## Appendix: Critical Review of the literature surrounding the effectiveness of narrative-driven digital educational games

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| **Authors** | **Country of Origin** | **Game Purpose** | **Mode of Delivery** | **Context for Play:Clinical Setting;Home only; School / Institution;Specific Location** | **Players per game:Single player; Multi- player; Both; Group; Single player and Group; Multiplayer and Group; All** | **Game Genre** | **Subject Area/s** | **Overall Outcome** | **EDUCATIONAL OUTCOMES:ATT = Attitude ChangeBEH = Behaviour Change ENG = EngagementENJ = EnjoymentKNO = Knowledge Acquisition MOT = Motivation SKI = Skill Acquisition OTH = Other****KEY:E = EffectiveM = MixedN = NegativeND = No Difference (to control group)** | **Participant Age** | **Number of Participants** | **Duration of Observation** | **Method** |
| **ATT** | **BEH** | **ENG** | **ENJ** | **KNO** | **MOT** | **SKI** | **OTH** |
| (Adamo-Villani & Wright, 2007) | USA | Educational | Virtual Reality | School / Institution | Single player | Virtual Reality/ Puzzle | ScienceMathematicsInclusive education | Effective | - | - | E | E | - | - | - | - | Primary school age | 21 | Total time taken to complete the game is not specified, but the mean time to complete one activity within it was 5:26 seconds | Pre test, recorded footage |
| RESULTS: Participants enjoyed using the application, and were engaged by it, however other learning outcomes are yet to be assessed. |
| (Adams & Clark, 2014) | USA | Educational | Computer | School / Institution | Single player | Puzzle | Science | Mixed | - | - | - | - | M | - | - | - | Secondary school age | 86 | 1 week | Multiple choice physics test |
| RESULTS: The learning differences between groups were not significant, with the higher number of answers provided by the base group attributed to more time spent on the game. Overall, the researchers concluded that cognitive load and flow should be taken into account if the aim is to enhance processing of information. |
| (Adams, Mayer, MacNamara, Koenig, & Wainess, 2012) | USA | Educational | Computer | School / Institution | Single player | RPG | Science | Negative | - | - | - | N | N | - | - | - | Tertiary | Experiment 1: 42, Experiment 2: 171 | Experiment 1: 75 minutes, Experiment 2: NA (time was measurement- roughly under one hour on average) | Experiment 1: multiple choice retention test, Experiment 2: demographic survey, pretest, posttest, and evaluation survey |
| RESULTS: Participants playing the game performed worse than those learning via a slideshow on a range of measures, including retention and transfer of knowledge; they also found the game more difficult to use. A detective story was not seen to add value within Experiment 2. |
| (Akkerman, Admiraal, & Huizenga, 2009) | NLD | Educational | Augmented reality | Specific location | Group | Location-based game | History | Mixed | - | - | E | - | M | E | - | - | Secondary school age | 216 | 1 day | Observation |
| RESULTS: The game evoked three types of ‘storification’: receiving, constructing, and participating. Participation evoked high activity in the game but less awareness of the overall story, which was most readily understood by students who had to construct it. Construction and participation were shown to make the participants more active and motivated during gameplay and, therefore, more engaged. |
| (Alvarez, Sanchez-Ruiz, Cavazza, Shigematsu, & Prendinger, 2015) | JPN/ ESP/ GBR | Educational | Computer | School / Institution | Single player | Simulation | Work readiness | Effective | - | - | - | - | E | - | - | - | Mixed ages | 30 | 75 minutes | Knowledge test, perception of learning questionnaire, perceived interest questionnaire |
| RESULTS: Two systems were evaluated, one without a ‘narrative manager’, and one with this function. The narrative manager provided participants with more problems to solve, but users reported finding its inclusion no more difficult than using the other system. They also found that it made the game more interesting. Knowledge tests revealed that students using the narrative manager had a positive effect upon users’ interest and learning. |
| (Annetta, Minogue, Holmes, & Cheng, 2009) | USA | Educational | Computer | School / Institution | Multi- player | Mystery | Science | Mixed | - | - | E | - | ND | - | - | - | Secondary school age | 129 | 90 minutes | Genetics unit test, observation and video recorded by two researchers |
| RESULTS: While post-intervention test scores did not demonstrate a significant difference between students’ understanding of content knowledge, students in the experimental group were shown to be more engaged than those in the control group. |
| (Arnab et al., 2013) | GBR | Educational | Computer | School / Institution | Group | RPG | Health: Sex education | Mixed | M | - | - | - | M | - | - | - | Secondary school age | 505 | 60 minutes | Observation, pre and post self-reporting questionnaire |
| RESULTS: After playing the game, participants felt that they were more confident in recognising coercion and actig to stop it, with gains in the game group marginally better than those in the control group. For positive attitudes to ‘saying no’, the control group showed greater gains. In relation to understanding personal risk and consequences, the game group showed gains, while the control group did not. |
| (Bagley & Shaffer, 2015) | USA | Educational | Computer | School / Institution | Single player | Simulation | Problem-solving | No Difference | - | - | - | - | ND | - | - | - | Secondary school age | 21 | 10 hours | Pre and post testing, reflection meeting discourse |
| RESULTS: The fact that no significant differences were found between learning conditions suggests that computer-based mentoring can be as effective as ‘face-to-face mentoring.  |
| (Barab, Gresalfi, & Ingram-Goble, 2010) | USA | Educational | Computer | School / Institution | Group | RPG/ Mystery | Science | Effective | - | - | - | - | E | - | - | - | Tertiary | 51 | 90 minutes | A post-test including multiple choice, short answer, and performance-based transfer questions, as well as interviews conducted by researchers and recorded for audio and video. |
| RESULTS: Both the immersive-world dyad and single-user conditions performed significantly better than the electronic textbook group on standardised test items, while the dyad group performed significantly better htan expository textbook condition on a performance-based task as well as the standardised test items. |
| (Barab, Pettyjohn, Gresalfi, Volk, & Solomou, 2012) | USA | Educational | Computer | School / Institution | Single player | RPG/ Mystery | ReadingWriting | Effective | - | - | E | - | E | E | - | - | Secondary school age | 65 | 12 classroom sessions | Observation, pre and post testing, engagement questionnaire, interviews conducted by researchers, persuasive writing task |
| RESULTS: While both classes of students showed significant learning gains, the gains were greater (significantly so) in the game group. Other benefits to students in this group were increased engagement and different factors shown to motivate their learning, while for the teacher the benefit was that they had to issue fewer reprimands. |
| (Barab, Sadler, Heiselt, Hickey, & Zuiker, 2007) | USA | Educational | Computer | School / Institution | Multi- player | RPG/ Mystery | Science | Effective | E | - | E | - | E | - | - | - | Primary school age | 28 | 2 weeks | Pre and post testing, audio and visual recorded observations and student interviews |
| RESULTS: Students demonstrated engagement in content, participating in rich scientific discourse and submitting higher quality work as a result. As such, they were able to demonstrate an understanding not only of the concepts, but of the ethics of science. |
| (Barros, Dantas, Veronese, & Werner, 2006) | BRA | Educational | Computer | School / Institution | Single player | Simulation | Work readiness | Effective | - | - | - | E | E | - | E | - | Mixed ages | 24 | Not specified | Pre and post testing questionnaires, discussion session |
| RESULTS: One hundred percent of participants approved this game design model. Researchers asserted that they had learned the intended lessons and had improved their skills in management. Just over half the students described the experience as pleasant, while almost ninety percent reported higher levels of interest in management as a result of participating. The researchers concluded that this game-based simulation was motivating, practical and fun, and suggested that challenge, visual effects, and time pressure were particularly engaging and entertaining for students.  |
| (Beaumont & Sofronoff, 2008) | AUS | Educational | Computer | Clinical Setting | Single player | Mystery | Social skills | Mixed | - | - | - | - | ND | - | E | - | Mixed ages | 49 | 5 months | Developmental history quenstionnaire, Childhood Asperger Syndrome Test, Social Skills Questionnaire: Parent and teacher forms, Emotion Regulation and Social Skills Questionnaire, WISC-III Short-form, Assessment of Perception of Emotion from Facial Express |
| RESULTS: This program had positive results in two measures: enhancing students’ social skills and emotional understanding, but showed no difference from the control condition in relation to measures regarding facial expression and body-posture recognition. Five months after the intervention, these treatment gains were maintained.  |
| (Bliemel & Ali-Hassan, 2014) | CAN | Educational | Computer | School / Institution | Single player | Simulation | Problem-solvingCommunication skills | Effective | - | - | - | - | E | - | - | - | Mixed ages | Not specified | Approx. 1 hour | Reflective questions |
| RESULTS: After participating, students were better able to reflect upon and apply IT management theories, particularly in relation to project management, budgeting, and the impact of IT projects.  |
