Playing your way to competency

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Abstract

The use of computer games as learning tools is now commonplace, but how effective is their delivery? This paper explores the impact of narrative and gameplay elements on student learning outcomes when computer games are used as education and training tools and asks if interactive gameplay provides a more appropriate context in which to deliver information than the more commonly employed multiple-choice quiz interactive? Activity Theory has been used to analyse quantitative and qualitative data collected during trials of two computer based products - an interactive game and a multiple-choice quiz. Initial results of the research indicate that deep, sustainable learning is more successfully achieved when learners engage with content delivered within an interactive game based framework.

Introduction

The acquisition of any skill base is achieved by participating in activities and articulating ways of learning through which knowledge is developed, defended, and modified. Intrinsically, gameplay has these same characteristics. Computer games have the capacity to become important learning systems because they engage participants by making them active agents in their own learning rather than passive consumers of received knowledge. Game players adopt and invest in new identities through gameplay, thus allowing learners to take risks and imagine themselves in the roles they are training to achieve. Optimum learning that is deep and enduring is more readily achieved when it connects identity with authentic activity. Virtual learning environments can provide learners with a system of essential variables and interactions that can easily become obscured in real world situations.

The virtual environment or ‘game space’ has the potential to cultivate:

- a more intense and broadly based affinity group - bonded through shared endeavour, goals, and practices and not through shared race, gender, ethnicity or culture identities;
- the leveraging of knowledge from other people and from various tools and technologies; and
- the fostering of networks with multi-layered forms of communication.

(Gee, 2003 pp.192-193).

Games have the capacity to engage learners in activities that involve interacting with a variety of social, psychological and physical channels. Process-driven pedagogical systems based on experiential learning provide a more durable model of skills acquisition than content-driven systems, which tend to promote surface learning with learners recalling facts in isolation (Gee, 2005). This paper compares the learning outcomes from two types of computer-based learning tools with differing levels of narrative and gameplay. The results show that the activity generated by process-driven systems creates deep learning environments in which key content elements become placed within existing conceptual structures and provide learners with more durable and transferable knowledge and skills.

Literature Review

Activity Systems

When using game-based products players concentrate their cognitive resources on game moves rather than content (Lindley, 2005). Does this user-focus on strategic gameplay affect learning outcomes? In order to investigate this question an activity framework has been adopted as both an analytic tool for evaluating complex Human Computer Interaction (HCI) systems (Engestrom, 2000) and as a learning system that takes account of the interactions between the various contradictory forces that produce learning outcomes (Engestrom, 1993; Squire, 2002).

Activity Theory provides a theoretical language for analysing the learning outcomes of training games. The Theory illustrates how the effectiveness of any learning system is dependant upon the interplay of subjects and objects (Leont'ev, 1978, Engestrom 1993) (see Fig. 1). Game players can be perceived as subjects, and the game world

