Zombie Division: Intrinsic Integration in Digital Learning Games

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The past twenty-five years has produced a substantial body of psychological, educational and development literature highlighting the educational potential of digital games (e.g. Gee, 2003; Kafai, 2001; Loftus & Loftus, 1983; Malone & Lepper, 1987; Prensky, 2001; Reiber & Matzko, 2001). However, this enthusiasm is tempered by the recognition that the majority of commercial 'edutainment' products have been wholly unsuccessful in harnessing this potential to effective educational use (e.g. Kirriemuir & McFarlane, 2004; Trushell, Burrell, & Maitland, 2001). Whilst budget and market considerations have obviously contributed towards this gulf, theoretical contrasts are evident and their identification is both commercially and theoretically important. One of the earliest and most frequently cited explanations offered for the contrast between effective and ineffective educational games is that of intrinsic and extrinsic fantasy (Malone, 1980). This work used computer games as a platform for studying intrinsic motivation, highlighting fantasy as a key element of its motivational taxonomy of games. Malone (1987) defines an intrinsic fantasy, as one in which there is an integral and continuing relationship between the fantasy context and the instructional content being presented. Nonetheless, this is a concept that appears to have a confused standing within the literature. Whilst many works, such as Reiber (1996) and Dempsey (Dempsey, Lucassen, Gilley, & Rasmissen, 1993) cite the concept of intrinsic fantasy without reanalysis, others including Kafai (1996), Fabricatore (2000) and Prensky (2001) offer their own reinterpretations. Some works, such as Loftus & Loftus (1983), Driskel and Dwyer (1984), Parker & Lepper (1992) and Kirriemuir & McFarlane (2004) cite Malone's work in other respects, but do not address this fundamental aspect of his theory. Despite the apparent contention, the literature has not produced a critique of intrinsic fantasy. However, our own work has examined its theoretical and empirical foundations and concluded that it cannot be justified as a critical means of improving the educational effectiveness of digital games. Instead the roles of flow, representations and game mechanics have been highlighted as factors more likely to create effective integration of learning content within digital games.

Flow, core mechanics and representations

Research on optimal experience and flow was a central reference in the justification of challenges as part of the motivational taxonomy for computer games (Malone, 1981). Flow theory proposes that clear goals, achievable challenges and accurate feedback are required to achieve a state of flow in an activity (Csikszentmihalyi, 1988, p. 34). Feelings of total concentration, distorted sense of time, and extension of self are experiences that are as common to game players as Csikszentmihalyi's rock climbers and these seem to be at the root of the engagement power of digital games. Furthermore, these seem to be the very kind of experiences that are missing in the majority of edutainment products and could be a major factor in the distinction between extrinsic and intrinsic learning in digital games.

Whilst most game players would identify with flow experiences, it is unlikely that they would agree on which games provide them with the greatest sense of flow. Digitally induced flow experiences are now offered in the form of immersive adventure stories, strategic war games, physical dancing games, intense sports games and gory shooting games, to list but a few. The range of game genres provides a good example of why the emphasis on fantasy within games can be so misleading. Consider these three games all based around the same fantasy of being an army commander in a medieval battle: the first gives you first-person control of your commander, furiously fighting your way through the throngs of enemy soldiers; the second gives you strategic control of the battlefield, determining when your troops should advance and who they should attack; the third puts you in charge of training your army, making allies and managing the resources for the whole campaign. All of these examples could employ fantasies with the same storyline, the same characters and even the same imagery, but represent a spectrum of game genres that appeal to completely different audiences. The differences between game genres are not directly attributable to the fantasy of a game but the "mechanism through which players make meaningful choices and arrive at a meaningful play experience" (Salen & Zimmerman, 2004, p. 317) – commonly referred to by game developers as the core mechanics. Core mechanics are the procedural mechanisms of a game that provide the essential interactions required to create a meaningful gaming activity. So the core mechanic of Breakout is in controlling the horizontal position of one object in order to intercept another moving object and keep it bouncing around a confined space. Whether the game uses the fantasy context of a bat and ball or (as in a later interpretation of the game) a space ship and energy bolt, it makes no difference to the fundamental gaming activity – or the flow experience that it creates.

Malone observed that, "Endogenous fantasies can also provide useful metaphors for learning new skills […] , and they can provide examples of real-world contexts in which the new skills could be used" (Malone & Lepper, 1987). There is a long tradition of research exploring how information should be represented to best support learning. One point of contact with digital games is in research concerning representations that make key features of the domain explicit, particularly through use of visual features. Another is research that explores how including dynamic or interactive features can enhance learners' understanding. Visual representations can also enhance learners' metacognitive strategies encouraging them to make more productive use of materials and to learn complex topics more completely (Ainsworth & Loizou, 2003). Through employing visual representations in environments such as Microworlds and Simulations (de Jong & van Joolingen, 1998; Papert, 1980) learners can be encouraged to participate in interactive exploration of learning content (Miller, Lehman, & Koedinger, 1999; Papert & Talcott, 1997) and the links between these approaches and those employed by digital games are evident (Reiber, 1996). Whilst visual representations are often employed to aide understanding in edutainment software it is rarely possible for the learner to interact with them in an active way. All this research seems to suggest that educational games would be more effective if they have intrinsic learning content, which is represented within the structure and interactions of the gaming world, and provides an engaging metaphor for understanding and exploring the learning content.