| (Bressler & Bodzin, 2013) | USA | Educational | Augmented reality | Specific location | Group | Augmented Reality/ Mystery | Science | Effective | - | - | - | - | - | E | E | E | Secondary school age | 68 | 2 weeks | Pretest, post-test, observation, group interviews |
| RESULTS: The findings of this study demonstrated the potential of narrative-driven Augmented Reality science games to foster collaboration skills and flow. While playing, students’ flow experience could be observed as a flash of intensity, sense of discovery, and the desire for higher performance. The experience of success within the game led students to crave more success, therefore playing for longer. These effects were observed in both girls and boys. While neither gender nor attitude towards science were shown to be reliable predictors of the variation in flow experience between students, a student’s attitude towards game-playing predicted 23% of the variance in flow experience while playing. |
| (Brom et al., 2014) | CZE/ AUT | Educational | Computer | School / Institution | Single player and Group | Simulation | Conflict resolution | Mixed | - | - | M | - | M | - | - | - | Mixed ages | 171 | 7 hours/ 4 hours | Pre-test, Flow Short Scale, Positive and Negative Affect Schedule, Post-test, Four knowledge tests, Social interaction inventory test/ Pre-test, Flow Short Scale, Positive and Negative Affect Schedule, Post-test, Retention tests. All participants were also |
| RESULTS: Flow was related positively to positive affect and negatively to negative affect, and both were related to learning gains. However, there was no relationship between affect and cortisol levels. In socially anxious boys, both cortisol and negative affect were elevated, suggesting that team games may not be suitable, or might have adverse effects, upon certain learners such as these boys.  |
| (Buffum et al., 2016) | USA | Educational | Computer | School / Institution | Group | Mystery | Computer skills | Effective | - | - | - | - | E | - | E | - | Secondary school age | 28 in pilot study, 48 in full study | 10-15 game play sessions (unit of time NA) | Field observation, survey, knowledge assessment instrument (used as pre and post test) |
| RESULTS: In this computer science-based intervention, boys initially showed greater learning gains, but girls caught up over the duration of the intervention. Researchers also hypothesised that collaborative activities were linked to a higher level of persistence in students of both genders. |
| (Chaves et al., 2015) | BRA | Educational | Computer | School / Institution | Single player | Simulation | Computer skills | Effective | - | - | - | - | E | - | - | - | Mixed ages | NA (described as "a very small sample of participants") | 180 minutes | Pre and post testing, Personal background questinnaire and motivation questionnaire |
| RESULTS: Outcomes of this study suggest that the game had a higher degree of learning effectiveness than the control condition, which was based upon a project-based instructional model. |
| (Chee, Tan, & Liu, 2010) | SNG | Educational | Mobile application | School / Institution | Multi- player | Strategy | Social issuesProblem solvingConflict resolution | Effective | E | - | - | E | - | - | - | E | Secondary school age | 6 | 2.5 hours | Interviews |
| RESULTS: Students reported high levels of enjoyment, learning, and usability. The researchers attributed these positive gains to the students’ growing sense of self-agency and control, meaningful gameplay experience, and satisfaction with the user interface. |
| (Chee & Tan, 2012) | SGP | Educational | Computer | School / Institution | Multi- player | Adventure/ Puzzle | Science | Effective | E | - | - | - | E | - | E | - | Secondary school age | 40 | 120 minutes | Pre and post testing, knowledge testing |
| RESULTS: Researchers noted that, through the process of inquiry, enacted within the game, students’ perseption of science, and of themselves as learners, began to shift. They also saw positive effects upon classroom culture.  |
| (Chen, Wu, Chuang, & Chou, 2011) | USA/ TWN | Educational | Computer | School / Institution | Single player | RPG | Engineering | Negative | - | - | - | - | Negative | ND | - | ND | Tertiary | 42 | NA | Knowledge achievement test post testing, questionnaire on intention to use game platform and satisfaction toward gaming platforms |
| RESULTS: While students’ intention and satisfaction with both game conditions, as well as their motivational factors were very similar, and both revealed a significant positive effect upon learning outcomes, the drill-and-practice gaming group scored significantly higher than the roleplaying gaming group on a knowledge test. |
| (Cheng, Lin, & She, 2015) | TWN | Educational | Computer | School / Institution | Single player | Strategy | Science | Effective | - | - | - | - | E | - | - | E | Secondary school age | 62 | 180 minutes | Concept learning assessment as pretest, one posttest after first gameplay session, second posttest after fourth and final gameplay session |
| RESULTS: For students who played the game, learning increased and was maintained in the long term. The time that students spent viewing the relevant information embedded in the game was significantly related to their performance.  |
| (Cheng, She, & Annetta, 2015) | TWN/ USA | Educational | Computer | School / Institution | Single player | Strategy | Science | Effective | - | - | - | - | E | - | - | E | Secondary school age | 260 | 2 weeks | Knowledge assessment as pre and post testing instrument, Game Immersion Questionnaire |
| RESULTS: Learning outcomes were positively affected by players’ gaming performance, and higher gaming performance was a result of the players’ game immersion experience. Players learned from playing an SEG, but the reliability of the science learning outcomes were not definitive as players became more attached to the game. |
| (Christopoulos, Mavridis, Andreadis, & Karigiannis, 2011) | GRC | Educational | Virtual Reality exhibit | Specific location | Single player | Virtual Reality | History | Mixed | E | - | E | - | M | - | - | E | Primary school age | 12 | NA | In situ observations. Face-to-face questionnaires |
| RESULTS: During the story, empathy and psychological proximity were established, and immersion and engagement proved to be particularly high during this production. Children answered correctly during a series of historical questions, and the majority of children reported that they enjoyed the aesthetic of the story. Further emotional support is needed, however, as some visitors could not remember any historical facts from the story, surveys indicated. |
| (Clark et al., 2011) | USA/ TWN | Educational | Computer | School / Institution | Single player | Puzzle | Science | Effective | - | - | E | - | E | - | - | - | Secondary school age | 280 | Three class periods | Pre and post testing on 'instructed concepts', a survey, observations |
| RESULTS: Learning and engagement were similar across the two countries, suggesting this type of educational games may be useful in science learning across multiple countries. As results showed learning on some measures, along with high engagement, further research is needed to confirm the potential of these games. |
| (Connolly, Stansfield, & Hainey, 2011) | GBR | Educational | Augmented reality | School / Institution | Multi-player | Augmented Reality | Languages other than English | Effective | - | - | - | - | - | E | E | - | Secondary school age | 328 | 10 days | Pre and post testing |
| RESULTS: Students reported that the ARG encouraged teamwork, collaboration and cooperation, with students believing they had gained new skills across the three areas. The ARG successfully delivered to the students a motivational experience, and most students reported that they would be willing to integrate the game into their foreign language course over a long period of time. |
| (Couceiro, Papastergiou, Kordaki, & Veloso, 2013) | PRT/ GRC | Educational | Computer | School / Institution | Single player | Sports | Science | Effective | - | - | E | - | E | - | - | - | Tertiary | 103 | 40 minutes | Knowledge questionnaire (as pre and post testing instrument) and feedback questionnaire |
| RESULTS: Students’ understanding of concepts such as program, output, input and interplay significantly affected positively by the game prototype, and some students’ previous misconceptions were corrected by playing the prototype. In general, the game as an alternative learning tool was well-accepted, and students’ responses were average to positive on the prototype’s game elements. |
| (Dickey, 2011) | USA | Educational | Computer | School / Institution | Multi- player | RPG/ Mystery | Writing | Effective | - | - | - | - | - | E | E | - | Secondary school age | 20 | NA (mentioned as 'a session') | Observations of student interaction, including in-game chat logs, questionnaires and informal interviews |
| RESULTS: The game-like environment supported curiosity, plausibility and intrinsic motivation initially, with the environment and narrative sustaining these effects. Prewriting activities showed transference of game-based experiences. There was some student resistance. |
| (Doucet & Srinivasan, 2010) | USA | Educational | Computer | School / Institution | Single player | Unspecified | Environmental awareness/ Nature appreciation | Effective | - | - | E | E | E | - | - | - | Mixed ages | 21 | NA | Pre and post testing |
| RESULTS: Players successfully learned and gained interest on the topic of energy use. Players also enjoyed playing the game. |