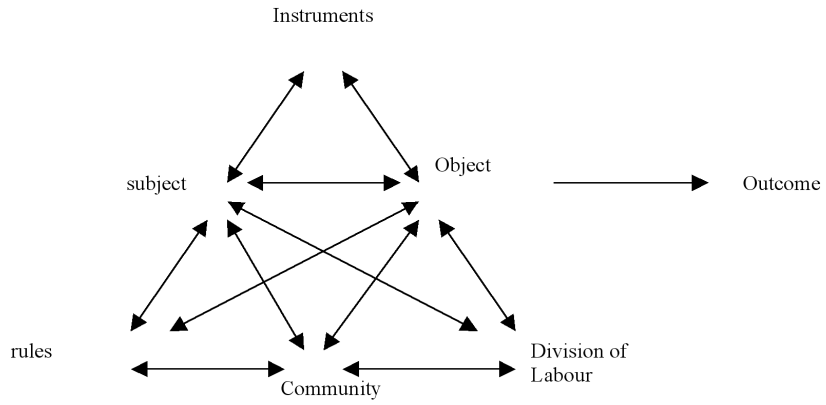

Figure1: ACTIVITY SYSTEM Based On Engestrom's Expanded Triangulation Of Activity

that they interact with, make decisions and effect changes in, is the objective cultural-specific environment. An Activity System allows for the interactions and consequent transformations of personal, social, cultural and technical elements within its boundaries (Squire, 2002). It represents the processes of learning as developmental transformations in the Vgotskian tradition, occurring through the interaction of contradictory variables within a dynamic system. This interplay of contradictions creates developmental transformations, which, in this case, are understood as learning outcomes. Activity Systems are capable of continual transformations, because any component's development will impact on the behaviour of other system components (Kaptelinin and Cole, 2002).

Activity theory also utilises the concept of the Zone of Proximal Development (ZPD)(Vygotsky, 1978), where the acquisition of new knowledge is dependant on its contextualisation with previous understandings and is scaffolded on pre-existing skills mediated by interaction with a tutor. Computer-aided learners must have an appropriate level of technical knowledge, as well as existing disciplinary and socio-cultural understandings in order to develop their learning. As existing skills are

required to scaffold new knowledge, learners and educators need to be games-literate in order for the delivery of learning activities via computer gameplay to be effective (see Fig. 2). Part of the difficulty games-based training products face in gaining acceptance is that the semantics, as well as the tools and actions, of gameplay can be unclear to the uninitiated. Educational developers, more skilled in traditional literacies, have accordingly marginalised computer game activities as 'timewasters' and playthings.

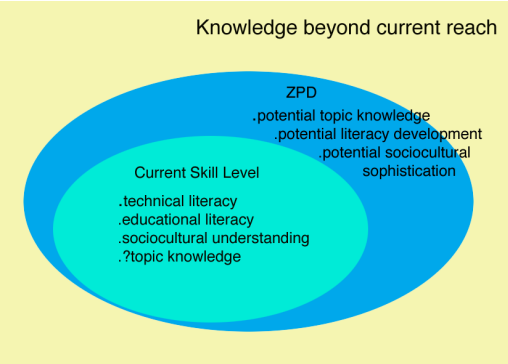

Figure 2: ZPD Factors Considered In The Design Of Educational Computer Games

Deep Learning

The activity phases of this research investigate whether deep learning is engaged by participation in game environments or if the substantial cognitive resources taken up by gameplay (Lindley, 2005) and the goal-focused orientation of computer games interferes with deep learning outcomes,

The rapid pace of technological and social change means that learners can no longer assume that specific skills will remain current. To achieve real competency learners must become capable of finding solutions to problems they have never encountered before. Deep learning is that which provides access to a series of skills and methods that equip learners to become effective problem solvers and information researchers, allowing knowledge to be adapted in new situations. The activity generated by process-driven systems creates deep learning environments in which key content elements can be placed within existing conceptual structures.

In process-driven learning the subject's immersion in the Activity System creates deep, sustainable learning. Deep learning is accessed through engaging in activity that involves interacting with a variety of social, psychological and physical channels. The system is transformed by the knowledge that the learner brings to it, even as the learner is transformed by interacting within the system.

Squire (2002) conceptualised the Activity System as one where subjects' interactions with physical or abstract objects are mediated by both tools (such as concepts, physical tools, artefacts or resources), and cultural context and occur within communities with whom the subject shares transformation of the object and mediates activity through division of labour and shared norms and expectations. The distinctions between sustainable process-driven systems and short-term content-dependent learning become apparent when learning methods and outcomes are evaluated in this way.

Narrative in Games

Although computer games are categorised as goal-orientated (Eskelinen, 2001), winning is often secondary to gameplay, especially when game moves (goal oriented actions in the game environment) are used as a way of exploring story. Gameplayers configure the game world by making decisions and taking actions. Game moves create narrative as much as the choice of a particular move is determined by the narrative's demands. Gameplay and narrative become components of the same semantic system. Gameplay moves with all their strategic and socio-cultural implications, become another component of the language through which narrative is constructed (Lindley, 2005) and can be undertaken as an interpretive as well as a configurative practice.

