**Flashcard-based design and spaced repetition in Computer Aided Language Learning (CALL): a literature review**

**Abstract**

**Purpose** – This literature review’s purpose is to address the following questions: How does the design of a flashcard-based Computer Aided Language Learning (CALL) application affect a user’s ability to acquire and retain language? What effect does spaced repetition have on the acquisition and retention of language in CALL applications? What other learning techniques can be used with such CALL applications to increase the efficiency of language acquisition and retention?

**Methodology**

*Search and selection strategy*

Google Scholar and the University of Portsmouth’s library Discovery and catalogue search to find articles and books to get a rough feel and overview of the topic areas, journals and research.

Scimago Journal and Country Rank was then used to find journals that are reliable. In some cases, articles that where of high relevancy but that weren’t published in a journal were also included, if they were published by a researcher at a University. Articles related to computer assisted learning will be limited to articles from the past 11 years (2007 and onwards) to ensure relevancy. The target end users an input and immersion approach to language learning and the majority are already familiar with research by linguist Dr. Stephen Krashen and as such his works will also be investigated.

*Refining the search criteria*

* *English only*
* articles *on Japanese language favoured over others*

Journals of interest and relevance are:

* Computers and Education
* Journal of Computer Assisted Learning
* Language Learning
* The Modern Language Journal
* Studies in Second Language Acquisition
* Computer Assisted Language Learning
* Language Learning and Technology
* Journal of Experimental Psychology: Learning Memory and Cognition
* Brain and Language
* Journal of Memory and Language
* Language & Communication

The articles found in language and linguistics journals will be limited to second language acquisition and selected upon relevance to language acquisition.

The articles found in psychology journals will be selected upon relevance to language acquisition and its relationship with technology.

**Findings**

**Research limitations**

**Practical implications**

Introduction

This literature review uses a combination of academic articles, books, internet webpages and existing systems to answer some important questions that will have a large impact on the design of the application. These questions include: How do we acquire language? How does the design of a flashcard-based Computer Aided Language Learning (CALL) application affect a user’s ability to acquire and retain language? What effect does spaced repetition have on the acquisition and retention of language in CALL applications? What other learning techniques can be used with such CALL applications to increase the efficiency of language acquisition and retention?

Knowledge obtained because of doing this literature review will be turned into requirements for the application.

**Advantages and dis-advantages of flashcard-based interfaces**

**Flashcard design**

* *Note specifications for certain devices and operating systems*
* *Discuss any other design elements*

**Spaced repetition and the Leitner system**

* *Forgetting curve, Leitner algorithm*

**Spaced repetition algorithms**

* *Discuss the many different implementations of the SM2 algorithm and its flaws*
* *Discuss other algorithms*

**Conclusions**

***Notes on research*** articles ***written up as paragraphs***

Language learning has dramatically increased in accessibility to the public in recent years due to the advancement in technology and software development. Before the huge step in functionality with the Apple iPhone in 2007, many language learning projects where constrained by poor audio quality, limited storage capacity, poor internet connectivity, difficult text entry and low-resolution screens on older handheld devices, Godwin-Jones (2011).

Because of the boom in mobile technology, we currently have an abundance of language learning software, a lot of which are just simple apps with no real research on language acquisition to back up their teaching and learning methods. This literature review aims to look at the research behind language acquisition, as well as existing systems, to draw up requirements for an efficient language learning web app.

Second Language Learning and Acquisition

There are a variety of different approaches currently being used to learn second languages and while often these are intertwined together in a variety of ways, there are two main approaches that learners tend to choose.