| (Dunleavy, Dede, & Mitchell, 2009) | USA | Educational | Augmented reality | Specific location | Group | Augmented Reality/ Simulation | MathematicsEnglish languageScience | Effective | - | - | E | - | E | E | E | - | Secondary school age | 80 students, 6 teachers | Researchers spent approx. 100 hours over the course of a year on site at the three schools collecting data | Formal and informal interviews, direct observation, web site posts, site documents |
| RESULTS: Participants, including students with behavioural and academic challenges, reported that the AR simulation was highly engaging. While the simulation proved to have transformative added value, there were a series of challenges, including managerial, technological and cognitive challenges, for teachers and learners. |
| (Echeverria, Barrios, Nussbaum, Amestica, & Leclerc, 2012) | CHL | Educational | Computer | School / Institution | Group | Simulation | Science | Mixed | - | - | - | - | E | - | - | ND | Secondary school age | 36 | 3 days | Pre and post testing, Conceptual Survey of Electricity (CSE), Game Experience Questionnaire (GEQ) |
| RESULTS: Students who played the redesigned game, using the Atomic Intrinsic Integration Approach, experienced fewer conceptual problems and significantly improved results. There were no significant differences between the fantasy and non-fantasy conditions. |
| (Facer et al., 2004) | GBR | Educational | Augmented reality | Specific location | Group | Augmented Reality | Environmental awareness/ Nature appreciation | Mixed | - | - | E | - | M | E | - | M | Secondary school age | 10 | Two days | Group interviews, observation using recording equipment |
| RESULTS: Through observation, it was confirmed that students were engaged and compelled by their ‘roles’ and ‘environment’. Technical difficulties proved challenging, however, and not all students understood the rules of the game. |
| (Foster & Shah, 2015) | USA | Educational | Computer | School / Institution | Both Single player and Multi-player | Adventure/ Puzzle | Mathematics | Mixed | - | - | - | - | M | M | - | - | Secondary school age | 25 | Three school terms (playing 1 game per term) | Post test after each game (one game played per term, post test after each term) |
| RESULTS: PCaRD evidently accelerated learning and content identification. Only mathematics resulted with significant knowledge gains and motivation to learn. |
| (Froschauer, Merkl, Arends, & Goldfarb, 2013) | AUT | Educational | Computer | School / Institution | Single player | Scavenger hunt | Arts/ Creativity | Effective | - | - | - | - | E | E | - | - | Secondary school age | 20 | NA (two hour art class is mentioned) | Pre and post questionnaires |
| RESULTS: ThIATRO results indicate that students perceived art in a deeper way, and changed the response of the player’s aesthetic interpretation. |
| (Frost, Matta, & MacIvor, 2015) | USA | Educational | Learning Management System | School / Institution | Single player | RPG | Work readiness | Mixed | ND | - | E | - | ND | E | - | - | Tertiary | 80 | NA | Pre and post testing |
| RESULTS: The results suggest that gamification had no effect in this study, despite some students reporting that they appreciated some aspects of the gamification. With small effect sizes, student interested and relatedness were significant. |
| (Furió, Juan, Seguí, & Vivó, 2015) | ESP | Educational | Augmented reality | School / Institution | Single player | Augmented Reality | Environmental awareness/ Nature appreciation | Effective | - | - | - | - | E | E | - | - | Primary school age | 38 | NA | Pretest, a posttest group questionnaire for each condition, after a swap of conditions another posttest group questionnaire for each condition was administered |
| RESULTS: Results show that the motivational satisfaction of students was higher in the iPhone game. Students gained a significant amount of knowledge about the water cycle for all methods used. There was no statistically significant differences between the iPhone and classroom lesson. |
| (Giannakos, 2013) | NOR | Educational | Computer | School / Institution | Single player | Adventure/ Puzzle | Mathematics | Effective | - | - | - | E | E | - | - | - | Secondary school age | 41/ 46 | 2 weeks/ 1 week | Pre and post testing in both studies, observation, informal interviews ('light conversations') |
| RESULTS: Learners learned more using the game, as opposed to traditional instruction. While enjoyment of the game was significantly correlated with performance, happiness and future intention to use was not correlated at all. |
| (Giannakos, Chorianopoulos, & Jacceri, 2012) | GRC | Educational | Computer | School / Institution | Single player | Adventure/ Puzzle | Mathematics | Effective | - | - | E | - | E | - | - | - | Secondary school age | 12 | 2 weeks | Pre and post testing |
| RESULTS: Especially for students with a lower-than-average performance in mathematics, performance and interest was higher in the story-based math game. |
| (Giannakos, Chorianopoulos, Jacceri, & Chrisochoides, 2012) | NOR | Educational | Computer | School / Institution | Single player | Adventure/ Puzzle | Mathematics | Effective | - | - | - | E | - | E | - | - | Secondary school age | 46 | 1 week | Feedback survey post testing |
| RESULTS: There was a positive correlation between intention to use and enjoyment of the game, with gender being a moderating effect. The results suggest that female players might be more attracted to storytelling components in games. |
| (Gomes, Lopes, & de Carvalho, 2013) | PRT | Educational | Computer | School / Institution | Single player | Simulation | Work readiness | Mixed | - | - | - | - | M | E | - | - | Tertiary | 15 | NA | Pre-gameplay instructional slideshow, post-test questionnaire. Informal interviews |
| RESULTS: The results have shown that the majority of players found the game intuitive (80%), realistic (80%), and educationally motivational (67%). Just over half of players (53%) reported that the game helped their understanding of the 5S method. 40% of students thought the subject content should go deeper, supported by 87% of students who thought the game would improve greatly by deepening the contents. All students agreed that this game, and similar others, are an asset in education. |
| (González-González & Blanco-Izquierdo, 2012) | ESP | Educational | Computer | School / Institution | Multi- player | MMORPG | Science | Effective | - | - | - | - | - | - | - | E | Mixed ages | 25/ 45/ 17 | Several sessions' | Post testing |
| RESULTS: Social learning in gaming communities, regardless of theme or contents, is the most significant type of learning in games. Once a gaming experience has had a substantial duration (beyond ‘brief’), a social community can develop in any game. |
| (Gordon & Schirra, 2011) | USA | Educational | Computer | Specific location | All | RPG | Social issues | Mixed | E | ND | - | - | E | - | - | - | Mixed ages | 38 | One community planning meeting | Demographic survey, eight one-on-one interviews |
| RESULTS: It was reported that when in a familiar environment, playing as a character was a powerful element in the gaming experience. Participants showed empathy with their characters, reporting that they thought about their characters and their needs during Stage Two of the game. No choices out of character, however, were influenced by their previous characters. When asked about the correlation between their virtual residents and their personal values for Chinatown, participants answered neutrally. The same response was received when asked about thinking about their characters needs in Stages Four-Six. |
| (Gunbas, 2015) | TUR | Educational | Computer | School / Institution | Single player | Puzzle | Mathematics | Effective | - | - | - | - | E | - | E | - | Primary school age | 128 | 3 weeks | Pretest (a paper-based maths word problem solving test for all conditions) and post testing |
| RESULTS: The computer story condition produced significantly higher achievement scores in comparison with the paper story. Furthermore, the computer story treatment was significantly more effective than the non-story computer treatment. |
| (Haake, Axelsson, Clausen-Bruun, & Gulz, 2015) | SWE | Educational | Computer | School / Institution | Single player | Puzzle | Mathematics | Effective | - | - | E | - | E | - | - | - | Preschool | 39 | 3 sessions | Pretest (Swedish language comprehension test), false-belief tests (Sally-Anne and Maxi and the Chocolate task), semi-structured interviews |
| RESULTS: Despite results of a standardised false-belief test showing a lower level of mentalising capabilities, results show that participants were capable of reasoning and reflecting upon their digital tutee. Participants proved to be engaged and interested in games involving an instructional digital tutee. |
| (Hainey, Connolly, Stansfield, & Boyle, 2011) | GBR | Educational | Computer | School / Institution | Group | Simulation | Computer skills | Mixed | - | - | M | - | M | - | - | - | Tertiary | 92 | NA | Pre and post testing |
| RESULTS: While 6 aspects of expectation were met for HE learners, only 3 aspects of expectations were met for FE learners. HE learners were more willing to play the game over time and as part of a computing course. In addition, HE learners were more accepting of the game, found it more engaging and promising for the future, were more focused, and had a greater desire to play again. |
| (Hakulinen, 2015) | FIN | Educational | Computer | Home | Multi-player | Alternate Reality | Computer skills | Effective | - | - | - | - | E | - | E | - | Open to anybody | 21 | NA | Feedback questionnaire |
| RESULTS: Participants’ results show computer science knowledge gain as a result of game use. Collaboration amongst students was observed. |
| (Hamalainen, 2008) | FIN | Educational | Computer | School / Institution | Group | Simulation | Work readiness | Mixed | - | - | - | - | M | - | M | - | Mixed ages | 20 | 45 minutes | After-game reflection, observational note taking, audio and visual recordings of gameplay session and analysis of in-game chat logs |