In entertainment games the constrained set of moves the player chooses from at any particular point of game play are commonly used for narrative purposes as well as providing player maneuverability. However, very few educational games contain this level of narrative sophistication.

Three game system semiotics: simulation, game, and narrative have been identified by Lindley (2005). Typically, education products have focussed on the game and some simulation elements. Anecdotal evidence suggests this is because educational developers believe learners might otherwise become lost in the narrative, concentrating their gameplay on achieving narrative-driven goals rather than on achieving the intended learning outcomes.

Fun in Games

Gameplay and it's connection with fun is a component of the Activity System that defines the learning domain in this research. Papert (1998) has described 'hard fun' as the enjoyment had from mastering hard and complex gameplay. Fundamental to the success of games is player enjoyment. If players do not enjoy the game, they will not play the game. In the educational context there are additional player motivations (Qu and Johnson, 2005) which need to be measured and tracked– these include the learners' desire for attaining educational qualifications. Fun or enjoyment can be defined and analysed by many different models. These include transportation theory which describes immersive experience (Green, Brock and Kaufman, 2004); disposition theory which examines player attitudes and empathy towards characters and actions in the game (Nabi and Krcmar, 2004); attitude, which is affected by the players' intentions and previous experience (Nabi and Krcmar, 2004) and social situations and parameters have also been identified as impacting on player enjoyment (Denham, 2004). These theories define fun in terms of one specific aspect or concept. Sweetser and Wyeth (2005) propose a gameflow model which consolidates the interactions and contradictions among these theories; consisting of eight core elements: concentration, challenge, skills, control, goals, feedback, immersion and social.

Methodology

This research involved students from the first and second years of the Advanced Diploma of Multimedia in the School of Creative Industries at Victoria University, Australia.

The research was completed in five phases:

1. Sourcing and creation of research products
2. Product use
3. Focus group discussion
4. Administation of test
5. Analysis of data

All phases involved the application of the principles of Activity Theory and triangulation of data. The Activity System described in this paper (see Fig. 3) is based on Engestrom (2000) and Squire (2002).

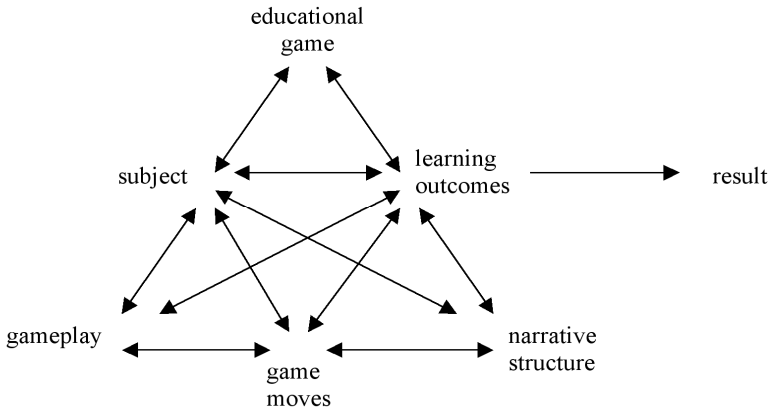

Figure 3: ACTIVITY SYSTEM for Bilby Project

In Phase 1, a game was sourced and a quiz was developed. The game was sourced from The Learning Federation, a federally funded educational game-development agency. Although simply constructed, *The Night of the Bilby* conforms to definitions of interactive narrative previously discussed by Frasca (2003), and Louchart and Aylett (2004). The second educational product, a traditional interactive quiz-type was then created to duplicate the factual content of the narrative game.

