Polyglot Cubed: The Design and Implementation of a Multi-Language Learning Game

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ABSTRACT

Polyglot Cubed is an educational game to facilitate the learning of multiple languages. It is designed to entertain while enforcing language listening comprehension. The modular language learning game system works interchangeably with a variety of languages. The game relies on a matching mechanic intended to balance comprehension based language recognition with a simple gameplay mechanic. The game is an implementation of theories in motivation, education and entertainment. It takes as its motivation academic critique of existing educational video games and in particular pursues those areas where educational games fall short of the needs of post-secondary learners. This document outlines the research, design, implementation and fundamental evaluation of the educational video game.

Categories and Subject Descriptors

J.5 [**Computer Applications**]: Arts and Humanities– *linguistics.*

General Terms

Design, Human Factors, Theory

Keywords

Entertainment and education, educational video games, language learning software

1. INTRODUCTION

The primary goal of the Polyglot Cubed game is to provide a general audience with a way to learn basic vocabulary for planned foreign language immersion. The game is designed to assist people who are planning a trip to a foreign country, a visit with foreign language speakers, or other standard situations in which a few common vocabulary words will be useful. The game is not intended to be a complete resource for learning a language. It does not teach syntax or contextual cues, which, depending on the language and situation, may be very important.

As such, Polyglot Cubed is similar to the variety of language learning tools designed for quick study of a language. Some of the most popular tool of this nature are the Berlitz book series and subscription based language learning podcasts. The majority of these systems balance a reading lesson with a guided audio listening session. The game seeks to extend the experience of these systems into the entertainment domain, making the experience of a casual video game educational.

Polyglot Cubed is a matching game designed around 6 rooms of floating, cubicle tiles. Each tile is assigned a foreign language word, and a pictographic representation of that word. The cubes are clustered by topic, usage, or form of speech to encourage contextual recognition and aid visual memory. The player must match the spoken word with the cube that corresponds to it. When the player has matched a word and its image correctly, the cube becomes a piece of an unfinished image in the room. When the player collects enough matches, the image is completed. In analogy, as the player collects words their understanding of the language becomes more clear.

2. Background

The impetus for developing Polyglot Cubed comes from a few common observations about many educational games. The following sections describe these observations:

Many Educational Games Are Focused on Children and Blended Environments

According to several researchers, more than 75% of educational games are focused on children [1]. While it is generally accepted that educational experiences in games are facilitated by blended classroom experiences [2] it is also true that not all people interested in learning have access to classrooms and instructors. This group includes the large number of adult learners who are not currently engaged in any formal curriculum.

Polyglot Cubed seeks to address their needs by providing an extensible learning environment that supports learner-directed educational practice for an audience inclusive of adult learners. In short, the game seeks to support the adult learner's intrinsic motivation and capability to work with little guidance [3].

Some Educational Games Allow Educational Goals to Interrupt Immersion

In the design of some education-oriented game designs the learning objective is tacked on to an existing entertainment strategy in haphazard ways. These typically result in an awkward coupling of game-goal with educational goal [4]. It is also results in an uncomfortable experience where gameplay may be interrupted by testing or other tasks not directly related to the game's goal. Both of these tendencies are anti-immersive, divorcing players from the enjoyable experience of the game [5].

Polyglot Cubed seeks to directly couple game goal with learning goal. For the game players, failure to recognize vocabulary means failure to succeed in the game environment. It also allows players to move freely about the virtual space, choosing the types, content, pace, and goal of the lesson they receive.

Many Educational Games are Mini-Games

Many educational games are designed as a kind of mini-game [6]. These mini-games typically scale learning objectives down to one or two more easily assessed objectives. For some educators, these micro-games are palatable, easily understood and easily tied to specific classroom competencies [7]. A typical language mini-game may only teach the vocabulary of numbers or the parts of a face for example. This one dimensional educational model often requires the learner to mix and match games to complete their fundamental objective of learning a language. Polyglot intends to provide a complete collection of specific learning objectives in a single game.

Many Educational Games Lack Aesthetic Style

Perhaps as a product of their target learning audience, funding, or access to aesthetically-oriented game designers many educational games fail to offer a visual presentation that encourages adult, immersive play. This is not to say that the pursuit of photorealism or highly detailed worlds bolsters the quality of a game. Instead, as "there is no reason that good learning games couldn't similarly appeal to players while embodying aesthetics that differ from the mainstream game industry" [8]. Polyglot Cubed pursues a distinct monochromatic aesthetic and conceptual visual space. It incorporates fundamental concepts in balancing color cues with anxiety reducing visual contrasts.

3. Implementation Design

Polyglot Cubed is designed around a few elementary assertions about a successful learning tool. These claims, supported by researchers, are illuminated in the following sections. They serve as the design tenets for the implementation of the game and the basis for the evaluation of its success:

Provide Simple Game Mechanics

Like a good game, a good learning environment facilitates goals while offering progressive challenge. It does not distract from the goal, but instead seems to constantly refocus the learner toward their objective. As such, the game provides one of the simplest game mechanics in traditional and digital games, matching. As a game mechanic matching two elements is the primary goal in many card games, board games and their digital equivalents. It is easy to learn, easy to implement and provides a transparency that allows players to move toward higher order cognitive skills [9]. In short it works toward that balance of challenge and relaxation, ludologists call flow.