| RESULTS: Epistemic scripts have educational potential in virtual game environments, as it helped players navigate through the game, and supported some others’ learning outcomes. Between the groups were great variations, despite scripted environment. Further research is needed to clarify how team collaboration and cognitive increase can arise without over-scripting learning. |
| (Harskamp & Suhre, 2006) | NLD | Educational | Computer | School / Institution | Single player | Strategy | Mathematics | Effective | - | - | - | - | E | - | E | - | Secondary school age | 302 | 4 weeks | Pretesting, observation, posttesting |
| RESULTS: Both computer programs showed improvement of problem-solving ability in comparison with traditional mathematics instruction. Despite expectations, both weak and skilled students’ quality of problem solving analysis and verification skills improved equally from computer programs. |
| (Hickey, Ingram-Goble, & Jameson, 2009) | USA | Educational | Computer | School / Institution  | Multi- player | RPG/ Mystery | Science | Effective | - | - | - | - | E | - | - | - | Primary school age | 116/ 105 | 4 weeks | Pre and posttesting |
| RESULTS: Larger gains in understanding and achievement were demonstrated in one teacher’s class using the curriculum when compared with his other two traditionally taught classes. A revised and refined curriculum was then administered to four of his classes showing even greater gains, and results indicated that students who engaged more with their formative feedback showed greater learning and achievement gains. |
| (Homer et al., 2014) | USA | Educational | Console/ Motion tracking software | School / Institution | Single player | Interactive e-book | VocabularyLiteracy | Mixed | - | - | - | - | M | - | - | - | Primary school age | 39 | NA (approximately 18 minutes per interactive story with games) | Pre-interview and test, plus self-report administered halfway through. Post -test: vocabulary, definitions and literacy testing, narrative comprehension and character identification tasks. |
| RESULTS: Significant gains for Active Decoding, Total Reading Score and High Frequency Words were found in both Kinect-Activities and Book Reading groups. Significant gains for Sight Words were only found for Kinect-Activities. |
| (Hou, 2012) | TWN | Educational | Computer | School / Institution  | Multi- player | MMORPG | Learning and practicing English, for non-English speakers | Effective | - | - | - | - | E | - | E | - | Primary school age | 100 | 335 days | Auto-record of every in-game action on a database |
| RESULTS: Through the interactive game, learners have the opportunity for mastery learning, in relation to the frequency distribution of gaming behaviours. MMORPGs, therefore, have a potential as an educational tool, when instructional strategies are employed. From these results, it is suggested that boys and girls may be encouraged to participate in games when they are a scenario-based educational MMORG, and may meet their needs. |
| (Hsiao, Chang, Lin, & Hu, 2014) | TWN | Educational | Computer | School / Institution | Single player | Adventure | Science | Effective | - | - | - | - | - | - | E | E | Primary school age | 51 | 9 weeks | Creativity assessment packet, divergent thinking task, flow experience questionnaire |
| RESULTS: The DGBL environment showed positive growth in students’ creativity, generation of flow experiences, and performance on manual skills. The ToES was effective in cultivating creativity, and accelerating improvement of practical behaviours. |
| (Hsu, 2012) | TWN | Educational | Computer | Specific location | Multi-player | Mixture | Science | Effective | - | - | - | - | E | E | - | - | Mixed ages | 47 | NA | Questionnaire relating to the Digital Museum for Children (via email or online) |
| RESULTS: Learning and motivation was inspired by the game-based educational website, and children’s’ learning effectiveness was enhanced. |
| (Huang, Yeh, Li, & Chang, 2010) | TWN | Educational | Computer | School / Institution | Multi-player | Puzzle | Arts/ Creativity | Mixed | - | - | - | - | - | - | M | - | Secondary school age | 72 | One semester | Pre and post testing |
| RESULTS: The ISCgame and the ISCgame-agent facilitated diverse problem solving ideas, and were helpful for brainstorming. The divergent thinking process did not immediately transfer to problem solving results. Further research is needed. |
| (Huizenga, Admiraal, Akkerman, & Dam, 2009) | NLD | Educational | Augmented reality | Specific location | Group | Location-based game | History | Mixed | - | - | E | - | E | ND | - | - | Secondary school age | 458 | 3 weeks | Engagement questionnaire, motivation questionnaire, Medieval Amsterdam test |
| RESULTS: Game-playing participants were engaged, and acquired significantly more knowledge on the topic of medieval Amsterdam when compared with the other group. The researchers found no significant differences in motivation for History between the two groups. |
| (Hwang, Chiu, & Chen, 2015) | TWN | Educational | Computer | School / Institution | Single player | RPG | Economics | Effective | - | - | - | - | E | E | - | E | Primary school age | 87 | 120 minutes | Pre and post testing (measuring learning style, learning motivation, satisfaction and flow state) |
| RESULTS: The approach encouraged students’ gains in knowledge, motivation, flow state and satisfaction. The ‘active’ learning style achieved more in learning from the approach than the ‘reflective’ learning style students. |
| (Hwang, Wu, Chen, & Tu, 2015) | TWN | Educational | Augmented reality | Specific location | Single player | Augmented Reality | Environmental awareness/ Nature appreciation | Effective | E | - | - | - | E | - | - | - | Primary school age | 57 | NA (works out to take roughly 2 hours) | Pretest on butterfly ecology attitudes and knowledge, post testing |
| RESULTS: Results indicated that AR-based games as an educational approach can positively influence learning attitudes and learning performances of students. |
| (Iglesias, Fernandez-Manjon, & Fernandez-Varais, 2013) | ESP | Educational | Computer | School / Institution | Single player | Adventure | Arts/ Creativity | Effective | - | - | - | - | E | E | - | - | Secondary school age | NA ('a small sample') | NA | Pre and post questionnaires |
| RESULTS: There were no significant findings of this study. There was, however, positive feedback on game performance, playability and pedagogical aspects. Significant technical difficulties need to be resolved before future research. |
| (Kajamies, Vauras, & Kinnunen, 2010) | FIN | Educational | Computer | School / Institution | Group | Adventure | Problem solving | Effective | - | - | - | - | E | - | - | - | Primary school age | 429 | 7 weeks with 1x45 minute session each two weeks | Pre and post testing, 6-month follow-up |
| RESULTS: Significant gains in word problem solving was found with the intervention students when compared to the control groups. |
| (Ke, 2008a) | USA | Educational | Computer | School / Institution | Both | Puzzle | Mathematics | Mixed | E | - | - | - | ND | - | - | - | Primary school age | 160 | 4 weeks | Maths exam and inventoryon attitudes toward mathematics used as both pre and post testing instruments |
| RESULTS: The results show that for game-based learning in cooperative goal structure, there were no significant effects on math test performance, but there was a positive effect in promoting positive maths attitudes. Students were influenced differently in gaming depending on their individual socioeconomic statuses. |
| (Ke, 2008b) | USA | Educational | Computer | School / Institution | Single player | Puzzle | Mathematics | Mixed | E | - | - | - | ND | - | - | ND | Primary school age | 15 | 5 weeks | Pre testing (Game Skills Arithmetic Test, a modified version of the Attitudes Towards Math Inventory, Junior Metacognitive Awareness Inventory), observations, think-aloud method, document analysis, qualitative data analysis, |
| RESULTS: More positive attitudes toward math learning developed from math gaming, but gaming had no significant effects on cognitive test performance or metacognitive awareness development. Not every math drill game played engaged children. |
| (Ke & Abras, 2013) | USA | Educational | Computer | School / Institution | Single player | Mixture | Mathematics | Effective | - | - | E | - | E | - | - | - | Secondary school age | 9 | 3 weeks | In-field observations, artifact analysis, school performance report, and three mini knowledge tests administered after each game was played |
| RESULTS: The results indicate that students with special learning needs can effectively learn and be engaged while playing educational games, if well designed and used. |
| (Kebritchi, Hirumi, & Bai, 2010) | USA | Educational | Computer | School / Institution | All | Mixture | Mathematics | Mixed | - | - | - | - | E | ND | - | - | Secondary school age | 103 | 18 weeks | Motivation surveys, academic achievement tests, interviews |
| RESULTS: While there was significant gains in achievement, there was no significant improvement in motivation for the two groups. Playing games in the classroom and lab encouraged greater motivation, according to students’ reports, than those that just played games in school labs. For those in the experimental group, English language and computer skills, as well as prior knowledge, were not significant components in achievement and motivation. |
| (Kim, Park, & Baek, 2009) | USA/ KOR | COTS | Computer | School / Institution | Multi- player | RPG | Problem solving | Effective | - | - | - | - | E | - | E | E | Secondary school age | 132 | 10 weeks | Social problem solving inventory and achievement tests were used as pre and post testing, each player's game score was used as achievement data as well |
