Crystallize: Simulating Language Immersion through Gameplay

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Abstract
Many people want to learn a foreign language, but find it challenging to sustain engagement when daily life is disconnected from the target language environment. Ideally, we would have language learning tools that provide the same benefits as being immersed in the target environment. Crystallize takes a first step towards this goal by providing a structured immersive experience. Instead of memorizing vocabulary words and grammar, the player solves linguistic puzzles, interacts with the environment, and infers word meanings from context.

Author Keywords
Games; Language Learning; Immersion; Spaced repetition

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K.8.0 [Personal Computing]: General *Games*.

Introduction
Foreign language learning is a critical part of secondary and tertiary education. However, many learners find it challenging to sustain motivation. Traditional curricula often emphasize rote memorization of vocabulary and verb conjugations and do not provide the learner much control over how he or she learns. This can be tedious and unrewarding. It also contrasts with how people learn when immersed in a foreign language environment, which

Figure 1: Crystallize gamifies language learning challenges by organizing them into quests. The player can always see a list of the active quests to direct the player and give them a sense of achievement as he or she completes them.

Figure 2: Players collect words by overhearing dialog. Word meaning is inferred from context.

provides opportunities to infer word meanings from context, learn through exploration and experimentation, and receive immediate feedback.

Ideally, we would have tools for language learning that capture the advantages of immersion. According to Isbister, games for learning are most engaging when they have mechanics that interface deeply with the target learning material and facilitate exploration [7]. Inspired by these ideas, we designed Crystallize, a Unity game that features an engaging sequence of puzzles. Each puzzle require the player to explore a 3D environment, infer word meanings and grammatical rules from context, build an inventory of words by taking them from phrases spoken by other characters, construct target phrases with words from the inventory, and reinforce vocabulary meanings over time.

Background

Traditional classroom language learning tends to focus on metalinguistic information (such as verb conjugations) and rote memorization. This structure has lead to two shortcomings in classroom learning: (1) lack of personalization and (2) lack of engagement. Classroom exercises such as translation and vocabulary quizzes are difficult to tailor to the individual needs of each student. Furthermore, students read language scenarios from textbooks rather than experiencing them.

Previous research projects and commercial products have used technology to address these shortcomings. For example, Duolingo gives students immediate feedback and offers uses point systems to motivate users [10]. However, Duolingo focuses on translating sentences and does provide deep immersion. Furthermore, the game mechanics are weakly related to language learning which many designers believe is ineffective [7].

Other work has focused on using immersion to engage language learners. The theory of situated cognition suggests that context is essential to the content being learned [1]. MicroMandarin makes use of the user's real world location as a source for vocabulary words [4]. Another game, Sanjigenjiten, uses a 3D environment to teach vocabulary words [6]. Both systems make use of visual context but are limited to individual words and do not provide a structured set of challenges.

Previous research suggests that language learning tools that provide personalized feedback, deep game mechanics, and an immersive experience would be most effective. However, there is a lack of games that combine all of these elements. We attempt to bridge this gap in Crystallize by combining rich context with personalized feedback in an engaging game.

Gameplay design

The game mechanics are designed to work with any language, but this particular prototype uses Japanese. Japanese grammar is significantly different from English grammar allowing us to test the game mechanics.

Crystallize uses four deeply embedded gameplay mechanics to engage users: (1) a questing system that motivates players, (2) computer-controlled characters that give contextual clues that facilitate inference of word meanings, (3) sentence construction puzzles that gradually expand the abilities of the player and (4) a spaced repetition system (SRS) that minimizes forgetfulness through personalized reinforcement.

Figure 3: Sentences are constructed by dragging words from the inventory.

Figure 4: Words are practiced after increasing intervals

Crystallize uses a questing system to provide guidance as well as freedom. Quests are completed by successfully conversing with non-player characters (NPCs). This is accomplished in two stages: (1) the words necessary to complete the conversation must be found in context and (2) the words must be used to construct the phrases needed for completing the conversation. Figure 1 shows the panel used to track the state of each quest and provides positive feedback by checking off completed quests.

NPCs provide clues to find the meaning of words without giving direct translations. Schneider et al. suggests that learning words through challenges rather than being given the meaning increases long term retention [9]. Two types of NPCs exist in Crystallize: interactive actors and passive actors. When a player approaches an interactive actor, that actor will initiate a conversation with a Japanese phrase. The words necessary to complete the conversation are indicated as empty slots in the player's inventory. The player must then find those words by either finding the words in the prompt, or approaching other characters. The meaning of words must be determined by context such as environmental clues. For example, one character may say "What are you [unknown word]?" and another character responds with "I am [unknown word] sushi." The player might guess from the exchange that the missing word is "eating". Use of environmental context can be seen in Figure 2. The meaning of "sayounara" can be inferred to mean "goodbye" because the word is said as one of the characters walks away. To provide another example, if a character says "This is an [unknown word]." while pointing to a cow, the unknown word is probably "cow".

Completing conversations requires the player to construct increasingly complex sentences. The theory of the Zone of Proximal Development (ZDP) states that each learner has a set of concepts that can be learned if provided guidance and that learning materials should continually target this set [8]. This balance of challenge with skill is not only good for learning, but also enables the player to reach a flow state [3]. In Crystallize, some words are given to the player and verbs are already conjugated in order to build challenges at rate which is challenging without being overwhelming. As shown in Figure 3, when learning the phrase, "am a student", the player is first asked to fill in the word "am", then the word "a student" and finally the entire phrase "am a student". If the player fills in the sentence incorrectly, the player receives immediate feedback and must fix the sentence before continuing the conversation. Drag and drop sentence construction allows for quick experimentation. By minimizing the effort of rearranging words, emphasis is placed on grammatical structures, allowing players to see patterns that may have otherwise been unclear.

To ensure the player is reviewing words enough to minimize forgetfulness, we designed Crystallize with a leveling mechanic. Increasing the speaker level opens access to more interactive actor conversations. This is accomplished by by translating words in the inventory after an appropriate interval has passed as is shown in Figure 4. The text is entered above the Japanese word, and flashing indicators show when a word needs to be ranked up. These reviews are scheduled using a SRS. SRSes use exponential back-off to facilitate memorization and have been found to be useful for language learning [5]. For example, if a base time of twelve hours was chosen, the word would be reviewed after 12 hours, then one day, then two days and so on. Answering incorrectly resets the word.

Conclusion and Future Work

In conclusion, Crystallize combines structured, personalized learning with immersion. The questing system provides the player achievable goals. Interactive NPCs enable the inference of word meanings using actions and the environment. Sentence building puzzles teach grammar. A SRS gamifies the tedious process of review. Although Crystallize shows the potential of gamified immersion, more work is needed to measure its effectiveness and explore new ways to motivate and teach.

We will deploy Crystallize to classrooms and game websites. Data will be collected both automatically through numerical usage statistics such as progress, time played and return rate as well as through interventions including surveys, interviews and pre/post-tests. These tests will allow us to continue to improve the game by adjusting variables such as the rate of increase of difficulty, the order of concepts and the review interval.

Other work will focus on content generation. New tools will be created to allow players to and instructors to produce quests tailored to specific interests and priorities of each learner. For example, if a student is especially interested in food, the game will prioritize vocabulary and grammar associated with this topic.

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