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My Learning Assistant: Instructional Support in a Video Game

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Abstract

The use of games for learning is gaining traction in education, but there is still resistance from those who do not consider games as serious learning opportunities. The integration of e-learning and game design holds promise for overcoming these objections. One method of integration is to provide domain relevant content within the gaming experience. This paper examines such content integration within the Third Person Shooter, Immune Attack, and the instructional design issues relevant to taxonomical information presentation. A usability pilot study of Immune Attack was conducted, and the results support the importance of adherence to usability and information architecture principles in the presentation of learning content.

Introduction

People who enjoy video games may understand the sentiment in Marshall McLuhan's famous quote, "Anyone who tries to make a distinction between games and education doesn't know the first thing about either" (reported in Prenksy, 2007, p. 90), for there are intrinsic pleasures in learning to operate and manipulate difficult and complex game systems; and in the rewards inherent in becoming skillful within a games premise and story line; in addition to those found in the immersive experience of losing a sense of self in action of the game (Breuer & Bente, 2010). Yet there has been resistance to the use of games as vehicles of the type of serious learning addressed by university and business education (Prensky, 2007). The notion seems to be that the intrinsic rewards in acquiring knowledge and skill should be motivation enough, and therefore content needs no enrichment. That idea seems to make sense, but on closer examination we realize that every message delivered is embodied — it has a form — and (in another of

McLuhan's dictums), the form is integrated with the message (McLuhan & Fiore, 1967). Content designers should consider the form of the delivery, for learning may be shaped by the form of a message (Oppenheimer, 2008) as anyone who has enjoyed a presentation may understand. If video games are to be purposed to educational ends, the design of the activities that engage learners should adhere to the principles of sound instructional design (Hirumi, Appelman, Rieber, and Van Eck, 2010).

Recent examinations of video game design (Hirumi et al., 2010; Breuer et al., 2010) help provide an understanding of the ways games and education overlap, and the means for their successful integration. To create video games that are effective vehicles for learning, one first needs to understand those aspects of the art of game design that engage and immerse users and actuate the intrinsic rewards for gaining knowledge and skills through gaming activities; as well those of aspects e-learning design that provide instructionally sound mechanisms for engaging students in knowledge and skill building activities (Hirumi et al., 2010).

As students spend an increasing amount of time playing video games (Ogletree & Drake, 2007; Kirriemuir & McFarlane, 2004), the integration of entertainment and learning is important. Without an understanding of the relationships between the elements and principles of game and instructional design, the duality between serious learning and fun will likely remain in educators' thinking about game-based learning. When games potentially engage students for many hours, the distinction is an important one, and instructional designers need to provide learning opportunities, relevant to the learning domain, through the gaming experience in order for games to be considered useful.

Instructional Support in Video Games

There are different ways video games can be used in and with learning activities, and many types of video game systems, which include personal computer, commercial game console, and hand-held and mobile devices (Kirriemuir et al., 2004). Bruener and Bente (2010) categorize educational computer and commercial video games among the various forms of e-learning, which they use in the broadest sense as, "any type of computer-based learning," (p.10). e-learning system design involves user interface design, information architecture, and instructional design (Govindasamy, 2001), whereas the play aspects of video game design, much an art form, owes its principles to the entertainment industry's practices in audience engagement and audiovisual communications (Hirumi et al., 2010). Together, theses disciplines guide the possible effective uses of video games in education.

Ritterfeld & Weber (2006) define the intersection of video game play and education through three methods or "paradigms": Reinforcement, motivation, and blended. Several facets characterize each paradigm, the most salient of which is the role the game serves in the educational setting. In the reinforcement paradigm, game play is a reward for learning performance and usually targets drill and practice activities. In the motivation paradigm, some aspect of the game exposes the learner knowledge and "seduces" their interest, but which is not strictly necessary for successful game play. Examples of this use are war games that employ historical contexts as a framing narrative or back-story to game-play. The blended paradigm entails embedding learning directly in game-play activity such that the progress in the game is dependent upon the learners' acquisition of relevant knowledge and skills. Simulations exemplify this paradigm, when learning is necessary to successfully manipulate the games elements and factors, and in which learning pathways are not necessarily predictable.

Breuer and Bente's (2010) further define levels of game player interaction. Learning in and around video games occurs in three modes of activity: Sensorimotor, e.g. players learn to control the physical input elements and devices of a game system to be able act within a game's virtual context — its story line and premise; cognitive, e.g. players learn to modulate our virtual actions within a game's context in order to successfully to manipulate game elements to some end; and meta-cognitive, e.g. we learn to modulate a game system, to change or extend a game, to create new game elements, aides, cheats, and scenarios.