| RESULTS: The results indicate that academic achievement and game performance were strongly affected by the social problem solving ability. Talking and observation activities were more effective for student’s learning and gaming achievements than writing activities. The results support the theory that gaming along with meta-cognitive strategies can improve learning and gaming performance. |
| (Kim, Kim, Shim, Im, & Shon, 2013) | KOR | COTS | Computer | Home | Multi-player | Adventure/ MMORPG | English languageWriting | Effective | - | - | - | - | E | - | - | - | Secondary school age | 59 | 2 months | KBS speech performance and writing test, EEG recordings |
| RESULTS: The experimental participants’ writing and speaking ability was vastly more improved than those from the control group. In a pilot ERP study, the processing of gaming activity in the brain was closely studied in relation to the educational course, reflecting the course of addiction and its influence on the fronto-central areas. |
| (Klopfer, Sheldon, Perry, & Chen, 2012) | USA/ SGP | Educational | Mobile application | Home | Multi- player | Online card battle game | Science | Effective | - | - | E | - | E | - | - | E | Primary school age | 20 | 4 days | Surveys, analysis of log data, debrief sessions/ discussions |
| RESULTS: With UbiqGames’ goals aiming to engage and promote interest in academic content for students, this study reaches those goals, with results showing that students were interested in learning the academic topics, and remained engaged by the game. |
| (Korat & Shamir, 2008) | ISR | Educational | Interactive e-Book | School / Institution | Single player | Interactive e-book | Vocabulary | No Difference | - | - | - | - | ND | - | - | - | Primary school age | 149 | 3 weeks | Pre and post test interventions of emergent literacy measures including word meaning, word recognition, phonological awareness |
| RESULTS: Results show that the emergent literacy levels of LSES children indicated larger improvement rates than the emergent literacy levels of MSES children. Children who experienced ‘Read with dictionary’ and ‘Read and play’ modes of activity showed more improvement than children who experienced ‘Read story only’ activity mode in their emergent literacy levels. Overall, results indicated that regardless of mode, both MSES and LSES children’s word meaning improved after experiencing the educational e-book activity. |
| (Kwon & Lee, 2016) | KOR | Educational | Computer | School / Institution | Single player | Simulation | Work readinessInclusive education | Effective | - | - | - | - | - | - | E | - | Secondary school age | 47 | NA (mentions 15 minutes between pre and post testing) | Pre, mid and post testing for hands-on task performance |
| RESULTS: Increased speed and accuracy of the hands-on task performance is shown in the results of this study. This suggests that simple job skills can be trained in people with developmental disabilities through the use of serious games, and can therefore be integrated into programs that aim to reduce training time and improve accuracy. |
| (Lamb, 2013) | USA | COTS | Mobile application | School / Institution | Single player | Puzzle | Mathematics | Effective | - | - | E | - | E | E | - | - | Open to anybody | NA ("My class") | NA | Observation |
| RESULTS: Students were increasingly engaged with Angry Vectors, Angry Parabolas and Angry Projectile Motion, and showed intrinsic motivation to learn mathematical concepts. |
| (Lazarou, 2011) | GBR | Educational | Computer | School / Institution | Groups | Racing | Science | Effective | - | - | E | - | E | - | - | - | Primary school age | 42 | NA (roughly works out to be 1.5 hours) | A presentation to showcase acquired knowledge, recorded footage for observation |
| RESULTS: The prototype was judged to be suitable for students and teachers. For the former, scenario-based learning was seen to be more effective than stand-alone simulations, while for the latter it appeared that it could provide a change in role, from content deliverer to facilitator. in an educational environment, giving both parties an active role to play in the scenario-based environment. Contradictions were quickly resolved. |
| (Lee et al., 2016) | KOR/ NZL | Educational | Mobile application | Specific location | Both | Location-based simulation | Work readinessProblem solving | Mixed | - | - | - | - | M | - | E | - | Tertiary | 25 | NA | Creation of a consultation presentation to showcase knowledge learned |
| RESULTS: Results showed that for the greatest improvement in critical thinking skills, the implicit cooperation condition was most important. Participants were interested in the content, and results indicate knowledge gains. A larger sample would most likely produce statistically significant results. |
| (Lester et al., 2013) | USA | Educational | Computer | School / Institution | Single player | Action-Adventure | Science | Effective | - | - | E | - | E | - | E | - | Primary school age | 800 | 4 weeks | Pre and post knowledge test, pre and post problem-solving test |
| RESULTS: Results showed an increase in knowledge gains, problem solving skills and engagement, which were consistent for genders. |
| (Liao, Chen, Cheng, Chen, & Chan, 2011) | TWN | Educational | Mobile application | School / Institution | Single player | Strategy | Mathematics | Effective | - | - | E | - | E | - | - | - | Primary school age | 9 | 2 months | Pre and post maths testing, face-to-face interviews, recorded footage for observation, Animal Companion Experience Questionnaire for post testing, post maths test administered a third time one month later |
| RESULTS: The results indicate that the game was engaging, and encouraged social discussion. |
| (Lim, 2008) | AUS | Educational | Computer | School / Institution | Single player | RPG/ Strategy | English languageMathematicsScience | Effective | - | - | E | - | E | E | E | - | Primary school age | 80 | 30 sessions | Pre and post academic motivation test, self-report questionnaire, commitment questionnaire, interviews |
| RESULTS: Motivation to learn, engagement, and social commitments may be enhanced by this approach. |
| (Lindström, Gulz, Haake, & Sjödén, 2011) | SWE | Educational | Computer | School / Institution | Multi- player | Digital Boardgame | Mathematics | Mixed | - | - | E | - | M | - | E | E | Primary school age | 40 | 9 weeks | Observations, group discussion |
| RESULTS: Results showed an increase in engagement, and knowledge gains from the experience of Teachable Agents. The TAs as a social entity has the potential to be a negative influence on knowledge gains as they may be downplayed. |
| (Liu, 2009) | TWN | Educational | Augmented reality/ mobile | Specific location | Single player | Location-based game | Learning and practicing English, for non-English speakers | Effective | - | - | - | E | E | E | - | - | Secondary school age | 67 | 8 weeks | Pre and post questionnaires, listening and speaking post test, interviews |
| RESULTS: The students in the experimental condition experienced more motivation, more satisfaction, and reported a pleasant experience in learning. |
| (Lopez-Arcos, Padilla-Zea, Paderewski, Gutierrez, & Abad-Arranz, 2014) | ESP | Educational | Computer | School / Institution | Single player | Adventure | Mathematics | Effective | - | - | E | - | - | - | - | - | Preschool | 32417 | NA | Pre and post testing |
| RESULTS: The narrative and incorporated characters helped students relate to the story, influencing decisions made, and ultimately encouraging learning. |
| (López & Cáceres, 2010) | ESP | COTS | Mixture | School / Institution | Both | Mixture | Social Sciences | Mixed | - | - | - | - | E | E | M | - | Mixed ages | Not specified | 10 years (not specified how long each game was observed individually) | A data-gathering instrument was designed relating to the classroom observation during the videogame experimentation process, for use as a resource in problem solving. |
| RESULTS: Acceptance and motivation from students indicated that the game was positively received. There were some challenges regarding collaboration and rule resistance. |
| (Lu, Chang, Kinshuk, Huang, & Chen, 2014) | CAN/ TWN | Educational | Context-aware mobile application | School / Institution | Single player | Simulation | Computer skills | Effective | E | - | - | - | E | - | - | - | Tertiary | 62 | 20 minutes | Demographic questionnaire, technology model questionnaire |
| RESULTS: Players’ attitudes and perceived game usefulness were positively influence by the CAM-RPG story. |
| (Majumdar et al., 2015) | USA | Educational | Computer | School / Institution | Multi-player | Unspecified | Health: Nutrition | Mixed | - | M | - | - | E | - | - | - | Secondary school age | 531 | 7 30-minute sessions over the course of a month | Pre and post testing |
| RESULTS: There was a significant reduction in processed foods and sweetened beverages for students who experienced the intervention. There were no changes for other behaviours. |
| (Manero, Torrente, Serrano, Martinez-Ortiz, & Fernandez-Manjon, 2015) | ESP | Educational | Computer | School / Institution | Single player | Adventure/ Puzzle | Arts/ Creativity | Mixed | - | - | M | - | ND | - | - | - | Secondary school age | 754 | 40 minutes | Pretest questionnaire, post-test questionnaire (including linguistic knowledge test, theatre play test, experience evaluation, and student interest scale) |
| RESULTS: The class with the actor captured students’ interest in theatre the most, followed by the video game condition, and then the traditional class condition. Comprehension of the plot and student knowledge was equally improved by both the game condition and the teacher condition. |
| (Marsh et al., 2011) | SGP/ USA | Educational | Computer | School / Institution | Single player | Puzzle | Science | Effective | - | - | E | - | E | - | - | - | Secondary school age | 57 | NA | Observations, questionnaires |