Require Language Understanding to Complete In-game Tasks

In concert with providing a simple matching game mechanic, Polyglot cube marries the in-game task of matching images to language recognition. The player must listen for a word, and match its spoken meaning to its pictographic equivalent. In a controlled study, Yoshi and Flaitz observed that combining text and image proved more potent in aiding vocabulary retention than either element on its own [10]. It is hoped that similarly combining textual, auditory and pictographic cues will aid players of the Polyglot Cubed tool.

Provide Educational Value without Requiring Additional Resources

Many educational video games rely on extra-game resources to supplement the learning experience. This extra game resources include books, websites, or other elements outside the game environment. Games of this type follow a kind of field-trip model, where previous reading or classroom experience informs the environment they are visiting. While this may prove a successful model, it does not support students whose education is fully facilitated by the educational game.

To balance these varied learning situations, Polyglot Cubed provides three learning modes. The first of these modes is a practice mode, which allows the player to explore the environment without penalty. In design, the player can initiate a self-directed learning situation within the tools environment and without any prior knowledge of the foreign language.

Exploit Repetitive Actions to Encourage Practice

Contemporary educational theory in language learning dictates that repetition is highly beneficial in the acquisition of vocabulary [11]. The model around which Polyglot Cubed is played employs repetitive tasks, randomly organized, and consistently evaluated. This is expected to aid in the retention of vocabulary and potentially inspire flow in game players [12].

4. Development

4.1 Prototypes

The game was developed in stages to test specific approaches to its design challenges. The first of these iterations included paper prototyping, in which a player was asked to identify one of three drawings based on an announced word. The second iteration was implemented as a website offering a timed quiz-like competition. Each round of the game required the player to identify a photograph that best matches the word spoken. In this second prototype, players could reveal the English translation of the word spoken, but in so doing they would be penalized several seconds on their timed evaluation. Both of these prototypes were implemented using Spanish as the foreign language. They were tested with English speakers in an informal environment.

After analysis of the two prior prototypes, a 2-dimensional digital prototype was created. This prototype was meant to evaluate the concept of a constantly expanding vocabulary visual represented by an increasing collection of words. In this third prototype, virtual balls rolled slowly across a plain. Each ball contained a symbolic equivalent of an acquired foreign language word. As the player succeeded in matching spoken words to their symbolic compliments, the number of balls increased. Similarly, the limits of ball's rolling were increased. The goal was environment that represented in analogy the increasing lexical resources of the player.

4.2 Final Design

From these prototypes, a final implementation was derived. In its current implementation Polyglot Cubed incorporates the general benefits of its predecessors. The game provides the player with a collection of six context driven areas represented as rooms in the 3D virtual environment of the game. The game is navigable via a 2D graphical user interface, keyboard and joystick using standard

game control schemes. Players can choose to play the game in one of three modes:

Practice: requires no prior foreign language experience and allows the player to explore without penalty and without time constraint. Practice mode is an exploratory mode.

Timed: requires the player to match words, but penalizes the player for wrong matches or failure to find a word in time. The vocabulary is limited to the player's current room.

Incremental: requires the player to match words, penalizes them for wrong answers, and linearly increments the vocabulary from the first room through the sixth room based on correct matches. This game mode is also timed.

Polyglot Cubed is designed to be user-modifiable. A modification tool was developed to facilitate the creation of new vocabulary sets for language learning. The modification tool allows users to substitute the images and sounds that constitute the games lessons. The modification tool is a separate, stand alone application authored in Microsoft's Visual Basic .Net.

4.3 Implementation

Polyglot Cubed was implemented against Direct X for the Microsoft Windows XP and Vista environments. It executes at a minimum resolution of 640 x 480 and requires 500 mb RAM. The game is typically played using a tablet or touch screen computer, but it supports mouse, keyboard and joystick driven input.

For testing and demonstration, Polyglot Cubed was implemented in Mandarin Chinese. For both versions there are six rooms, divided by language use group. The six areas are:

- Basic Introductory Language: Greetings, numbers, and politeness
- Transportation: Directions, modes of transportation and location identifiers
- Eating: Food types, allergies, and requests
- Verbs: Tense and most common verb uses
- Shopping: Sizes, articles of clothing, and currency
- International: Nationality and immigration concerns

4.3.1 Gameplay

At the start of the game, players are offered a setup and start screen that allows them to choose their play mode, screen resolution and input device. Once selections are made, players begin the game in the first room, basic introductory language. Players can steer the camera to alternate rooms at any point during gameplay. In all but the incremental game mode, moving to a new room will change the vocabulary being learned. A player can prompt the game to repeat the match word by tapping the repeat key or an empty space in the environment. The game continues as the player moves through the virtual space, sliding between orbiting pictographic cubes and matching spoken words to their image equivalents. When the player correctly matches, the cube moves to the edge of the room and contributes to a picture being assembled. The player is also supplied the English language equivalent of the word the have matched. Dependent on game mode, the game ends when the picture is complete.

