnings.

1 The Four Pillars of the P-III Framework

The P-III framework offers a method for the design and development of serious games (see Figure 1). It is characterized by four conceptual pillars that are ubiquitous within the framework below:

1) *Player-Centered Design:* In the field of digital game development, user involvement is usually restricted to user testing in order to resolve usability issues, or to ensure that the game has a fair difficulty level [8,10]. Although such tests do involve the eventual player in the later stages of the process, it rarely offers players the opportunity to already participate in the creative part of the game development process. In denying the eventual player of a game from any creative input upfront, designers risk ending up with a self-referential design. Such an 'I'-methodology is a dangerous proposition, especially when the target audience of the game differs from the game's designers [6,15]. Considering

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serious games, the gulf between the game developers and the target group is usually more articulated than with commercial-of-the-shelf games. Whereas game developers are still mainly male, technology savvy, and higher educated [10,16], targeted serious game players are often children, seniors, people with disabilities or of a different social economical status. For game design to lead to a worthwhile game experience, tapping into the wishes and expectations of the players is a necessity [12,13]. Therefore, the P-III process incorporates specific methods to involve the player throughout the design process: from ethnographically inspired inquiries at the start of the project, participatory design sessions during the design phase to user test during the development. In this sense the P-III framework adheres to a human-centered design process according to the ISO 13407 [14] standard.

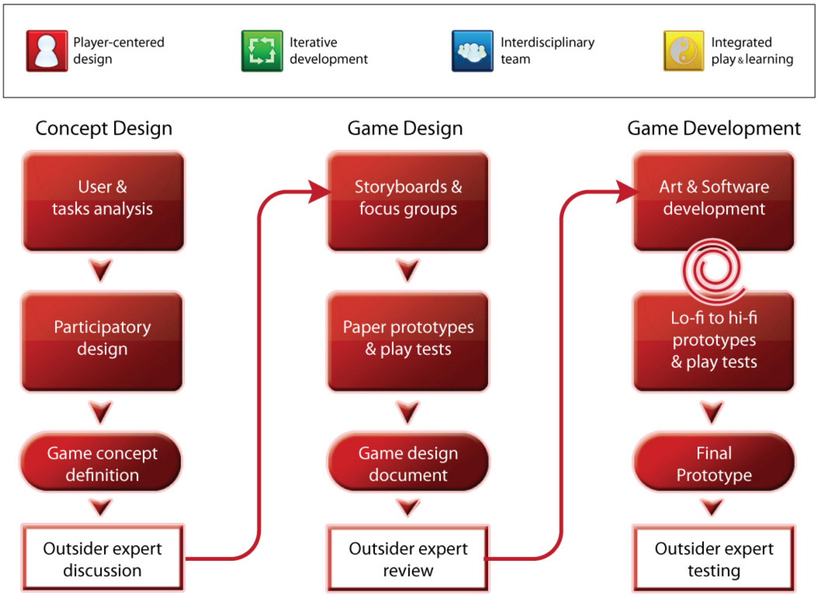

Fig. 1. An illustration of the P-III framework

2) *Iterative Development:* The P-III framework proposes an iterative and incremental approach to game design and development. The process evolves over several pre-defined phases that interact with each other (see Figure 1). The three main phases are Concept Design, Game Design and Game Development. The main focus of the Concept Design phase is to use the acquired understanding of the player group and the problem domain to come up with a first concept of what the serious game should be. After the concept design has been verified and approved, we move on to the Game Design phase. In this phase the game transforms from a concept into a detailed game that can serve as input for the game developers and digital artists. Finally, the actual Game Development process starts. The team will define different milestones and user tests throughout this phase of the process, leading up to a final prototype that can be assessed. To do so, the team will define the biggest risks the project faces (with

regards to its learning goals, “fun” or technological challenges) and make sure that these are mitigated as soon as possible. While the exact duration of each phase depend on the specific nature of the serious game, we found that Concept Designs and Game Development typically last between three and six months, and Game Development lasts between six months and twelve months. From these numbers, one can easily understand that the sum of the analysis and design of a serious game takes as long as the actual development.

3) *Interdisciplinary Teamwork:* Ever since the era of the bed-room coder has ended, the game industry has been home to a heterogeneous crowd. From software engineers to visual artists, project managers and game designers, the game industry consists of many contrasting profiles. Serious game development, however, requires an even broader range of expertise. Its serious goals necessitate the involvement of social scientists, as well as experts from the serious domain of the game. In order to develop a game that is both fun to play and effective in reaching its serious goals, instructional and game designers need to collaborate [2]. P-III takes this philosophy a step further and preaches a genuinely interdisciplinary approach in which all team members, not just the designers, participate in every aspect of the development process and learn from each other’s field of expertise.

4) *Integration of Play and Learning:* Aside from the educational potential that digital games share with simulations - such as a safe environment for experimentation alongside easy replayability - or the social context surrounding gaming, the most intriguing promise of serious games is their motivational quality [3]. To retain the motivational aspects and the flow experience [4] of digital games, academic literature has indicated that play and learning needs to be integrated as close as possible [5,6,8]. According to P-III, a successful serious game provides a seamless blend between the game fantasy and core mechanics on the one hand, and learning principles on the other. (For an overview of established learning principles that are suitable for use in digital game design, we refer to [7,11].) P-III suggests that game designers and domain experts exchange knowledge in order to choose those game mechanics that not only provoke the desired emotional responses from players, but also align with the serious objectives.

While we have presented the four characteristics as four separate pillars it is obvious that these are intertwined and reciprocal. Integration of play and learning is only possible through the interdisciplinary and intense collaboration between domain experts, user researchers, game designers and developers. Moreover, iterative and incremental development with small cycles of development alternated with user testing is innate to a player-centered design and development process. Yet, in this paper, we deemed it beneficial to unravel these for our reader in order to provide sufficient attention to each of these four characteristics. Finally, we emphasize that in this paper we have limited ourselves to describing the four pillars leaving out the specific process that the P-III framework additionally prescribes.