| RESULTS: Technical terms, scientific terms, and relevant language were all better promoted in the extended narrative and character versions, as it was easy to embed in the narrative. The narrative versions were rated as more enjoyable in all aspects by participants. |
| (Mayer, Warmelink, & Bekebrede, 2013) | NLD | Educational | Computer | School / Institution | Both | Mixture | NA | Effective | - | - | - | E | E | E | - | - | Tertiary | 503 | Gameplay experience was evaluated after between 1 and 7 weeks, depending upon the duration of the course that it was part of | Pre and post testing |
| RESULTS: Researchers found a strong positive correlation between learning satisfaction and motivation, attitude, enjoyment, effort, and quality of the teacher. Learning satisfaction was significantly determined by the degree of translation from in-game experiences to underlying theories. The in-game environment quality did not matter. |
| (Meluso, Zheng, Spires, & Lester, 2012) | USA | Educational | Computer | School / Institution | Both | Puzzle/ RPG | Science | Effective | E | - | - | - | E | - | - | - | Primary school age | 100 | 4 days | Pre and post testing: an adapted version of Self-Regulated Learning Scale, science content knowledge assessment |
| RESULTS: There was a significant increase in self-efficacy and learning gains from gaming overall, but there were no differences between playing conditions. |
| (Nash & Shaffer, 2011) | USA | Educational | Computer | School / Institution | Single player and Group | Simulation | Work readiness | Effective | - | - | - | - | E | - | - | E | Secondary school age | 14 | 4 weeks | Pre and post interviews, in-game interactions recorded for analysis |
| RESULTS: From the modelling of epistemic frames, epistemic network analysis was successful in learning, as players mirrored the mentors’ thinking. |
| (Neville, 2015) | USA | Educational | Computer | School / Institution | Single player | Simulation | Writing | Effective | - | - | - | - | E | - | - | - | Tertiary | 32 | A semester | Pre and post testing, group discussions, 300 word narrative construction assignment |
| RESULTS: Results show that the immersion for the experimental group produced more sophisticated and knowledgeable written narratives, indicating a reliance on story maps. Further research is needed as participants’ stylistic and grammatical features could be improved. |
| (Noorhidawati, Ghazal Ghalebandi, & Siti Hajar, 2015) | MYS | Multiple games (Educational/ COTS) | Mobile application | School / Institution | Single player | Mixture | NA | Mixed | - | - | E | M | E | - | E | - | Preschool | 18 | One week | Demographic survey for the parents to fill out, recorded footage for later analysis |
| RESULTS: Results show that learning for the children involved cognitive processing, such as learning knowledge and intellectual attitude development, psychomotor-based means, such as tactility and movement, and affective means, including emotion, attitudes, and perceived value. |
| (Novak, 2014) | USA | Educational | Learning Management System | School / Institution | Single player | Simulation | Statistics | Mixed | - | - | - | M | E | - | - | - | Tertiary | 64 | NA | Prerequisite knowledge test, post test |
| RESULTS: Both simulation-based interventions’ participants reported higher enjoyment in comparison to traditional learning, and had statistically significant positive effect in knowledge gains. The intervention without a storyline’s students reported higher enjoyment from the simulation than the students from the intervention involving a story. No significant differences in learning outcomes between intervention participants was found. |
| (Novak, Johnson, Tenenbaum, & Shute, 2014) | USA | Educational | Computer | School / Institution | Single player | Simulation | Computer skills | Negative | - | - | N | - | N | - | - | - | Tertiary | 64 | 120 minutes per student | Overview of concepts to be practiced, pretest knowledge, post test of knowledge (SDVVR instrument), demographic survey, and simplification of IMMS engagement survey |
| RESULTS: Both simulation conditions had significant learning gains, but the simulation with a storyline did not produce significant results in learning effectiveness, engagement or efficiency improvements. |
| (Okita, 2014) | USA | Educational | Computer | School / Institution | Single player | Puzzle | Mathematics | Effective | - | - | - | - | E | - | - | E | Primary school age | 40/ 22 | One hour/ two days | Pre and post testing |
| RESULTS: The self-other condition, using ProJo, showed results that calculation time and accuracy improved, along with students monitoring and self-correcting more frequently in the game than the other condition. |
| (Pirovano, Mainetti, Baud-Bovy, Lanzi, & Borghese, 2016) | ITA | Educational | Console/ Motion tracking software | Home | Single player | Augmented Reality | Health: Rehabilitation | Effective | - | - | E | - | - | E | E | - | Mixed ages | 7 | NA | Questionnaires |
| RESULTS: All participants reportedly enjoyed the games, rating it positively, and found them stimulating and engaging. Results indicate a sustained level of challenge for participants, while simultaneously demonstrating motivation, safety, and supervision. |
| (Romero-Hall, Watson, Adcock, Bliss, & Adams Tufts, 2016) | USA | Educational | Computer | School / Institution | Single player | Simulation | Work readiness | Effective | - | - | E | - | E | - | - | - | Tertiary | 56 | 3 month recruitment process, data collection in one day | An expertise questionnaire, a demographic questionnaire, facial expression recording, visual attention recording |
| RESULTS: Results showed higher performance scores in the simulation task from novice participants, in comparison with experienced participants. Participants of both conditions reported the animated agents as being realistic, helpful, engaging and credible. |
| (Rosas et al., 2003) | CHL | Educational | Handheld gaming system (Nintendo Gameboy Replica) | School / Institution | Single player | Mixture | ReadingWritingMathematics | Mixed | - | - | - | - | ND | E | - | E | Primary school age | 1274 | 3 months | Preferences survey, reading-and-writing pre and post test, mathematics post test, classroom observations via direct observation and video recording, survey of change expectations as post test for teachers of experimental group. |
| RESULTS: While there were no significant differences in aspects of Reading Comprehension, Math and Spelling between the internal control group and the experimental group, significant differences were found in those aspects between the external control group, and the experimental and internal control groups. Reports indicate an improvement in motivation, and confirms the experimental tool’s positive transfer. |
| (Ross, Hogaboam-Gray, & Hannay, 2001) | CAN | Educational | Computer | School / Institution | Single player | Puzzle | Computer skills | Mixed | - | - | - | M | E | - | E | E | Mixed ages | 221/ 147 | 2 months | Performance tasks, self-reported computer use, student enjoyment of computers, student self-efficacy scale, in Study 2 parents filled out a parent attitude towards instructional use of computers survey. |
| RESULTS: Reports show improvement in computer self-efficacy and skills, and greater computer use. Grade 1 participants experienced greater enjoyment of computers. Small-to medium size univariate effects were robust, for both grades and genders. |
| (Rotunda, West, & Epstein, 2003) | USA | Educational | CD-ROM | School / Institution | Single player | Quiz | Health | Effective | - | - | E | - | E | - | - | - | Tertiary | 73 | NA (20-30 minutes of gameplay per participant) | Knowledge test administered in-game after each module, anonymous post survey on the software and learning content |
| RESULTS: Participants had an increase in interest of the subject matter, and reported greater knowledge gains. Some students reported that the technology itself was dissatisfying. |
| (Rubino, Barberis, Xhembulla, & Malnati, 2015) | ITA | Educational | Mobile application | Specific location | Single player | Location-based RPG | History | Mixed | - | - | - | - | N | E | - | E | Mixed ages | 37 | NA | Questionnaire, semi structured interviews |
| RESULTS: The data log showed the mobile system to be more effective than a multimedia mobile guide. Results indicate that the digital storytelling game was compelling enough to combat reading fatigue, has significant learning potential, and was entertaining and enjoyable. The cultural contents were effectively communicated, and the use of the game lead students to explore the museum more widely. Players’ knowledge gains were mainly superficial. |
| (Rubin-Vaughan, Pepler, Brown, & Craig, 2011) | CAN | Educational | Computer | School / Institution | Single player | Puzzle | Health | Effective | E | - | - | E | E | - | - | E | Primary school age | 307/ 226/ 438 | Fall 2008 and Winter 2009 | Pre and post testing |
| RESULTS: Students’ bullying awareness and bullying prevention knowledge improved significantly. Students found the game engaging, enjoyable, and felt confident after use. |
| (Sabourin & Lester, 2014) | USA | Educational | Computer | School / Institution | Single player | RPG/ Mystery | Science | Effective | - | - | E | - | E | E | - | E | Secondary school age | 400 | NA | Pre test on science knowledge, the Big Five Personality Questionnaire, goal orientation, Cognitive Emotional Regulation Questionnaire, science curriculum knowledge test created by researchers administered pre and post play, post questionnaire of feelings |
| RESULTS: The results show that learning, engagement and positive affect promotion are supported in an educational game environment. Learning and motivation are positively correlated with positive emotions, and negative affect states are correlated with disengagement and distraction. |