Guidelines for achieving intrinsic integration in digital learning games

Based on my own theoretical analysis, the following design guidelines are suggested for more intrinsic integration of learning content in digital games:

1. Deliver learning material through the parts of the game that are the most fun to play, riding on the back of the flow experience produced by the game, and not interrupting or diminishing its impact.

2. Embody the learning material within the structure of the gaming world and the player's interactions with it, providing an external representation of the learning content that is explored through the core mechanics of the gameplay.

However, whilst this may seem to represent a better definition of intrinsic integration than intrinsic fantasy, there is still no evidence to suggest that such an approach would produce more effective learning. In fact, this definition actually makes it easier to see how a more integrated approach might produce less effective learning, as an intense state of flow is likely to inhibit the reflection required for metacognition and the acquisition of declarative knowledge. This may raise further questions about the type of learning material appropriate for intrinsic games and whether their true potential is in the proceduralisation of knowledge rather than its initial acquisition. These are just some of the issues that need to be empirically investigated before any useful conclusions can be drawn from the concept of intrinsic integration.

Zombie Division: An experimental evaluation of intrinsic integration.

The next stage of our research is to design an empirical study to investigate the relative effectiveness of intrinsic and extrinsic approaches in creating educational games. The Zombie Division concept integrates mathematical division strategies into the combat mechanic of a mathematics game for primary school children. This is a third person action adventure game in which the player must defeat skeletal enemies in hand-to-hand combat in order to progress. Enemies take the form of long deceased athletes from the time of Ancient Greece, who have risen from the dead to prevent the hero from completing his quest. As a result each enemy has a competitor number on their chest, which provides the key to defeating them in combat. Different attacks divide skeletons by different numbers and skeletons are only defeated if the attack will exactly divide their number without a remainder. Defeated skeletons break into smaller skeletons with appropriate numbers on their chests in order to reinforce this external representation of division.

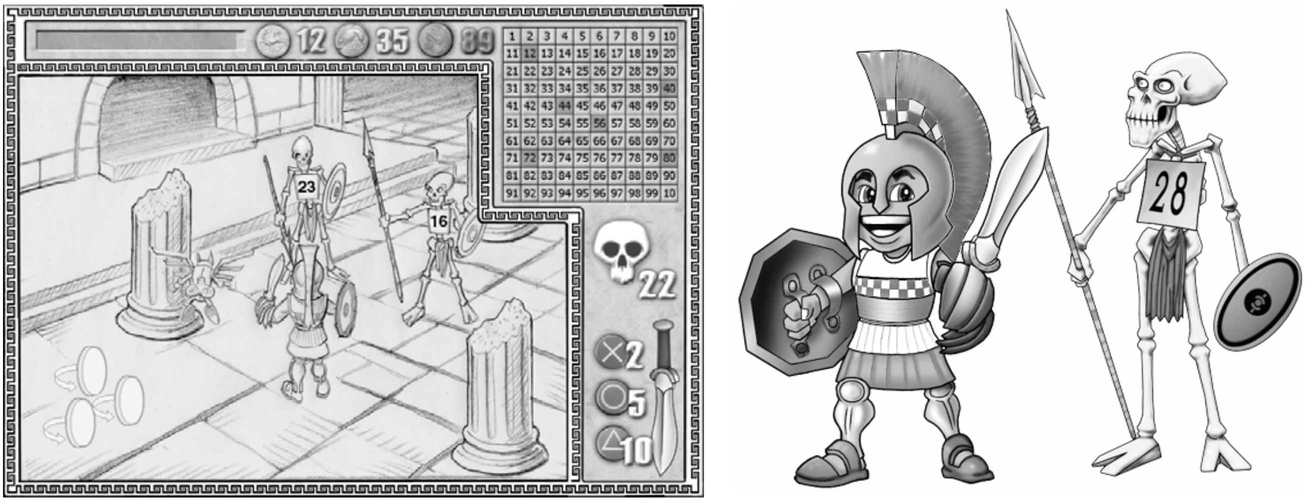

Figure 1: The Zombie Division Concept

The learning content will be augmented by a number grid highlighting the patterns and relationships between weapons and the defeated skeletons. There will also be mathematical relationships between the different attacks so, for example, chopping a skeleton once with a sword divides by 2, twice divides by 4 and three times divides by 8. All this should ensure that learning material is embedded within the structure of the gaming world and the player's interactions with it, providing an external representation of the learning content that is explored through the core mechanic [1]. Choosing an action adventure format with a strong emphasis on combat should ensure that it is a game that creates a flow experience for the target audience through exactly the same core mechanic that is delivering the learning material [2].

An extrinsic version of the same game would be produced for the purposes of the comparative study. Many considerations need to be made to ensure that it is truly comparable, and there are too many to go into here. However, broadly speaking this would be identical in all respects to the intrinsic version except that the numbers on the skeletons and their relationship to combat would be removed. In it's place the player would be drilled on the same mathematical content at the end of each level.

The first planned study using this software will compare learning outcomes given a fixed amount of time in the classroom. Process measures will be taken in addition to (pre and) post tests to compare the difference between transferable learning outcomes and learning outcomes in the gaming context. A later study is also planned to look at free use of the different versions without artificial time constraints.

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