Development of an Extensible Game Architecture for Teaching Transcultural Nursing*

Hiba Wehbe-Alamah, PhD, RN, FNP-BC, CTN-A, Michael E. Farmer, PhD, Marilyn McFarland, PhD, RN, FNP-BC, CTN-A, Alec Tower, BS, Miyako Jones, BS, Vidhin Shah, and Joyce El-Hayek, BFA

1 Department of Nursing, School of Health Professions and Studies, 2 Department of Computer Science, Engineering Science and Physics, and 3 Department of Visual Communications, University of Michigan-Flint, Flint, MI.

Abstract

Video games have been shown to assist students in learning course content by making learning fun which improves learning and content retention. Video games provide a number of interesting tools for educators, including integration of a broad range of content and allowing the dynamic presentation of material to match students’ needs. Developing video games, however, is time consuming and potentially expensive. In this paper the authors describe a game framework based on an extensible architecture that allows faculty to regularly download new content as well as allow the game to be used across multiple courses and even multiple subject domains through a custom-built editor application which presumes no knowledge by the instructor of computer programming or esoteric computer languages. This system has been used to develop a game to teach Transcultural Nursing to undergraduate students at the University of Michigan-Flint Department of Nursing.

Keywords

transcultural, game, Leininger

Introduction

Research has shown that motivated students learn better and have greater long term retention of information. Some of the characteristics of a motivated learner are that they are enthusiastic, focused, and engaged (Garris, Ahlers, & Driskell, 2002). Computer games are a creative teaching strategy to enhance the students’ motivation which will then enhance learning and problem solving. Some benefits of computer games are: “they immerse users into a world, they are interactive, engaging, and fun... and they provide instant feedback” (Fasli & Michalalopoulos, 2005). Another important aspect of games for education is that they must strike a balance between fun and educational value (Moreno-Ger, Burgos, Martinez-Ortiz, Sierra, & Fernandez-Manjon, 2008).
The authors of this paper developed a computer cultural simulation game called Culture-Copia©, which was designed to make learning about transcultural nursing and cultural competence interesting, stimulating, and fun. The game provides immersion of the student in a variety of settings which would be challenging to provide in the real world such as rapid moving between classrooms, hospital rooms, patients at home, and other contexts. The general objectives of this project are: 1) to foster digital-based engagement and cultural competence learning through the use of educational computer gaming, 2) to promote customized culturally diverse learning experiences, 3) to promote long-term memory and transfer of transcultural care knowledge for application to clinical nursing practice, and 4) to increase student motivation to learn about culturally competent care.

While improving motivation, another key objective of this work was to not overburden the instructor or require a level of computer competency above what their profession would normally require. In the case of health-based games our assumption is that the instructors have no programming knowledge and no knowledge of esoteric computer science topics such as the Extensible Markup Language (XML) which is popular for easily transmitting user-defined data between computer systems. Also the goal was to develop a game environment that could be adapted through content changes to other life sciences domains such as cellular biology.

**Background of Games in Healthcare Education**

Originally the focus on healthcare related to video games was in relation to the health hazards, however there has been a significant change in direction and video games are becoming more commonplace as educational and training aids (Kato, 2010). Numerous games have been developed for healthcare education such as Oncology Game for cancer patient care, Pulse!! and Burn Center for triage and disaster scenario training, as well as games for pediatric care training (Kato, 2010; Sward, Richardson, Kendrick, & Maloney, 2008). Additionally video games are playing an increasing role in areas such as health education, physical education, and physical therapy (Kato, 2008; Papastergiou, 2009). Clearly there will be a broad range of educational and entertainment value across all of these games.

As stated by Wong, et al. “the assumption is that there is a relationship between entertainment (enjoyment) and education (learning)” (Wong, et al., 2007). The challenge of game developers is to balance the fun with the educational aspect. Interestingly, Moreno-Ger, et al state: “different designs found in the field seem to have an aim that is usually biased towards fun or educational content (Moreno-Ger, Burgos, Martinez-Ortiz, Sierra, & Fernandez-Manjon, 2008).” The concept of fun is of course not universal and depends heavily on the target audience. The CultureCopia© game is directed towards nursing students and is based on real life experiences. For example, the nursing faculty found that nursing students derived great pleasure from competing against each other to raise money for various charities. This concept was therefore incorporated into CultureCopia© where student players are presented with opportunities to earn money for faux charities by correctly answering questions.