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deLearyous: An Interactive Application for Interpersonal Communication Training

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1 Introduction

For many people, interacting with clients or contractors is an important part of their professional activities. Employers often require those responsible for sales or customer services to partake in training activities to improve their interpersonal communication skills. This sort of training normally requires specialized coaching and is thus expensive and time-consuming.

Fig. 1. The interpersonal Circumplex

Many communication training sessions are based on psychological models of communication. One of these models is the interpersonal circumplex [5,8], which models human interaction on two orthogonal axes: a vertical power axis and a horizontal love axis (figure 1). In a discussion, each conversation partner takes on a certain position on both axes, thereby influencing the position of the other. For instance, if the speaker takes on a dominant position, along the top of the power axis, (s)he will provoke a submissive position in his conversation partner – and vice versa. By contrast, positions along the love axis are symmetric: a cooperative approach from the speaker will result in cooperation in the listener, while opposition will incite opposition [10,13].

S. De Wannemacker et al. (Eds.): ITEC/CIP/T 2011, CCIS 280, pp. 87–90, 2012.

2 Application Pipeline

With this poster presentation, we introduce some of the intermediate results of the ongoing project *deLearyous* [2], a collaboration between Group T Leuven Engineering College and the University of Antwerp. The aim of the project is to create an interactive application for interpersonal communication training, thus decreasing the need for individual coaching. Users will interact with the application through written natural language input and engage in conversation with a 3D virtual agent. They take on the role of a manager in a company, tasked with calming an employee (the virtual agent, or VA) who is disgruntled about a recent management decision to start charging money for parking privileges. The application pipeline is divided into a number of modules (figure 2), which are discussed below.

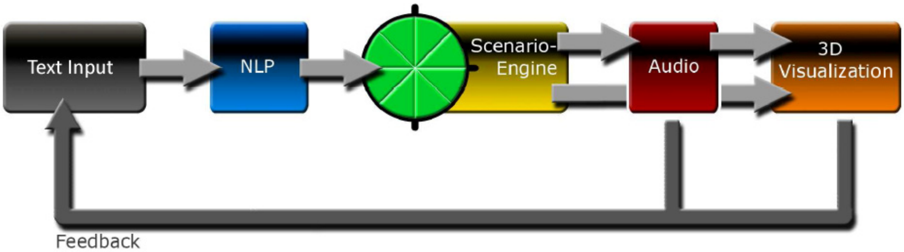

Fig. 1. Pipeline for the deLearyous application

2.1 Natural Language Processing

When the user enters a statement, his input is processed by the **natural language processing (NLP) module**. The artificial intelligence (AI) of the VA is driven by the circumplex model, meaning that it uses the position of the user on the circumplex as a parameter in its decision making process. To determine the user's position, we have trained an automatic classification system [3,6] that accepts any sentence as input and provides the position of the sentence on the circumplex as output. Because the first, context-independent version of this system had a low accuracy [11], we are currently developing an upgraded classifier which uses context information to improve classification results [12]. The NLP module also identifies the keywords in the user input. It determines if keywords need to be negated and expands the keyword set through a thesaurus. This expanded set of words is then passed on, along with the predicted circumplex coordinates, to the scenario engine.

2.2 Scenario Engine

The **scenario engine** is tasked with selecting an appropriate response to the player's input on the basis of the identified keywords and the circumplex positions of both player and VA. It achieves this by feeding the input into an internal finite state machine (FSM) which models the relation between the expected statements of the user and the available responses of the VA [9]. Once the user's input sentence has been matched to a state of the FSM, a reply is selected from the available follow-up states. Additionally, the emotional state and circumplex coordinates of the VA may be updated, and this information is then sent to the audio manager.

The FSM, which forms the core of the scenario engine, has been created and refined through a series of increasingly specific user tests, ending with a wizard-of-oz test where we simulated the application by having a human actor play the VA. Care has been taken to separate application logic and scenario-specific information, so it is relatively easy for an administrator to define a new scenario and plug the corresponding FSM into the application.

2.3 Audio

The **audio module** collaborates with the 3D visualization module to output audiovisual feedback to the user. It receives input from the scenario engine and searches through its internal database of audio files, selecting the one which most closely matches the response sentence and the emotional state of the VGP.

2.4 3D Visualization

Finally, the **3D visualization module** is responsible for rendering a convincing 3D representation of the VA. It contains a database of poses and body animations, each of which is linked to a certain position on the circumplex, and possibly annotated with context information such as affirmation, negation, stress, etc. Based on the output of the scenario engine, a pose and one or more of these animations will be selected and played during playback of the audio file.

The visualization engine is also responsible for the facial animation of the VA. Facial animation is achieved by analyzing which phonemes occur in the sound file selected by the audio module and then creating an animation morph based on the head meshes for the corresponding visemes. While the results are less impressive than more advanced techniques [1,7], this approach has the benefit of simplicity and real-time generation of animations. The resulting animation is further blended with a facial representation of the VA's emotional state [4]. The head and body animations are subsequently combined into the final animation.

3 Conclusion

The deLearyous application aims to instruct its users in the theory and practical usage of Leary's interpersonal circumplex, through a natural language-based conversation with a 3D virtual agent. The application is structured in four separate modules which sequentially process the input of the player, and finally generate an appropriate output in the form of a response, circumplex coordinates and animations for the virtual agent. The subject and flow of the conversation is stored in a scenario file separate from the application logic, so changing it is simply a matter of plugging in a new scenario.

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