

Teaching Japanese through Game Mechanics: An exploratory study

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ABSTRACT

The goal to design a game that is both educational and enjoyable can present some unique challenges. Using effective educational methods can sometimes conflict with good design strategies for creating an enjoyable game. Kanakatana is an exploration into using procedurally generated content in foreign language learning role-playing-games (RPG). It was designed so that its most important mechanics leverage similarities between learning a new language and playing an RPG. Through using specifically procedural content generation, the authors are able to create a game that detects the progress of the learner and automatically increase to more advanced levels based on prior performance. A 21-person user study shows that although less than 50% of the participants self-assess as having learned any Japanese by playing Kanakatana, their own post-game assessment performance suggests that 68-72% did in fact learn.

General Terms

Design, Human Factors, Languages.

Keywords

Procedural content generation, Japanese, Learning.

1. INTRODUCTION

Kanakatana is meant to teach Japanese through the mechanics of an RPG. There are several methods to teach a second language from, a traditional classroom based approach to an individual learner using a form of technology (book, language learning device, or computer) [1]. Kanakatana attempts to explore the overlap in experiences between playing a role-playing-game and studying a second language and use this area of overlap to actually teach a language while still retaining the appeal of a game that focuses purely on entertainment. The primary design philosophy for Kanakatana is to build its mechanics within these areas of overlap so that the game's mechanics support both of these goals. For example the game uses procedurally generated groups of enemies to both keep gameplay fresh and to encourage players to practice learning kana that they do not understand well.

2. GAMEPLAY

In Kanakatana, the player explores randomly generated levels from a top-down perspective while the player uses kana based abilities to combat enemies and searches for more kana. Players use the mouse to move their character on screen and use the keyboard to activate abilities. To use an ability, the player presses a key associated with a kana. This causes the player to hear that kana vocalized, and a word that begins with that kana to appear on the screen. The kana that spell the word appear scrambled, and the player must use the number keys to select the kana in the proper

order. Doing so causes an ability associated with that word to activate. For Example, いなずま(inazuma) means "lightning." When the player selects the い kana, the word いなずま(inazuma) appears on screen with the relative positions of the kana randomized. If the player selects the kana in the correct order to spell いなずま, Lightning will strike at the location of the mouse cursor (Figure 1). When players enter through portals, a level layout is randomly generated, and it is then populated with a variety of enemies based on how frequently and effectively the player has been using their abilities. Once players have gathered all available kana, they gain access to a boss fight, which is designed to be more difficult, requiring players to be able to identify their kana rapidly.



Figure 1. Kanakatana Screen

3. DESIGN DECISIONS

3.1 Grinding and repetition

RPG games will often be designed in a way that leads players to grind, repeatedly revisiting the same content [2]. Sometimes this is for some steady growth in power, or a slim chance to obtain something powerful. In a similar fashion, foreign language learners are expected to endure great amounts of repetition.

Though this can be arduous, this repetition is vital to learning a new language [3].

3.2 Player abilities

One of the key ideas of Kanakatana is that the players' ability to act is restricted by their recognition of kana. To use an ability, the players must learn to associate the sound of the kana to its appearance. Making effective use of these powers is necessary to succeed in Kanakata. Use of abilities is meant to be inherently rewarding, encouraging the player to better learn these kana. It also means that the player's learning progress can be continuously monitored, rather than intermittently tested [4].

3.3 Power

In many RPGs, players' powers increase by finding new items or fighting enemies [2]. In Kanakatana, this still holds true, but the items that players find are kana that unlock new powers. As long as the gameplay is enjoyable, and powers are fun to use, finding more powers will be rewarding to players. The game rewards them with more power if they find new kana with which to interact. In doing so, players are intentionally exposing themselves to more kana, which means more to learn. The reasoning behind putting the kana in the world as physical objects is to encourage the player to expose themselves to new kana when presented with the opportunity, so that interacting with the kana is a choice they consciously make.

4. BACKGROUND

In this paper, the authors focus on digital game-based learning, as defined by [5] as "any learning game on a computer or online," as opposed to computer-assisted language learning, which more broadly includes any use of a computer to assist in language learning. We review some existing projects with similar goals to our own below.

Project LRNJ: Learn Japanese RPG, developed by Darrell Johnson, teaches Japanese using RPG gameplay. Players see hiragana, katakana, and kanji on screen and must type the equivalent romanji to attack the on screen enemies. Although the contents of the game are not procedurally generated, the player's capability to recognize kana is considered when selecting what kana or kanji to display next. It also tests the player's familiarity with Japanese by having enemies take action based on time, encouraging players to become very familiar with the kana and kanji they are learning [6].