Lastly, one interesting aspect of games is that “role playing also helps players develop their sense of empathy, or understanding the feelings and viewpoints of different people” (Kato, 2010). As will be shown in the following section, this makes video games ideal for teaching transcultural nursing.

**Transcultural Nursing**

Transcultural Nursing (TCN) refers to a discipline of study and practice that focuses on comparative culture care similarities and differences among and between cultures with the purpose of assisting human beings to attain and
maintain meaningful and therapeutic culturally based health care practices (Leininger & McFarland, 2006). Transcultural nurses, who function either as specialists, generalists, or consultants, draw on their education and field experience to provide competent and safe care to people of diverse cultural backgrounds (Murphy, 2006). Their refined assessment and analytic skills are central to planning, implementing, and evaluating culturally congruent nursing care practices (Andrews & Boyle, 2008).

Transcultural Nursing is a relatively new formal area of inquiry and practice that was established in the mid-1950s by Dr Madeleine Leininger, a visionary nurse anthropologist (Murphy, 2006). As a mental health nurse, she observed the effects of cultural beliefs and practices on nurses’ and patients’ perceptions of health or illness (Andrews & Boyle, 2008). Her doctoral study in anthropology gave birth to the earlier versions of the theory of Culture Care Diversity and Universality, the Sunrise Model (currently known as the Sunrise Enabler), and the ethnonursing research method. Today, thanks to the efforts and dedication of Dr. Leininger and other transcultural nursing scholars, transcultural nursing has been recognized as an established field of study whose importance increases as the world becomes closer, smaller, and increasingly multicultural (Murphy, 2006).

As geographical barriers continue to have a diminished influence due to increased immigration, travel, and internet use health care providers will increasingly come into contact with and care for patients from diverse cultural backgrounds. A lack of awareness of cultural beliefs and practices of patients may lead to cultural misunderstandings, cultural pain, cultural clashes, cultural imposition, stereotyping, client dissatisfaction, distrust, and lack of adherence to nursing/health care plan. On the other hand, when health care providers demonstrate cultural sensitivity and perform the appropriate cultural assessment needed to plan and implement culturally congruent health care practices, trust establishment between the practitioner and the patient will be enhanced. In addition, client satisfaction and adherence to nursing/health care plans will be increased.

**Overview of the Architecture of CultureCopia©**

The basic video game architecture being presented in this paper has three core components, (i) main game, (ii) module editor, and (iii) web-server database as shown in Figure 1. The main game is the core component which comprises the actual game engine and all the content for each specific course for which it is being used.

Figure 1: Architecture of the CultureCopia© video game.

According to Gentile and Gentile, games should (Gentile & Gentile, 2008):

- include clear objectives, at multiple levels of difficulty and should adapt to the prior knowledge, skills and pace of each learner
- require learning to be active with practice
and feedback to the point of mastery

- result in knowledge and skills being over-learned so that they become automatic
- include both intrinsic and extrinsic motives
- present activities in video games in levels of increasing difficulty, complexity or pace, with skills at lower levels prerequisites for higher levels
- encourage a close-to-optimal combination of massed and distributed practice
- result in knowledge and skills being learned and practiced in many different ways with several problems and examples across a variety of contexts.

Another useful taxonomy for understanding the development of an educational video game has been proposed by Aleven, et al which consists of three key components that must be addressed: (i) Learning objectives, (ii) Mechanics/Dynamics/Aesthetics (MDA), and (iii) Instructional design principles (Aleven, Myers, Easterday, & Ogan, 2010). The basic idea of the learning objectives of the game are the same factors faculty consider when developing traditional course material; student prior knowledge, desired knowledge students should learn, and additional skills that may transfer into other areas of learning. As these are common topics for any course development they will not be discussed further here.

The MDA aspects of the video game address the basic behavior of the game and the experiences encountered by the user, and their resulting level of enjoyment of the game. As developing a video game from scratch is a daunting exercise, the CultureCopia© team decided to loosely base the MDA aspects on an existing game, namely the Nintendo game “Ever 17” by Hirameki International Group Inc., shown in Figure 2. It was a very simple yet popular video game. In this game the basic mechanics include a stationary background scene and a foreground avatar. At the base of the screen is the rolling text of the dialog. The authors modified the structure slightly and provide a typical frame for the game in Figure 3. The main deviation made in the game was to not have the text overlaid on the image as it was felt that for a learning game, this would become tiresome for the player and may negatively impact the learning objectives. All of the specific frame types for

Figure 2: Ever 17 video game for Nintendo which served as the MDA motivation for CultureCopia©.