| (Sadler, Romine, Menon, Ferdig, & Annetta, 2015) | USA | Educational | Computer | School / Institution | Single player | Simulation | Science | Negative | - | - | - | - | ND | - | - | N | Secondary school age | 1888 | While the project was run for 2 years, classes used the program during one unit of work, which differed in duration and scope between sites. | Pre and post testing of proximal and distal assessments, pre and post testing of the Student Interest in Technology and Science instrument |
| RESULTS: While neither computer condition nor narrative condition gained scientific interest, both groups significantly improved their biological content knowledge, as well as both showing similar results in time interaction as there was no significant difference. |
|  (Samsonov, Pedersen, & Hill, 2006) | USA | Educational | Computer | School / Institution | Single player and Group | RPG/ Strategy | Science | Mixed | - | - | M | - | M | - | M | - | Secondary school age | 29 | 12 session days | In-class and recorded observations, open-ended interviews |
| RESULTS: Over a third of students reported the game as being boring and frustrating, with most of these students having prior poor academic performance. The students who found the game engaging, enjoyable and intriguing were the students who completed all the tasks without assistance. These results indicate a correlation between prior academic standard and level of enjoyment. |
| (Sánchez & Olivares, 2011) | CHL | Educational | Mobile application | School / Institution | Teams | Mixture | Science | Effective | - | - | - | - | - | - | E | - | Secondary school age | 373 | 3 months | A structured, self-applied survey, a scale for the perception of problem-solving skills, a scale for the perception of collaborative skills |
| RESULTS: The experimental group got a higher score in problem solving plan execution, and reported a higher perception of collaboration skills, in comparison to the control group. |
| (Segers, 2006) | NLD | Educational | Computer | School / Institution | Single player | Interactive e-book | VocabularyLiteracy | Effective | - | - | - | - | E | - | - | - | Primary school age | 18 | 2 weeks, with a 1 month follow-up | Pre and post testing, The Active Vocabulary Task from the Dutch Language Test for All Children, the yes/ no vocabulary test |
| RESULTS: The children with special needs were equally attentive in both conditions. The experimental children demonstrated greater gains in experimental words, and positive effects on vocabulary growth was shown. |
| (Serrano Laguna, Torrente, Iglesias, & Fernanez-Manjon, 2015) | ESP | Educational | Computer | School / Institution | Single player | Puzzle | Computer skills | Mixed | - | - | E | - | ND | - | - | - | Tertiary | 44 | NA (one hour per group) | Pre and post testing |
| RESULTS: Gains in engagement, active attitude, and post-class practice was shown by students who played the game, with all gains being higher than the lecture group. While instruction in the game was effective, there was no significant difference in learning gains between groups. |
| (Shih, Shih, Shih, Su, & Chuang, 2010) | TWN | Educational | Computer | School / Institution | Teams | Adventure/ Puzzle | Problem solvingCollaboration | Effective | - | - | - | - | E | - | E | - | Primary school age | 4 | NA | Observations from an observation room, recorded observation, interviews, game path analysis |
| RESULTS: Findings reveal that effective learning for individuals occurs within collaboration, with participants’ cognitive performances improving when in a positive collaboration. Slow-achievers have the opportunity to take leadership in collaboration, as participants are inter-dependent in a group. |
| (Shrimpton & Hurworth, 2005) | AUS | Educational | CD-ROM | Clinical setting | Single player | Adventure | Health: Recovery from psychosis | Mixed | - | - | E | - | M | - | - | - | Mixed ages | 29 (14 interviewees, 15 focus group participants) | 1.5 hour interviews, 2 hr focus groups | Face-to-face interviews, focus group discussions |
| RESULTS: Pogo’s Pledge participants all voiced their strong support for the psychosis education intervention. The general feedback, however, indicated that participants believed the educational tool could be improved by changing the game induction, navigation, interface design, and a smoother integration of educational content into game play. |
| (Silseth, 2011) | NOR | Educational | Computer | School / Institution | Teams | RPG | Social issuesCollaboration | Effective | E | - | E | - | E | - | - | - | Secondary school age | 12 | 4 weeks | Video taped session for observation |
| RESULTS: Results indicate that educational gaming is most effective when students’ experience of games outside the classroom can be invoked within the classroom environment, and when teachers can accept the role of facilitator in order to collaborate with students. |
| (Sim, MacFarlane, & Read, 2006) | GBR | Educational | Computer | School / Institution | Single player | Mixture | Science | Effective | - | - | - | E | E | - | - | E | Primary school age | 25 | 3 days | Knowledge on 'Life Processes', 'Solar Systems' and a mixture in pre and post tests, observation, survey methods including participants ordering the games from most fun to least, and easiest to use to least |
| RESULTS: There was a correlation between observed fun and usability, and students successfully differentiated between software quality-related constructs. Learning was not correlated with usability or enjoyment. |
| (Sindre, Natvig, & Jahre, 2009) | NOR | Educational | Computer | School / Institution | Single player | Quiz | Computer skills | Mixed | - | - | - | - | M | E | - | - | Tertiary | 64 | NA | Pre and post testing |
| RESULTS: Perceived learning effect and motivation was reported and observed to be higher for students in the gaming condition. The same amount of time was spent on the learning activities across all conditions, with feedback being provided on potential improvement of complicated questions. |
| (Sisler, Brom, Cuhra, Cinatl, & Gemrot, 2012) | CZE | Educational | Computer | School / Institution | Single player | Adventure | History | Effective | - | - | E | - | - | - | - | - | Secondary school age | 71 | NA | Questionnaire, group interviews |
| RESULTS: For interest and engagement, the game’s concept was received well, and although comic and video styles were accepted, it is apparent that a 3D multi-player RPG would be the most appreciated style of game. Real story-based storylines were most preferred, with the most positive attitude toward the World War II period, but all time periods received a positive attitude from students. |
| (Smeets & Bus, 2015) | NLD | Educational | Interactive e-book | School / Institution | Single player | Interactive e-book | ReadingVocabulary | Mixed | - | - | - | - | M | - | - | - | Preschool | 136 | 4 weeks | Pre and post-testing with two vocabulary tests, and the Taaltest voor Kendren. |
| RESULTS: Overall, the story elicited strong treatment effects on vocabulary. Vocabulary gains were highest with the students who used the interactive animated e-books, followed by students who used the non-interactive animated e-books, and finally the students who used static e-books. Story comprehension was no affected negatively nor positively by interactivity or animations. |
| (Smith, 2012) | USA | Educational | Interactive e-book | School / Institution | Single player | Puzzle | Literacy | Effective | - | - | - | - | E | - | E | - | Primary school age | 40 | Two sessions | Post test on spatial questions about the stories |
| RESULTS: Students who used books with embedded games had significantly higher results on all questions, which included spatial questions, story items, and text-specific spatial questions. |
| (Smith et al., 2013) | USA | Educational | Interactive e-book | School / Institution | Single player | Interactive e-book | ReadingVocabulary | Effective | - | - | - | - | E | - | - | - | Tertiary | 57 | 2 2-hour sessions | Pre testing included a questionnaire plus Vocabulary Knowledge Scale. Post testing included questionnaire on perceptions of the computer games, and interviews. |
| RESULTS: Game scores were found to be significantly correlated with post-test vocabulary scores. Students in the game condition had significantly higher vocabulary gains than the control condition students. |
| (Squire & Jan, 2007) | USA | Educational | Augmented reality/ mobile | Specific location | Group | Augmented Reality/ Mystery | Science | Effective | - | - | - | - | E | - | - | E | Primary school age | 28 | Spring and Fall of 2005 (6 months?) | Observations, interviews, attitude questionnaire, science-related knowledge questionnaire |
| RESULTS: Scientific argumentation skills were developed in this study by using augmented reality games. These enabled by the game’s emotional engagement, promotion of responsibility, new participation that leads to new ways of thinking, and encouragement of scaffold thinking, as well as creating evidence to compliment argument. Collaboration was also important in scaffolding thinking. |
| (Suh, Kim, & Kim, 2010) | KOR | Educational | Computer | School / Institution | Multi- player | MMORPG | ReadingWritingListening | Effective | - | - | - | - | E | - | - | - | Primary school age | 302 | 2 months | A survey, English learning achievement test, motivation test, self-directed skill test, computer use ability test, game skill test |
| RESULTS: Higher scores for reading, writing and listening skills were found for students who were studying English in conjunction with playing MMORPGs, in comparison to the students in the traditional class. A student’s English learning achievement has shown to be positively affected by motivation, network speed, and prior knowledge. |