The first is where the learner learns the “building blocks” of a language with a bottom-up approach, starting from the basics of the language’s grammar and vocabulary, learning how to string sentences together and how the language’s alphabet is pronounced. A good example of this would be standard language classes that uses a textbook as the main material and where a teacher takes the learner step by step through different structures. According to Krashen (1982, p. 10) this is language *learning* and refers to conscious knowledge of a second language, i.e. knowing the rules and being able to talk about them and that this is independent from language *acquisition.*

The second is to use a top-down approach where the learner spends as much time exposed to the foreign language as possible. The idea being that the longer and more time you spend with the language, the more you will become able to understand and eventually output. This type of approach is common in immersion or bilingual programs used at schools in countries where there are one or more official languages, for example in Canada where both English and French are official languages (Central Intelligence Agency, n.d.). Immersion-based strategies work better than standard classes and going abroad to a country which speaks the target language according to research by Freed, B. F., Segalowitz, N., & Dewey, D. P. (2004, p. 276).

Krashen (1982, p. 10) says that these two approaches are in fact two distinct and independent ways of developing second language competence. He states language *acquisition* to be “a process similar, if not identical, to the way children develop ability in their first language” and that conscious language *learning* helps us only as a “Monitor”, which can change the output, speaking/writing, of the language *acquisition* system before or after output, Krashen (1982, p. 15). This implies that conscious learning plays a limited role in second language performance therefore language acquisition is the more important to focus on in order to gain language ability.

The Input Hypothesis, Krashen (1982, p. 21), states that “We acquire by understanding language that contains a structure that’s just beyond our current level of competence *(i + 1)*. This is done with the help of context or extra-linguistic information.” This is something that immersion learners will experience due to the massive exposure they get to the second language. The more exposure the learner gets to the second language, the more chances there are of being exposed to *(i + 1)* comprehensible input which can explain why immersion-based programs work better than study abroad and standard classes. The concept of comprehensible input is now widely accepted by most applied linguists to be necessary for language acquisition, Cummins (2000, p. 8). Learning from comprehensible input would imply that language learning software should focus less on trying to teach the language and instead simply provide language learners with comprehensible language aimed towards their current level so that they can acquire language through understanding the language.

Learning vocabulary

There are a variety of different approaches that people use when trying to learn vocabulary in Japanese. Kanji make up a big part of Japanese vocabulary and there are also a variety of ways of tackling them too.

**Spaced repetition and the distributed practice effect**

Spaced repetition is the act of learning something and then spacing time out for the next review to allow a person to consolidate their understanding of the subject, to learn partially missed or completely missed information on the previous run and to also give the learner feedback to allow them to test their correctness of the knowledge that they gained from the previous run, David P. & Mohamed (1965, p. 149). As such the learner will gain a deeper understanding of the topic with each review.

An experiment by Bloom & Shuell (1981, p. 247) showed that distributed practice allowed learners to remember “substantially more words than those students who had studied under conditions of massed practice”, finding that the performance of the distributed practice group was 35% better. The results from Cepeda et al. (2009, p. 244) suggests that the gaps between learning sessions should be increased to months, instead of days or weeks to “efficiently promote truly long-lasting memory”.

[DISCUSS SPACED REPTITION IN MORE DEPTH]

**Flashcards**

Flashcards often have a front and a back where the user must recall the back of the card to get the flashcard correct. Flashcards are a great way of increasing second language vocabulary as they often make the learner retrieve and recall L2 vocabulary from memory, which facilitates learning as shown in research by Barcroft (2007, p. 48) and Karpicke & Roediger (2008, p. 967).

Phillips (2011, p. 61) suggests that using an intelligent and computer-controlled spaced repetition flashcard system might be an effective way to improve scores in language tests however he does note that there were many variables left unaccounted for in his method and pushes for further research on the topic.

**Rote repetition**

Rote memorisation tends to be a go to approach for Japanese learners particularly when it comes to learning Kanji. Japanese children are taught to repetitively write out Kanji by hand until they know them [INSERT CITATION] and this approach makes its way to Japanese learners via textbooks and native Japanese teachers. However, not only is rote repetition less efficient than spaced recall, Atkinson (1972, p. 126) but teachers don’t tend to consider that students whose first language doesn’t use the Chinese writing system, or an adopted version, don’t already have knowledge of Kanji making this approach a lot harder for native English speakers.