Figure 3: The basic narrative frame of CultureCopia© demonstrating its MDA aspects.

Hello everyone and welcome to the first module of our class, Transcultural Health Care. I’m your instructor, Dr. Hiba Wehbe-Alamah. I am a family nurse practitioner and a certified advanced transcultural nurse. I am originally from Lebanon but I was born and raised in Kuwait. I was educated by French nuns in Catholic schools in Kuwait and Lebanon even though I belong to the Muslim faith. As a result, I speak Arabic, French, and of course English. I attended the American University of Beirut in Lebanon and transferred to Saginaw Valley State University in MI where I finished my BSN and MSN. I earned my PhD with a focus in transcultural nursing from Duquesne University in Pittsburgh, PA. I am married and have 2 children. My research focus is studying the care beliefs, values, and practices of people from diverse cultures.
the Main Game will be discussed in Section 5.

While CultureCopia® game is not highly interactive, neither was the “Ever 17” game, and as Wong has found: “In contrast to the widespread belief that interactivity is a crucial factor in media based learning, [their] findings cannot confirm the assumption (Wong, et al., 2007).” In the current prototype, the avatar is drawn into the frame as shown in Figure 3, but the XML files and the Module Editor have been designed with a pre-planned improvement to have separate graphics files for the background (the wall and chalkboard in Figure 3), the foreground (the desks in Figure 3) and the avatar. This will then allow an animated avatar to be easily inserted as more art students are available to draw a moving mouth and arms.

One key factor within the MDA component is the dynamics of how the game player will navigate through the game. This is based strongly on the computational model which for most games can be characterized as state transition systems with the actions of the player resulting in a sequence of state transitions ultimately resulting in the reaching of one or several end goals (Moreno-Ger, Burgos, Martinez-Ortiz, Sierra, & Fernandez-Manjon, 2008). In CultureCopia® this is accomplished through the Module Editor where the instructor defines the next game frame to which the user advances based on their answers to questions in the current frame. Correct answers and incorrect answers will result in differing paths through the game to try to reinforce the learning. Frames that are purely informational result in a single defined flow to a subsequent frame. The key benefit of the Module Editor is it presupposes no special computer knowledge of the users, including but not limited to programming languages and state machines.

**Main Game**

The main game provides the entire infrastructure to support the display of all of the game content, as well as provides frames for adding new users, downloading new content, uploading and viewing grades, and selecting the charity for which the student is raising money. The game was developed in FLASH using ActionScript 2.0 (Deehan & Armstrong, 2005).

All of the frames currently available in the game and their navigation can be found in Figure 4. Note the core frame is the Main Game Frame. This frame actually does not have any visible display to the user, but rather is responsible for parsing the XML and providing the content to the content display frames, which consist of a Narrative Frame, a Video Frame, and three question frames: Multiple choice, Sorting, and Matching. The game play begins with the Game Splash Frame shown in Figure 5. Once the user logs into the system, their navigation through the various content modules occurs at the Bookshelf Frame (see Figure 6) where the user selects the learning module they wish to complete. This content will be managed throughout the semester by the instructor who will upload additional content modules which will then appear as additional books on the stack in the bookshelf.
All of the content is provided via an XML file which is developed by the Module Editor. The XML template for the multiple choice question is provided in Figure 7. The XML refers to image, audio, and video files through the appropriate fields such as ‘bgImage’, etc. Notice also that for questions, the instructor provides feedback for both correct and incorrect answers, and can define the navigation based on the student’s correct or incorrect answer through the ‘correctNextFrame’ and ‘wrongNextFrame’ XML fields.

Based on the frame order that the instructor defines using the Module Editor, the XML file is parsed and the user is guided through the various content frames. The Narrative and Video Frames (see Figure 3 for the narrative example, where for video frames the avatar is replaced by a video screen) provide the traditional lecture style learning content, while the three types of questions (see multiple choice, sorting, and matching which is shown in Figure 8) provide an active learning mechanism. Notice that to add interest and some animation, the background switches from the view of the instructor for narrative and question feedback to the view of the students in the classroom for questions (to signify the instructor is waiting for their response).

The instructor through the Module Editor also has the ability to direct whether feedback (see Figure 9) and correct answers for the match-
Let us try something new. How about we try to match some terms to their definitions? Here we go:

- a) A scientific area of study & practice in nursing based on people’s cultural care differences & similarities to promote cultural congruent care.
- b) The scientific study of the origin and behavior of man, including the development of societies and cultures.
- c) A common set of beliefs, values, and shared understandings and patterns of behavior of a specific group of people
- d) The most rewarding profession.