KOE is an RPG in development that uses communicative language learning. Players use abilities associated with particular words in Japanese, and gain access to these words as they interact with objects in the 3D game world [7].

Crystallize differs from the previously mentioned games in that it is not an RPG game, but simulates being immersed in a modern context where Japanese is used. Players are challenged to express a certain idea in Japanese but they must be exposed to an NPC who speaks the word to gain the ability to speak it themselves. Players also have a speaker level that must be increased to pass specific puzzles, and raising their speaker level requires revisiting old vocabulary, reinforcing its meaning [8].

The motivation behind using digital games as a medium for teaching a foreign language is Krashen's [9] Input Hypothesis, in which he states:

We acquire, in other words, only when we understand language that contains structure that is "a little

beyond" where we are now. [...] We use more than our linguistic competence to help us understand. We also use context, our knowledge of the world, our extra-linguistic information to help us understand language directed at us. [9]

Much like a language learner would rely on gestural cues from an instructor or illustrations in a textbook, digital games provide a wealth of extra-linguistic information. They do so primarily in the form of environments and non-player (computer-controlled) characters which, when combined with the sounds, animations, and interactivity of a digital game, provide a rich context for language learning without overwhelming the learner.

In addition to his Input Hypothesis, Krashen's Affective Filter Hypothesis [9] is also relevant to the discussion of digital games for language instruction. He cites three factors that often determine the success of a learner in becoming proficient in a foreign language: motivation, high self-confidence, and moderate anxiety. These attitudes, Krashen claims, are optimal for learning, and he goes on to say, "Those whose attitudes are not optimal for second language acquisition will not only tend to seek less input, [...] the input will not reach the part of the brain responsible for language acquisition." An instructional tool, then, that can motivate the learner with an engaging experience and minimize anxiety by keeping penalties for failure low may thus provide an ideal setting for optimal learning [10].

More recently, as mentioned in [11], games have been studied as a language learning tool for multiple reasons, including adding "interest to what students may not find very interesting." The authors in [11] list additional reasons for games as compelling language learning tools, including providing meaningful context to content. Some of the listed benefits could be seen as related to Krashen's Hypotheses, such as improving learning by reducing anxiety.

Beyond investigating potential benefits of using games to teach language, principles for developing useful and entertaining language teaching games have been investigated [4]. Of particular interest are the principles of organizing content around tasks and tracking free production tasks throughout the game. Other aspects of developing good teaching games are explained, such as creating informative failure states. To aid in teaching the player, Kanakatana uses artificial intelligence (AI) that analyzes the player's inputs and adjusts the game to aid the player in learning. It records the frequency in which players see specific words and kana, as well as their success rate in identifying said kana. It then uses this information to select the order in which the player is exposed to new words. It also adjusts the ratio of enemy types to incentivize using a wide variety of kana.

5. APPROACH

5.1 AI-guided new word selection

A common complaint among early Kanakatana playtesters was that the game gave players new content to learn at a pace that was too fast for them. In response to this, an AI was implemented that selects the easiest new word to introduce to players. It begins by generating a list of words that introduce the least number of new kana. When new kana are introduced, the AI prioritizes kana that the player has most successfully identified from other words. In the case when more than one word may meet this criterion, the shortest word is chosen; in the case that more than one word share the same length, the word is chosen based on its frequency of appearance in Japanese print.

5.2 AI-guided enemy spawn ratio adjustment

In addition to selecting new words, the AI decides what kinds of enemies are spawned, and adjusts the ratio of enemies to incentivize players to use a variety of abilities. When a player frequently misidentifies a kana in a word, The AI will spawn more enemies that are easily defeated by abilities that utilize that kana. For example, more slow moving, high-health bears will spawn if the player consistently misidentifies a kana used in slow, hard-hitting abilities. In addition, the AI will grant enemy's resistance to particular abilities if players use those abilities to the exclusion of other abilities. This resistance significantly reduces the damage the enemies take from that ability, causing most other abilities to be a more effective options. This resistance goes away, once players begin to use a larger variety of kana.

The authors worked on finding natural rates of enemy propagation based on the user's success with all words seen at a given point in the game. In order to prevent a level from becoming flooded with enemies during poor user performance, we decided to keep the number of enemies constant and adjust the ratio of enemy propagation in relation to all other enemies.

After experimenting with multiple means of using performance data, we found the most successful method of finding appropriate enemy propagation rates to be calculated as detailed in Figure 2.

$$(Raw) EnemyRatio = \frac{WordWrong}{WordSeen} + \left(1 - \frac{WordSeen}{TotalSeen}\right) + \frac{WordWrong}{TotalWrong}$$

Figure 2. Enemy Propagation Rate Formula

This formula uses three ratios to determine a raw value (later to be normalized) for an enemy based on the word that is meant to be entered (or, to use the game's terminology, the spell to be cast), which will henceforth be referred to as the target word.