Games used in education may be complex enough that they are employed in more than one paradigm and involve multiple levels of activity. Thus, a First Person Shooter (FPS), in which players view a virtual 3D world through the eyes of a game character, simulating WWII combat may stimulate acquisition knowledge of events during WWII through it's back-story in the motivation paradigm, while at the same time employ the blended paradigm by requiring knowledge of specific WWII era weapons to compete successfully within the FPS virtual activity. WWII information resources may be only loosely referenced in the narrative, while weapons information will likely be provided through in-game mechanisms such as window overlays. In the same FPS, sensorimotor activity is required to engage in the virtual game system controllers — for example to manipulate weapons, and to move within the virtual landscape. Cognitive activity is necessary to compete within a scenario in which the player is placed — for example, the skill necessary for a player to become oriented within the game's in the virtual landscape, and to determine where the enemy is hiding. Meta-cognitive activities include those that allow players to enhance the gaming experience by trading virtual weapons with other players, or by creating new scenarios and landscapes.

One means of joining learning and gaming in the blended paradigm is to provide references to domain specific content within the game itself (Breuer et al., 2010). Such reference mechanisms, often found in the form of window overlays, are used to make game rules and play instructions accessible in commercial games and alleviate the need for players to consult a separate manual or text by presenting content in situ, when and where in the flow of gameplay such information is necessary. In the preceding FPS example, information detailing available weapons might be displayed using pop-up window. In-game references provide the possibility of a higher level of learning content integration by keeping players engaged in the gaming activity context. By integrating learning content within the learning environment activity, student motivation may be enhanced, and in specific learning contexts, where content directly impinges on problem solving, extraneous cognitive load may be reduced (Van Bruggen, Kirschner & Jochems, 2002).

We studied the integration of instructional content, presented to players through an in-game reference, in the game, Immune Attack (2010). Immune Attack (IA) is a Third Person Shooter, a variant of an FPS, where instead of viewing gameplay through the eyes of game characters, an overhead perspective view of the characters is provided. IA is designed to introduce immunology to high school and first year university biology students. Students use IA to embark on a Fantastic Voyage style mission through the immune system, piloting a miniature drone through a 3D representation of the human circulatory system. The game-play goal is to aid the immune cells in overcoming invading pathogens by targeting pathogens with the drone's weapons. IA employs a blended learning paradigm where progress within the game is dependent on player's acquisition of immunology specific concepts that are presented through the in-game reference. Knowledge gained through the reference guides the cognitive activity necessary for

players to identify which immune system functions and pathogens are important in order to proceed through successive levels of game-play. IA was created in 2004 (Kelly, Howell, Glinert, Holding, Swain, Burrowbridge, & Roper, 2007). IA 2.0 is currently under development through an NIAID research grant (Immune Attack, 2010), and the opportunity to contribute to IA's development was presented in a Human Computer Interaction doctoral seminar.

My Learning Assistant

Our research group chose to examine an instructional support system within IA, called My Learning Assistant (MLA) (Figure 1), from an information navigation and usability perspective. MLA is similar to the help systems we commonly find in computer applications: In IA, content in MLA is delivered within IA game play in a context-sensitive popup window. When a student clicks on a game object (e.g. pathogen or blood cell), the flow of student's FPS activity within IA is paused and an information window appears with details about the object. The player can either close the window and continue playing, or click on the window to view the MLA. In the MLA, information about the selected object is displayed using text and media elements. The MLA is a multifunction window sporting a collapsible, taxonomical hypertext menu of game elements and concepts in one window pane; detail information about the selected item in a second pane; together with a glossary. Students can select other game objects from the menu and FPS play remains paused until the MLA is closed.

[INERT FIGURE 1 ABOUT HERE]

FPS game play is meant to be an immersive experience in which players feel themselves to be in the imaginary world represented in the game (Nacke & Lindley, 2008), caught up in the measures they initiate and execute as they manipulate the games elements and controls in a psychological condition called, flow. Flow describes a mental state in which players derive

intrinsic rewards from their involvement in the activity required to successfully participate in the game (Nacke & Lindley, 2008). In IA, players experience flow through the actions necessary to pilot the drone in order to hunt down invading pathogens. The flow experience is a motivator for people who play video games, however because flow involves a state of absorption in performance and action, declarative knowledge that is not intrinsic to that activity is delivered externally.