Transcultural health care starts with becoming aware and sensitive to the cultural differences and similarities that exist among and between cultures; the next step is gathering theoretical and evidenced based knowledge; and the third phase is using the combination of the first 2 steps into clinical practice and, of course, this will be an ongoing quest.

continually providing feedback to the student.

Upon completion of the module, the user is directed to the End of Module frame (see Figure 10), where their total score is revealed, a brief motivational comment is provided, and their earnings towards their charity is shown. At this point in the game, the student may either repeat this module or complete another module by navigating back to the bookshelf, or they may go to their grade book which provides the scores for up to three attempts per module (see Figure 11). The score is stored as a Shared Object which is the only mechanism FLASH has available for storing information locally (Deehan & Armstrong, 2005). The game...
engine saves the score and date for multiple attempts at playing a module. Also being saved is the student’s user information such as their first and last names, username, and password. The shared object saves a hash map of all this information. Figure 12 shows the database tables for the data saved in the shared object. A network name (user name) points to a hash map of all of the student’s information. The modules key points to an array that holds each module number, which holds each attempt (which holds the date and score of the attempt).

The game is currently structured so that the

Figure 12: Structure of Shared Object.

XML and all the supporting game content, such as images, audio clips, and video clips are stored on the users’ local machines and downloaded when the user selects the ‘Get Updates’ button on the Splash Frame. This decision may be reconsidered at a future time, but was considered optimal in order to ensure timely system response under all network conditions, and more importantly also to allow the students to play the game without being on the network or to never lose the results of a game due to network loss since many times the nursing students may be doing homework where network connectivity is not allowed, such as at the hospital.

One additional benefit of video games over traditional classroom learning is the ability to immerse the student in an environment that would be difficult to provide in the real world. In CultureCopia© the student has the opportunity to visit patients in their hospital rooms and other organic settings which could not possibly be replicated in a classroom setting include living rooms in patients’ houses, park settings, and other contexts.

**Module Editor**

The role of the module editor is to provide an easy to use tool for the instructors to provide content into the video game. Rather than requiring instructors to know either XML or a programming language as required in other games such as seen in (Fasli & Michalalopoulos, 2005), the Module Editor allows any instructor with basic computer skills to be able to develop academic content for the game. In addition to supporting development of all the material in the game for any of the frame types, the module editor provides a preview feature to allow the instructor to see the content exactly as it will appear in the game. It also allows the instructor to easily view and modify the flow of the game from frame to frame since thumbnails for each frame are provided on the left side of the module editor (see Figure 13). The order of the frames can then be easily modified by using the

Figure 13: Question content screen for module editor.
were encouraged to use I-Clicker response system simultaneously with CultureCopia®, which added another layer of interactivity and allowed for immediate visualization of student feedback. It also opened the door for additional discussion of comparative answers. Some student feedback include: “I learn best when using my senses, this game helps me remember information that I have seen, heard, and experienced” and “This is a fun way of learning new material; I like that I am working both independently and collectively with my classmates to achieve an objective (raising charity money), when I am actually learning new information and applying it at the same time.” Interestingly, of the four provided options for selection of a nursing charity for which students earned money by answering questions correctly, the students seemed to always select the Nursing Students Stress Relief Fund as their charity of choice! This anecdotal finding may warrant further observation and study of stress level experienced by students enrolled in nursing programs.

Summary and Conclusions
The authors have developed a highly extensible game framework based on Flash and XML with a Java-based instructor tool for rapidly and easily creating and modifying content. The game architecture provides an interesting and entertaining environment for learning. CultureCopia® adopted a popular game paradigm from early Nintendo gaming, which does not require intensive animation but rather relies on high quality still frame images with modest avatar animation. The game provides immediate feedback to the students as they play to facilitate higher quality learning. The authors believe the game establishes a proper balance between fun and educational value. The Module Editor allows any faculty with only normal computer literacy to develop content which makes the game easily adopted by faculty in a variety of disciplines. The initial CultureCopia® game was developed to teach transcultural nursing and is in
parallel being extended with additional content frame types to support teaching cellular biology to both secondary school and college students. Initial application within the classroom setting revealed a need to address some technical aspects to improve game structure and use. It also showed that student users seemed to enjoy and benefit from existent game structure and content. Additional studies are needed to explore full potential and limitations.

References


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Original Team

Second Team

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