Variables WordWrong, WordSeen, TotalWrong, and TotalSeen are defined as follows:

- WordWrong: The number of times the target word was entered incorrectly
- WordSeen: The number of times the target word was attempted
- TotalWrong: The sum of all WordWrong values for all accessible words
- TotalSeen: The sum of all WordSeen values for all accessible words

These three ratios were chosen because they represent different means for evaluating a user's performance. Specifically, we can see the rate a user has incorrectly entered a word, how often that word has been attempted compared to all other words, and how often that word was entered incorrectly compared to all other incorrect entries. By using all three values, we prevent an enemy's propagation rate from becoming too high or low based on a single value (e.g. a player has never entered a word correctly but has only thus far made one attempt).

6. THE USER STUDY

6.1 Structure

The user study was conducted in a computer lab on 2 laptops and 2 desktops, all running Windows 7. Each station was set up to have a browser window open to the survey and a launcher for the

game. Participants were instructed to begin the study. The first half of the study was used to determine any prior ability to speak or read Japanese, with participants answering multiple choice questions about their own level of knowledge. The study prompted them to open the game and begin playing.

The 21 participants are games students taking the course "Interactive Entertainment Engineering." Participants receive credit on a user study assignment and they have a choice of several studies to participate in. Participants are instructed to first take a short anonymous survey establishing their level of competence in the material, followed by the play session and finally a second anonymous survey.

Participants are to play the game until they either explore the games content, become stuck on how to proceed or find the game unpleasant to play. They are also instructed to return to the second survey once they are finished with playing the game. The second half of the study focuses on testing the participants' ability to recognize the words and kanas presented to them in the game. These questions are primarily designed to test how well the game meets its goal of educating the players. It also serves to give some indication of how the game was teaching the players. The post-game survey contains qualitative questions on the game play experience. These questions are designed to get an in-depth description of the player's perspective on their learning. To a lesser extent, they are designed to gauge how well the game performs as entertainment.

6.1.1 Pre-exposure questions

Before the participants were exposed to the treatment, some baseline measures were taken to establish their existing ability to speak or read Japanese.

The pre-exposure questions were:

- Can you speak Japanese?
- Can you read Japanese?
- What Japanese systems of writing would are you capable of reading aloud?

6.1.2 Post-exposure questions

After the participants had been exposed to the treatment, they were asked the following questions:

- Did you Understand what was happening in the game? Did you understand what it was trying to teach?
- What are kana? What do they represent?
- What is Hiragana? How is it used?
- For the next four questions, you will be shown a word in Japanese and will be asked to give its English translation.
- Did you feel like the game successfully taught you some basic Japanese?
- If you felt that the game taught you some basic Japanese, please explain what you have learned. If you feel the game did not teach you any Japanese, please explain why you think the game failed.
- When did you feel that you had the most trouble recognizing kana?
- When was learning easy for you? At what points did you struggle to learn?

7. DATA ANALYSIS

The data collected from the user study suggests that Kanakatana is reasonably successful as an educational tool and that players found the core mechanics of Kanakatana to be fun.

28.6% of users describe themselves as able to “read some Japanese.” While the remaining 71% of participants have no prior ability to read Japanese, none of the participants describe themselves as fluent (Figure 3).

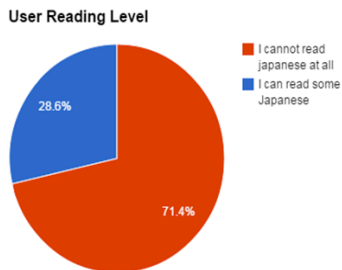


Figure 3. Perceived reading level

As detailed in Figure 4, participants indicate that they do not learn very much. This result is surprising because the data from the survey indicates that they do, in fact, learn the words and kanas they are presented with. Of the 12 participants who feel that they do not learn, 10 had no prior ability to read Japanese. Four out of six previous Japanese readers feel that they learned from playing Kanakatana. So prior ability to read kana may have some impact on the participant’s perception of how much they learn. Overall, nine out of the 21 participants self-assess as having learned some Japanese.