FPS games use windows such as the MLA are used to provide game related learning that is not embedded in the cognitive activity of student's player's flow. Because the appearance of the MLA in IA causes a break in users flow, it is important that the mechanism used to display information about the immune system's cells, functions and processes, represents that content in a fashion that reorients the player from the previous flow state of cognitive activity (Hirumi et al., 2010). One aspect of this orientation is the degree to which the presentation and usability aspects of the information in the MLA window helps to reorient the user from a flow mode to the new and more semantically involved cognitive state necessary to process the textual information in the MLA. Our group conducted a pilot study to explore users' sense of place within the domain knowledge structure, or information space of the taxonomy, and MLA information usability, as a measure of this reorientation process.

Classification of concepts is an important learning activity (Gagné, 1965). Hierarchical lists are useful organization aides because they present classification schemes in visual form. They facilitate learning which concepts are related by their spatial placement within a representation of hierarchy. Computer users regularly encounter such lists in the form of outlines, taxonomies, directories and cataloging systems, tables of contents, indexes, and hypertext menus. In video games, such systems are used to convey information related to the

game (e.g. the game, Civilization, the Civilopedia). The classification schemes represented visually in these lists provide important information about organizational relationships of the hierarchically related concepts (Furnas, 1996). When viewers are able to place a given concept within the hierarchy, information is revealed about relationships to parent, sibling and child concepts. Systems that assist viewers in finding a given concept help to establish a sense of location or place within the information space presented. Similar to the, "You are here," icon on a mall map, hypertext systems mark the current concept or page by highlighting it on a menu, site map, or navigation bar, helping to orient the user within the system's organization. We might conclude that a sense of place would be important to learning with hypertext systems; however, the usefulness of such navigation aides with respect to learning has been debated. Navigation features in hypertext systems that instill a sense of place by marking current and past items visited have been seen as important usability issues (Conklin, 1989; Johnson-Eilola, 1998), but navigation usability is an indicator of the navigation mechanism's efficiency and user performance in the information space, rather than the system's instructional efficacy (Dillon & Vaughan 1997).

Pilot Usability Study

The central hypothesis of our research design was that a sense of place is essential in instances where users do not explicitly navigate through the information space by, for example, clicking directly in the MLA's taxonomical menu, but rather arrive at a detailed description of particular concept or principle through their actions in the FPS activity of the game. Because, for the student, flow is broken and they are thrust into a different mode of cognitive activity, using navigation cues to mark the current concept's place in the domain's taxonomies will, in such instances, facilitate students' ability to understand the taxonomy by making it more quickly

usable. A MLA style window, so designed, would reduce the resultant cognitive load in the reorientation process. An analogy is found in book design, where we place chapter numbers and titles at the top of each respective page. It is a way of saying "you are here" — navigation cues in MLA style content representations help orient students mental model of the information space within the cognitive structures we would like them to acquire. In this type of interaction, navigation cues facilitate learning by making it accessible.

The design of our pilot study was crafted to first collect demographic and prior knowledge data; then to observe individuals follow a set of tasks while using IA's MLA window; followed up with exit interviews to record qualitative impressions and comments; all administered in a usability laboratory. Five participants were recruited from a midwestern university. The participants were all graduate students, between the ages of 25 and 40. Two were male and three were female. All were competent using technology and all but two had played a FPS before, but only casually — none were active FPS game players. Users were briefly trained to click on a cell to elicit the MLA while in FPS mode of the game. Each participant observed as they followed a script of seven information retrieval and navigation tasks (Table 1) using the MLA's hypertext list, item detail and glossary windowpanes. Participants' actions were recorded using the interaction tracking software, Morae. After they completed the tasks, the exit interview was conducted. Data was analyzed for mouse usage and MLA interaction, and the follow up interview videos were transcribed, inter-rater coded, and analyzed for common themes. The themes that emerged were categorized into those that related to the MLA taxonomical menu: Navigation cues and interface usability; those that related to the MLA glossary use; and those related to information multi-media representation.

Results and Analysis

The participants in our pilot study were largely concerned with the ability to access information presented in the MLA. Four of the five participants thought the default view of the taxonomy items should be in alphabetical order, and thought the current item being viewed was difficult to locate within the taxonomy for that reason. Three were concerned that the list was taxonomical too long and, "the concept list should default to collapsed," though one contradicted this observation and preferred the list default to expand all items. One participant thought, "We should be allowed to alphabetize the information and organize it differently." Three participants asked for a search feature, so they would not have to scroll through the taxonomical representation in order to find a concept. Three participants commented on the integration of media elements in the descriptions of game elements accessed through the MLA, and the value of multi-media to supplement the textual information presented for each game element. Two participants noted the separation of image and information windowpanes (see Figure 1), and commented that they could be merged into one pane so that the text describing the image was closer to the image. One participant preferred the glossary windowpane functionality, but noted it did not contain the same list of concept as the taxonomy. Three participants mentioned the graphical images of the cells gave no sense of the size the cell relative to others, and could use some graphical marker or ruler to indicate cell size.