| (Sun, Ye, & Wang, 2015) | TWN | COTS | Mobile application | School / Institution | Multi- player | Puzzle | Science | Mixed | - | - | - | - | M | - | - | - | Secondary school age | 83 | Two weeks | Pre and post concept maps and multiple choice tests, prior game experience questionnaire |
| RESULTS: Both games successfully promoted physical concepts’ elaboration potential for students. Significant knowledge gains were shown for students who played Cut the Rope, while Angry Birds Space did not show significant learning gains. |
| (Sung, Hwang, & Yen, 2015) | TWN | Educational | Computer | School / Institution | Single player | Simulation | Health | Effective | - | - | - | - | E | E | E | - | Primary school age | 52 | A number of classes over approx. 5 weeks | Pre and post test on knowledge, questionnaire of problem solving, questionnaire of motivation, questionnaire on flow experience |
| RESULTS: Students in the experimental group showed gains in learning achievement, motivation, and problem-solving skills. The significant reciprocal interaction showed advance knowledge benefitting students with high motivation more than those with low motivation. |
| (ter Vrugte et al., 2015) | NLD/ BEL | Educational | Computer | School / Institution | Single player | RPG | Mathematics | Effective | - | - | - | - | E | - | E | - | Mixed ages | 145 | 200 minutes over 4 sessions | an arithmic test called Tempo Test Rekenen, domain knowledge test, post game perception questionnaire |
| RESULTS: As proportional reasoning can be demanding for prevocational students with low prior knowledge, who have also proven to have high resistance to learning, it is particularly noteworthy that proportional reasoning skills improved after playing the game. Computer fluency was crucial for improvement. No added value of the support was found, suggesting that the structure may have been too demanding. |
| (Tice et al., 2009) | USA | Educational | Computer | Specific location | Single player | Real-time data visualisation | Environmental awareness/ Nature appreciation | Effective | - | E | - | - | - | - | - | - | Tertiary | Not specified (College-wide awareness campaign) | Approx. 3 months (Spring of 2008) | Plug-load and lighting pre and post testing |
| RESULTS: The results of the intervention showed, in the common sense, significant reductions in electricity use compared to other systems. |
| (Tüzün, Yılmaz-Soylu, Karakuş, İnal, & Kızılkaya, 2009) | TUR | Educational | Computer | School / Institution | Multi- player and Group | Puzzle/ RPG | Geography | Effective | - | - | - | - | E | E | - | - | Primary school age | 24 | 3 weeks | Pre test school motivation test, post test game motivation test, pre and post achievement test, open-ended questions observations, informal interviews, recorded footage of gamplay classes |
| RESULTS: Students in the game condition showed more independence, less focus on getting grades, and achieved significant learning gains. While immersed in the gaming environment, students showed statistically significant higher motivation intrinsically, and statistically significant lower motivation extrinsically. |
| (Virvou & Katsionis, 2008) | GRC | Educational | Virtual Reality | School / Institution | Single player | Virtual Reality/ Adventure | Geography | Mixed | - | - | - | E | - | - | - | M | Primary school age | 50 | Between 5 and 8 hours spent on game play (variation depended upon student interest) | Interviews, questionnaires on useability and likeability |
| RESULTS: Results from writing tasks show improved achievement scores, voluntary writing increase, and decrease in teachers’ time spent attending to students with questions. |
| (Warren, Dondlinger, & Barab, 2008) | USA | Educational | Computer | School / Institution | Multi- player | RPG | Writing | Effective | - | - | - | - | E | E | - | E | Primary school age | 44 | Seven 'treatment periods' (school periods) | Pre and post testing |
| RESULTS: Results from writing tasks show improved achievement scores, voluntary writing increase, and decrease in teachers’ time spent attending to students with questions. |
| (Warren, Dondlinger, McLeod, & Bigenho, 2012) | USA | Educational | Augmented Reality | School / Institution | Teams | Simulation | Problem solving | Mixed | - | E | - | M | E | - | - | - | Tertiary | 89 | Duration of a subject in an undergraduate course: at least "a few weeks"; presumably closer to 10 | weekly student web log reflections, semi structured interviews with students, course evaluation scale, tech skills achievement pre and post test |
| RESULTS: Quantitative results show that students in the treatment group demonstrated greater improvement and statistically significantly higher satisfaction than the comparison course, but overall, collected results were generally mixed on measures of retention, achievement and satisfaction. |
| (Warren, Dondlinger, Stein, & Barab, 2009) | USA | Educational | Computer | School / Institution | Multi- player | RPG | Writing | Effective | - | - | E | - | E | E | - | - | Primary school age | 44 | 4 weeks | Observations, interviews, video recordings of gameplay sessions |
| RESULTS: Students showed improvement in writing skills, and a significant correlation between engagement and intrinsic motivation became apparent. In-game chat and an overly-controlled gameplay environment by the teacher negatively influenced the session. |
| (Watson, Mong, & Harris, 2011) | USA | Educational | Computer | School / Institution | Group | Strategy | History | Effective | - | - | E | - | - | - | - | - | Secondary school age | 98 | 1 week | Observation, focus groups, interviews, student's assignments for analysis |
| RESULTS: Activity and engagement from students were much higher as a result of the game’s implementation, as the focus from teacher-centered moved to student-centered. Some students even carried their discussion of gaming strategies and experiences outside of the classroom. |
| (Wilson et al., 2006) | FRA | Educational | Computer | School / Institution | Single player | Racing | Mathematics | Mixed | - | - | - | M | E | - | - | - | Primary school age | 9 | 5 weeks | Data analysis of in-game activity, observations |
| RESULTS: Positive feedback indicates the software had the versatility for different levels of knowledge and speed, students’ increase in mathematical confidence, an appreciation of the entertaining animations, deadlines, and sound feedback, and a satisfaction with rewarding elements. Children typically grew bored of the software after 10 hours of use. |
| (Wouters, Oostendorp, Boonekamp, & Spek, 2011) | NLD | Educational | Computer | Home | Single player | Puzzle | Science | Mixed | - | - | E | - | ND | - | - | - | Mixed ages | 29 | NA (works out to be 30 mins-1 hour) | Post testing of the curiosity questionnaire, open-ended questions for recall information |
| RESULTS: Results show that although the GDA-supported backstory did not produce significantly higher learning gains than the control, the experimental condition did inspire curiosity from participants. |
| (Wrzesien & Alcaniz Raya, 2010) | ESP | Educational | Virtual reality display | Specific location | Group | Virtual reality | EconomicsScience | Mixed | - | - | E | E | ND | E | - | - | Primary school age | 48 | One week including preparatory class, but 70 minutes playing on site | Pre test of biographical information, natural science and ecology knowledge test), post test of knowledge, and post test feedback questionnaire, observations |
| RESULTS: Students who experienced the serious virtual world were more engaged, had more intention to get involved, and enjoyed the class experience more than the traditional class students. There were no statistically significant differences in learning effectiveness between the groups. |
| (Yang, 2015) | TWN | COTS | Computer | School / Institution | Group | Simulation | Work readiness | Effective | - | - | - | E | E | - | E | - | Secondary school age | 68 | 27 weeks | Pre and post testing |
| RESULTS: The experimental group showed significant improvements in problem solving, critical and creative thinking, and academic achievement when compared with the comparison group. The comparison group was effective in encouraging creative thinking and knowledge gains, while the experimental group benefitted employment-related skills most by creating an accurate environment for the knowledge to develop. |
| (Yeşilyurt & Kara, 2007) | TUR | Educational | CD-ROM | School / Institution | Single player | Adventure / Puzzle | Science | Mixed | E | - | - | - | M | - | - | - | Secondary school age | 72 | 1 school term, including pre-tests, treatment, and post-tests. Actual gameplay was four 'class hours' of 45 minutes each | Pre and post testing using the genetic concepts achivement test, genetic concep test, biology attitude scale |
| RESULTS: Students’ biology attitude was significantly changed by the instructional program. The software positively affected students’ knowledge on biology, and produced an increased achievement from the experiment group’s students. Misconceptions remained present among experimental students after the use of software. |
| (Zheng, Young, Wagner, & Brewer, 2009) | USA | Educational | Computer | School / Institution | Multi- player | RPG | Learning and practicing English, for non-English speakers | Effective | - | - | - | - | E | - | E | E | Secondary school age | 4 (two American girls, two Chinese girls) | The chat log spanned over 10 weeks | Observations, interviews, analysis of game's artifacts (chat logs) |
| RESULTS: While successfully completing quests, participants demonstrated an intercultural collaboration, leading to the formation of meaning and identity, and a series of practices that were also enacted. Language used while navigating each action is what lead to meaning-making. |

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