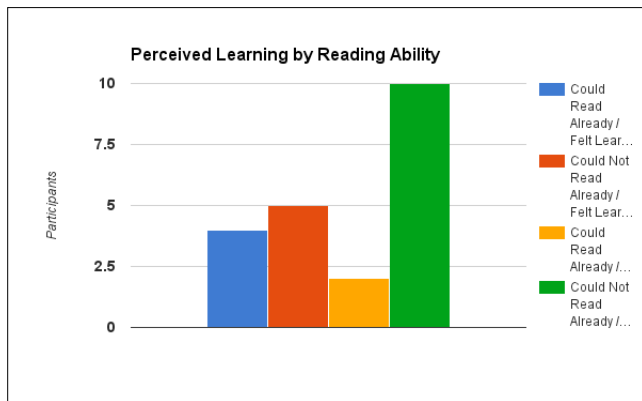


Figure 4. Perceived learning by reading ability¹

Contrasting these self-reflective views about how much learning was acquired is the data from the questions asking participants to identify words from the game written in hiragana (Figure 5). The four words the participants are asked to identify are the names of abilities in the game that had to be spelled to cast. On average, participants are able to identify correctly 72% of the words. *あり* (ari) is the first ability introduced to participants and is frequently useful throughout the game. It is also only 2 kanas long. It is likely that some of these factors have contribute to its

¹ The first two bars from the left are the numbers of participants who self-assessed as having learned some Japanese (4 and 5 people respectively), while the third and fourth bars are the numbers of participants (2 and 10 respectively) who indicated they learned no Japanese from the game.

high recognition rate, as they would increase the amount of times the participant is exposed to the word. In contrast to this, *きりかぶ* (kirikabu) is used very infrequently in the game which may account for its lower identification rate.

When participants who self-identify as “able to read some Japanese” are removed from the calculations, the rate of correct identification drops from 72% to 68%. If the participants are correct in their evaluation that they did not learn, one would expect much lower identification rates. Randomized answers to the 5-option multiple-choice question would produce a baseline of 20%. As shown in Figure 5, participants have low confidence in how much they had learned, even though their ability to identify the kana indicates that they did learn to read some Japanese.

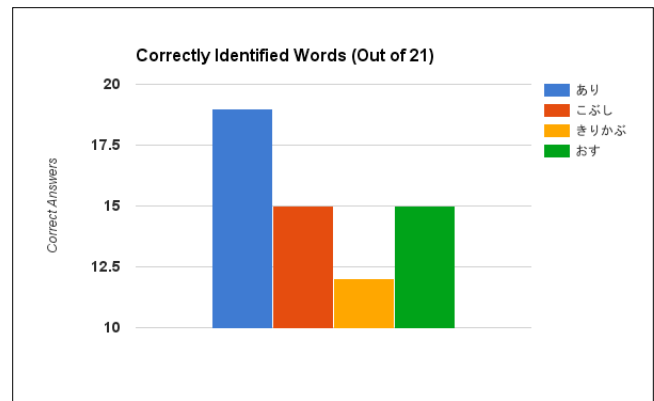


Figure 5. Subjects who correctly identify each word

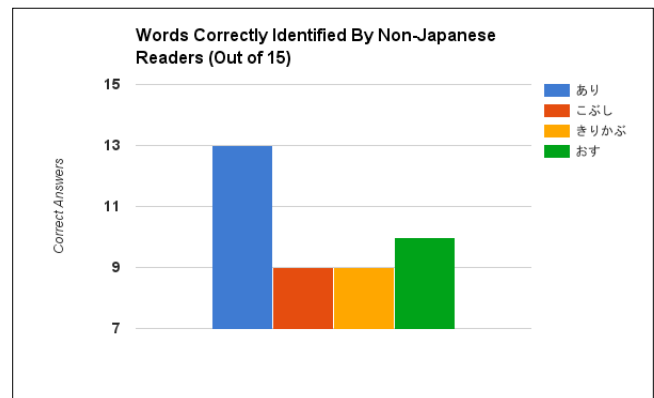


Figure 6. Numbers of non-readers of Japanese who correctly identified each word

Some trends can be identified from the qualitative responses. The data indicates that 14 of the participants express frustration at some point in the game. Six participants feel that the game could be easily beaten using only two or three abilities and that the rest of the abilities were not useful. Two participants express that trying to guess the order of kana for new spells is very frustrating and was just luck. Most participants report at least one visual bug. For the participants who express confusion, they suggest better/more audio cues and textual instructions be added to the game.

8. CONCLUSIONS

The results of this project indicates that the treatment succeeds in familiarizing players with hiragana and a few words in Japanese, and most participants express interest in the game, even though this was partially undermined by frustrating experiences and lack

of direction in the game. Fortunately, these problems seem to be with particular aspects of the games implementation and not its core mechanics or philosophy. The user study reveals that Kanakatana can more strongly succeed as both an educational game and an educational game. Furthermore, the AI system appears to achieve the desired outcome. However, the latent dissatisfaction and the relative low opinion of how much learning took place suggest the game could be improved in its presentation and how much feedback is provided to the user.

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