**Mnemonics**

Using memory techniques can be effective when learning Japanese vocabulary, particularly when it comes to kanji. Parts of, or whole, kanji can be combined to form new kanji and whole words. Remembering the Kanji, a book by Heisig (2001), teaches learners to make use of this unique way of building new meaning with kanji by using mnemonics and keywords for each character. In the example below we have the character 泊, meaning *overnight,* which is built up of the components ⺡, meaning *water*, and 白, meaning *white*.



Figure 1: Example of Heisig’s (2001, p. 74) method.

By combining keywords from the components that build up a character, and the characters keyword, the learner can create mnemonic stories that allow them to remember a character for when they need to write it. This method is extremely fast in allowing learners to learn the meanings and how to write Kanji characters, but it doesn’t teach the learner how to read each of the characters. Learning lists of vocabulary using mnemonic devices show considerably better results over other strategies when building vocabulary according to Meara (1980, p. 225) and Cohen (1987, p. 59) and while Meara (1980, p. 225) does point out that research on mnemonics often "completely ignore the complex patterns of meaning relationships that characterise a proper, fully formed lexicon, as opposed to a mere word list”, if a learner already associates a word or kanji with a particular meaning then learning pronunciation afterwards might be easier.

And if the learner can apply a other techniques, such as flashcards to teach them the pronunciation of a kanji, to learn how each character is said then they can build from their base knowledge.

**Vocabulary lists**

This is one of the more popular approaches due to vocabulary lists being a common feature of language textbooks. Students will often skip to the back of a chapter to find the list of vocabulary used and attempt to memorise the list. Often students will just look at the Japanese and attempt to rote memorise the characters, the pronunciation and what it means in English all at the same time. [INSERT A CITATION ABOUT VOCAB LISTS BEING GOOD OR BAD

**Vocabulary acquisition by reading**

Beheydt (1987, p. 63) states that we need context when learning vocabulary: “From a psychological as well as a linguistic point of view, undeniably the first guideline would be that vocabulary must be learned in context. The meanings of words are more easily somaticized if they are embedded in a meaningful context”.

**Learning vocabulary with sentences**

This type of vocabulary learning is recommended by Antimoon (n.d.), a website about learning English written by two Polish men who learnt English as a second language. They recommend using sentence flashcards in conjunction with a spaced repetition software such as Anki (n.d.) or SuperMemo (n.d.).

As with learning vocabulary by reading, it’s much more likely that better understanding of a word’s correct usage will be gained by seeing the word used in a variety of contexts than by seeing it in a single dialog or in a list as noted by Godwin-jones (2010, p. 4).

There’s also a couple of other reasons why sentence flashcards are favoured over other card types to learn vocabulary. These include being easier to make and review than standard L2 to L1 vocabulary cards. This is because the learner can take sentences from native sources by copying and pasting them into their flashcard program and they are easy to review because the goal is to simply understand and read the sentence correctly.

Anki

Quizlet

iKnow!

[DISCUSS WHY THIS IS RECOMMENDED AND FIND EVIDENCE TO SUPPORT IT]

Analysing existing software

Rahimi (2014) took thirty-four lower-intermediate language learners and divided them into two groups (17 in each group) based on their choice to work with a mobile dictionary or a printed version for their language course. The experimental group used a dictionary installed on their mobile phones while the control group worked with the printed version of the same dictionary. The result of the study showed that the experimental group outperformed the control group in the final test. This study suggests that having easy access to a dictionary straight from your phone plays a vital role in a language learners success. The quick dictionary look-up Google Chrome extension rikaikun provides pop-up definitions for words in the web browser and is very popular among Japanese learners with over 199,000 users, Speed (n.d.). Similar implementation of a hover over dictionary would be very useful for learners to have built-in to their language learning apps.

Anki (n.d.) is an example of a spaced repetition flashcard software that’s used by a large portion of medical science and language students because it claims that “it's a lot more efficient than traditional study methods, you can either greatly decrease your time spent studying, or greatly increase the amount you learn.”

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