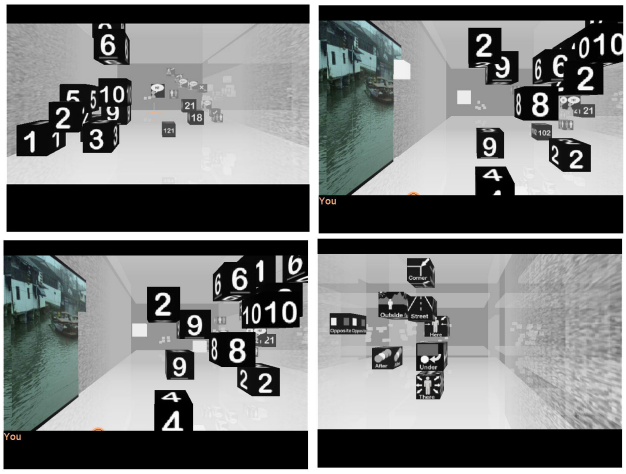

Figure 1. Gameplay

4.3.2 Mandarin Chinese Test Implementation

Mandarin Chinese was selected as the first language for which Polyglot Cubed was implemented. The language was chosen for its popularity, relative absence in the universe of language learning video games, and growing interest among native English speakers.

The Mandarin Chinese vocabulary was chosen by comparing linguistics accounts of the 500 most common words used by English Speakers and Mandarin Chinese speakers as identified by several linguists. As illustrated in figure 2, this list was then compared to common language learning resources for fast acquisition of basic skills. Finally, the list was shared with Chinese Language instructors at the University of Illinois, Chicago (UIC), USA. From this list, 200 words were chosen for their frequency in everyday language, their application in multiple situations, and the ease of creating a symbolic reference image.

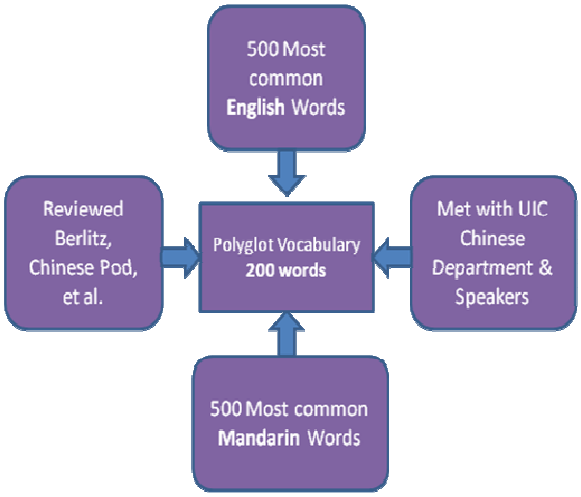

Figure 2. Resources for vocabulary

4.3.3 Pictograph Design

For each of the 200 words a pictograph was designed. The design of these pictographs was informed by research in symbolic language conducted by the American Institute of Graphic Designers [13] and Western conventional pictographs. 150 original pictographs were designed and implemented for the Mandarin Chinese version of Polyglot Cubed. Figure 3 illustrates a few of these original pictographs.

Figure 2. Sample pictograph images from game

There were approximately 50 pictographs for which no reliable precedent and no physical analogies could be constructed. In such cases, the pictograph applied an abstract conceptual visualization of the word in question. To improve comprehension, the abstract conceptual visualizations were supplied with the English-language word below them. Relevant vocabulary for which an abstract visualization was necessary include the words vegetarian, use, was, which and very. Often, the solution for such words also included pairing and contrasting two pictographs (e.g. is and was).

5. Future Work

The game has been displayed and informally evaluated at a variety of venues including Michigan State University's Meaningful Play conference in 2008 and a submission to the Independent Games Festival in 2009. The Mandarin Chinese and Portuguese language versions have been provided to players through other venues including Internet, conference and classroom distribution. As an educational game, the projects rests in the sometimes uncomfortable space between commercial products and academic inquiry. It is the researcher's goals to pursue the academic potential of this design and implementation in the hopes of furthering investigation in educational game development.

The Polyglot Cubed learning environment is currently being tested by a variety of students in traditional colleges and self-motivated, non affiliated students of language. The game will be evaluated for its educational efficacy in the coming year. As with most language learning evaluation the evaluation of a tool's effectiveness may take substantial amounts of time to complete. It is the hope of the researcher that additional language lessons can be constructed for the environment. Coupled with a controlled educational efficacy evaluation, the future of Polyglot Cubed rests in its ability to effectively teach foreign language vocabulary.

6. Conclusion

This document is meant to provide a survey of related language learning research, design theory and an sample implementation of the application of these theories. As with complimentary research in educational video games, this document seeks to outline a proposed solution to a very complex challenge, providing language education through a video game. It is hoped that this overview of the design influences, educational theory and resultant implementation provide future researchers with perspective on methods of addressing the challenges of creating educational entertainment in language acquisition.

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