Quantitative and qualitative data were collected for this research during Phases 2, 3 and 4. Quantitative data were generated by subjects participating in one of two computer-based learning activities, the effectiveness of which was subsequently surveyed by the administration of a questionnaire consisting of multiple choice and open-ended questions. Qualitative data were collected during mediated focus group discussions and through observation of participants while they were undertaking the computer-based learning activities.

The research was designed with attention to the interplay of secondary contradictions following Engestrom's (1993) classification of primary and secondary contradictions in Activity Systems; where primary contradictions are those that occur within a component of a system; and secondary contradictions are those that occur between components of a system, for example: subject and game moves; or learning outcomes, subject and narrative structure (see Fig 3). In Phase 2, two different games were played by two groups of participants. The Activity System allowed for three component variables between the two games: the gameplay; the narrative structure; and the game moves, the other components remaining the same for both products.

In order to track the behaviour of the system's contradictions and to reveal how the variable components both interact with and manifest as learning outcomes, this research adapted Kaptelinin and Nardi's, (1997) Activity Checklist during the activity-focussed data generation phase and in subsequent analysis, with key attention to:

- The structure of the user's activities - how the gameplay facilitates /constrains successful learning outcomes;
- The structure of environment - integration of game design with narrative elements, gameplay and game moves;
- The structure and dynamics of interaction –interaction with the information and transformation through the game to knowledge gained; and
- Development - developmental transformation of components as a whole

Research design

Two computer-based educational products, a game and a quiz, were administered between 18 subjects. Each product contains the same information about the behaviour and habitat of the Australian bilby, however, they present their information in differing ways. The products differ in their narrative content and in the sophistication of their interactivity. The interactive game has the user playing the role of a bilby searching for food, avoiding predators and eating enough during periods of nocturnal activity to qualify for the task of finding shelter before sunrise. The quiz delivers this same content as multiple-choice questions, and although there are many educational

products of this form being identified as ‘games’ there is limited interactivity and no narrative structure. The interactive game delivers information via gameplay with the pressure of achieving strategic goals in a limited time. Text-based information is delivered in response to user’s actions during the game. The quiz is based on the content-driven, test-teach-test method of educational delivery. Players choose one of four responses to a given question and then click a button to check their answer. A correct response receives a congratulatory statement. Incorrect responses generate a statement explaining the correct answer.

Subjects were randomly divided into two groups, and were allocated either the quiz or the game to complete individually. Upon completion, subjects returned to their group and participated in a focused discussion on the positive and negative aspects of their experience. Subjects have had some experience analysing game-based products and were able to comment on user activity, the game environment, the level of interactivity, and interface design.

A test on bilby behaviour was subsequently administered to the two group approximately two hours after they had undertaken the game activity, with subjects identifying themselves as players of either the quiz or the game. Until this point subjects were unaware that they were to be tested on the games’ factual content and at no time had the opportunity to use the version they had not previously played, to ‘prepare’ for the test or even discuss their experience undertaking the game or the quiz.

The test consisted of 8 questions relating to information delivered in both products. The results of this test constitute the quantitative data of this study, represented in Table 1.

Qualitative data were collected from the discussions of the two groups, the whole group discussion, and observation of subjects while engaged in the activity phase.

Findings and Discussion

A two-sample 2 tailed t-Test with unequal variance indicated a significance value of *p=0.016* (see Table 1). A 95% confidence interval analysis of the quantitative data shows a significantly greater proportion of correct answers in the test from subjects who played the game version over those who played the quiz.

TYPE	N	MEAN	STD DEVIATION
Quiz	9	5.78	1.39
Game	9	7.22	0.67
F Test		p=0.052	
T Test		P=0.017	

Table 1 : Data set for answers on Bilby Test

An F-Test indicates the variance in the score results for the two educational products were significantly different which indicates the requirement for considering heteroscedastic 2 sample unequal variance in the t-Test.

Qualitative data also reveals that the level of specific detail given in response to open-ended non-multiple choice questions by the players of the interactive game was far more comprehensive than those supplied by the quiz respondents.