All participants highlighted problems with MLA interface usability. Two participants thought the font used (see Figure 1) to display information was too small and difficult to read. Two participants thought the level of list indentation needed to be larger, and found items taxonomical representation, "unclear as to what it category belongs to." Three found that the only way to scroll the taxonomical list was to, "click on the arrows to scroll," and could not use the mouse scroll-wheel or drag scrollbar thumb to scroll the MLA display. Four of the five

participants were interested in knowing the current item's location in the taxonomy when the MLA first opened: They wanted to locate the current concept or game element being viewed within the taxonomy, as well as marking previously visited list items. They thought, "highlighting the active item," and to "know what information I have already read," would be helpful in navigating the information presented in the MLA window – "I was unable to tell where I had been, would be helpful to have it in a different color if already visited." One suggested a help screen, on "how to use the MLA," was necessary.

Discussion and Conclusion

Because the sample size was small, we are limited in the conclusions we can draw, but the information we gathered points to the importance of applying usability and information architecture principles, which are important aspects of e-learning systems design. Participants commented on information organization and presentation more than any other aspect of the MLA. Providing flexible information organization (Rosenfeld & Morville, 2002), to the design of an MLA style information delivery mechanism would allow users to navigate the information space on their own terms. Moreover, the data shows users' apparent need for a sense of place in easing the cognitive reorientation necessary in the shift to the semantic knowledge acquisition activity of the MLA, in navigation of the information. Disorientation within structured information is a common user interface issue (Melguizo, Van Oostendorp, & Juvina, 2007), and visual cues in software navigation mechanisms constitute information scents that provide users with the visual feedback necessary to discover the semantic relationships of navigable items (Lawrance, Bellamy, Burnett, & Rector, 2008). The shift from FPS to MLA activities appeared to bring user awareness of place within the MLA taxonomical menu the forefront, and further

study is necessary to understand the problems of such cognitive shifts in activity and how they might be lessened and integrated seamlessly within interactive learning environments such as IA.

Elements of learning content integration are already employed in commercial game design (Hirumi et al., 2010) and in the entertainment industry: Motion picture arts have developed mechanisms for purposefully focusing attention from one scene to the next using different types of transitions and cuts. Video games likewise employ visual transitions between game modes to prepare players for the ensuing activity. The instructional design of content delivery systems in games, such as IA's MLA, sometimes use declarative, semantic representations of knowledge with supportive multi-media elements (e.g. graphic images — see Figure 1). These types of help systems and online glossaries of terms and definitions, concepts and processes, are valid instructional supports, they are only as good as the cognitive change they facilitate in the learner. IA attempts to facilitate learning in Ritterfeld & Weber's blending paradigm, by requiring that the knowledge gained through the MLA's descriptions of the various immune system cells, proteins, and the pathogens they target, are necessary to successfully advance to subsequent levels within the game. MLA content is intrinsic to game-play progress, but its presentation mechanism needs to adhere to best practices in usability and information architecture. The melding of instructional and entertainment design disciplines, detailed by Hurumi et al., will help ensure information presented in MLA style mechanisms support the game's blended learning design efficiently and effectively.

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[FIGURE 1]


Immune Attack
MY LEARNING ASSISTANT
Self
immune system
white blood cells
monocyte
How do monocytes exit the blood vessels?
Where do monocytes exit the blood vessels?
What happens once a monocyte exits the blood vessel?
Game tip
macrophage
neutrophil
lymphocytes
mast cells
What do mast cells do?
circulatory system
connective tissue
chemical signals
macromolecules (self)
selectins
ICAMs (Intercellular Adhesion Molecules)
Non-Self
Bacteria
Pseudomonas
Staphylococcus
Salmonella
Viruses
What are mast cells?
A mast cell is a resident cell of several types of tissues and play an important protective role in wound healing and defense against pathogens.
GLOSSARY

[FIGURE 1 CAPTION]

Figure 1. MLA displays the hypertext taxonomy in the left windowpane; the selected concept detail on right – text above and image below; and a glossary button at the lower left.

Figure 1
Common.Links.ClickHereToDownloadHighResolutionImage

Caption for Figure 1

Figure 1: MLA displays the hypertext taxonomy in the left windowpane; the selected concept detail on right; and the dual function glossary button in the lower left.