The players of the interactive game also more frequently responded to questions in their own words, rather than reiterating auditory or textual information delivered in the game. This was a particularly interesting outcome given Lindley's (2005) conclusion that during gameplay, "the performance of game moves consumes most of a player's cognitive resources." and when compared with Scouller's (1996, 1998) findings that students use surface learning strategies when engaged in multiple-choice format activities.

The results obtained from this study show that, in spite of the fact that the same information was delivered, the different formats caused subjects to employ different strategies in order to complete each learning task. Since the multiple-choice tests

required low-level cognitive processes, relying on memorisation and short term retention (Scouller, 1998), the improved retention of information in subjects playing the interactive game suggests that participating in narratological gameplay provides deeper, more sustainable learning and skills retention (Biggs, 1999). The secondary contradictions of the Activity System engaged in the use of the interactive game appear to effect learning outcomes because of their interaction with subjects' approaches to learning.

Interestingly, and in contradiction to the analysis, part of the qualitative data collected included negative comments recorded in focus group discussions, which indicated that participants thought the engaging gameplay in the game product distracted from learning information. One participant said that this version was "less educational" than multiple-choice quiz games. Subjects that played the interactive game indicated that it was enjoyable to play and observation of participants during Phase 2 indicated that this group were more engaged in the activity than the group undertaking the quiz. The participants playing the game version were more focused, intent on successfully playing the game and appeared to be having fun as well.

Users of the quiz version reported positive aspects as "no other distractions because of simple design" and "informative and full of interesting facts". Users of the interactive game described their version as "bright and fun" but called for "more text reinforcement".

Subjects playing the quiz version reported negative aspects including "insufficient feedback" and "no enticement to continue". However, the amount of informative fact-based feedback was no greater in the game version than what these subjects experienced in the quiz. What did differ was that the information in the game was delivered throughout the game environment and reinforced by players having to revisit specific information in the gameplay.

In spite of the perception within groups that the quiz seemed to be more focused on delivery of information, and that the game version was fun and not so focused on learning; it is observed from this study that learning outcomes, as well as user

engagement, are improved with the introduction of narrative elements and increased interactivity.

Conclusions

Analysis of the learning outcomes in this study showed that by making computer based training tools more dynamic and narrative-driven the learning process was indeed enhanced. The interactive game proved to be a more effective educational tool than the quiz. These results indicate that in computer-aided training better learning outcomes can be achieved by designing products that require users to apply increased cognitive resources to the acquisition of information through gameplay within a narrative framework than through a focus on the target content. These findings were interestingly at odds with the perceptions of the study's participants who believed that engaging in gameplay would conflict with educational outcomes.

The study indicates that increased interactivity and narrative structure in educational games will improve learning outcomes. Integration of game environments and gameplay into learning products has the capacity to heighten engagement for users and foster deep learning. However, it should be noted that usability remains a crucial issue in the development of any multimedia product. The subjects of this study were technically proficient multimedia consumers. In an educational context designers must ensure that the skill level of the user matches the skill requirements of the game. However, as technical literacy in the general population increases we should expect to see basic game moves become part of the learner's standard literacy toolbox. Indeed in some demographics we should already assume that this is so.

The heightened level of engagement, and narrative ownership through gameplay opens possibilities for computer games to become unique tools for education and training. Over the past decade, computer games have become increasingly sophisticated with the release of more complex products that draw more heavily on concepts of immersive worlds, fictive blocks, interactive story and massive multiplayer online communities. The educational games sector should be seriously considering the further development and integration of these features as learning tools.

This study explored the impact of narrative and gameplay elements on student learning outcomes when computer games are used as training tools. The promising initial results indicate that further investigation into the design and development of immersive training environments and an assessment of the optimal level of interactivity and complexity of game moves for satisfactory learning outcomes should occur. This study has indicated that deep learning is accessed by learners engaging with content matter within a games-based narrative context. This result suggests exciting possibilities for future collaborations between the VET sector and game design sectors.

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