Guidelines for creating tablet based learning games of compound kanji for non native learners.

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List of Acronyms

**HCI:** Human Computer Interaction

**MALL:** Mobile Assisted Language Learning

**JSL:** Japanese as a Second Language

**DSRM:** Design Science Research Method

**IT:** Information Technology

**SDK:** Software Development Kit

**API:** Application Program Interface

**UML:** Unified Modeling Language

**UI:** User Interface

**CAL:** Computer Assisted Learning
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Abstract

This thesis describes the process of identifying design and implementation guidelines for tablet based learning games focusing on the Japanese writing system which consists of multiple complex logographic characters called kanji. The kanji system covers over 2000 different characters where each character has multiple readings. The characters can also be joined to form new words these are called kanji compounds. Through an iterative process of prototype design and creation, we developed and evaluated three game concepts and a digital game artifact for tablet computers. The results of this research presents five design and implementation guidelines for tablet based learning games focusing on compound kanji which were identified through the results from three evaluations which were performed together with participants that had a background in both interaction design and Japanese.
1 Introduction

Kanji is one of three Japanese syllabaries which is imported from the Chinese language and consists of a wide range of complex characters with multiple readings. One of the common problems when learning the Japanese writing system is to understand these complex characters [10]. In many cases kanji consists of three different readings, “On-yomi” which represents Chinese reading of the kanji, “Kun-yomi” which is the Japanese reading [12] and "Nanori" which is a reading most commonly used when the kanji is included in a Japanese name.

In Japanese a kanji is normally read by it’s Kun-yomi reading, however when placed in a compound that consists of two or more kanji this is not always the case. An example is the kanji 月 which means Day or Sun and is pronounced differently depending on where it’s placed in a kanji combination. For instance the compound 一日 is pronounced “Nichiyoubi”, were 月 has two different pronunciations “Nichi” and “Bi”. While in the compound 日本 “Nihon” 月 is pronounced as “Ni”. Considering the complexity of this system it has the potential to make the learning process confusing and is a major roadblock that the learners encounter [8].

Kanji compounds form a very important part of the Japanese language, but also poses a learning challenge to Japanese language students [13]. Computer assisted learning (CAL) has been used several times to support the learning of kanji. However, CAL systems that use desktop based computers are not placed in a real world context. Which makes them unable to provide language learning at any time [8]. The research reported in this master thesis focuses on the concept of Mobile assisted language learning (MALL) as MALL covers a wide range of mobile devices including smartphones and tablet computers. Using the concept of MALL the user is able to use learning tools even if there is no access to a desktop computer. Several mobile games and applications have been developed for learning kanji, introducing different learning approaches in the area of research that supports the kanji learning process[12, 10, 5, 11, 18].
1.1 Research Questions

In the context of digital games for language learning, clear guidelines for games that mainly focus on teaching compound kanji is something that has not yet been emphasized. Therefore the main objectives of this research are translated to the following research question.

RQ1: What features and aspects of a tablet based kanji learning game are preferred by non-native speakers for remembering the readings and meanings of different kanji compounds?

1.2 Research Aims and Goals

The goal in this thesis project was to identify guidelines for the design and development of mobile games that mainly focus on teaching kanji compounds. This was approached by identifying several requirements through iteratively developing and evaluating different game concepts. By following this process the plan was also to deliver the developed game concepts and prototypes together with a digital game artifact for tablet computers which included the requirements that where identified.

1.3 Limitations

The work that is presented in this master thesis had several limitations. The limited amount of time could be considered as one of the major factors which limited our evaluations to a fewer number of participants than originally intended. In addition the artifact was not able to cover all the intended features, however, we still managed to include a majority of the essential features that we planned to test. Recruiting participants with knowledge in the Japanese language also posed a challenge, instead the concepts were evaluated through an online platform which enabled a wide range of Japanese students and experts to test our concepts.
2 Literature Review

There has been a generous amount of research in the area of kanji learning. In the following literature review, the aim was to explore different technologies, features and approaches that have been used when creating games for vocabulary learning of multiple languages. This section discusses collaborative learning, HCI aspects such as gestures and game based interfaces in mobile language learning applications and presents how technology such as audio can be used for learning vocabulary and logographic characters. In addition it also discusses challenges students of the Japanese language have regarding kanji and kanji compounds.

2.1 Background and Challenges

The Japanese writing system kanji consists of over 2000 different characters and compounds while a wide range of these compounds are very complex and some of them are not listed in dictionaries [13]. Kanji is considered to be one of the most challenging problems for students learning Japanese as a second language [11]. However learning the Japanese language is a difficult task even for Chinese speakers that already have the fundamental knowledge about the different kanji and their meanings [16]. Sa et al. [16] also highlights that the most kanji in the Japanese language has plural readings as one of the reasons. However Ochi et al. [13] mentions that foreign learners have a shorter learning period compared to native Japanese speakers as foreign learners do not start practicing the kanji system at elementary level. Syson et al. [18] also mentions the growing number of foreign students attempting to learn Japanese and mandarin. And learning the Hanzi and Kanji is considered to be one of bigger challenges faced by the foreign students [18].

2.2 Game based interfaces

According to Stubbs [17] additional work can be done regarding the design of computer games for learning foreign characters [17]. Traditional interfaces for learning foreign characters are not designed to be as entertaining as games are, however using game based interfaces for learning Japanese characters is in terms of effectiveness equal to a traditional interface. Nevertheless game based interfaces are more beneficial as they provide more entertainment to the learners [17]. In addition Wagner and Barakonyi [21] states that classical
learning applications are often considered as demotivating for learners while digital games have a potential of keeping users focused on their learning activities for a longer period of time.

2.3 Gestures in games for vocabulary learning

Tablet computers introduce a new human computer interaction paradigm which was not available before, and portability is considered to be one of the most important characteristics for supporting learning [1]. In the research by Baloian [1] multiple vocabulary learning games are developed for evaluating gesture based interaction in language learning games. Amongst younger learners there seems to exist a generally positive attitude towards gesture based learning games [1]. In addition a performed ranking of different gestures shows that the pinch and stretch gestures where the most accepted but have a lower rank regarding performance. The tilt gesture was the second in acceptance and had the highest performance rank, while the trace gesture was least accepted and had a medium performance rank. Nevertheless the drag gesture was considered to be the more common gesture and a essential part of many features in the application [1].

2.4 Collaborative learning in games

It is stated that there is an importance of encouraging collaboration among learners [14], there have been multiple studies exploring collaborative learning of kanji or hanzi characters in the context of digital games[18, 20]. Tian et al. [20] develops a mobile game that requires learners to collaborate for teaching children the Chinese hanzi characters. In this study two games were developed based on the analysis of 25 different traditional Chinese games. Both games focus on letting the learners write the characters, as the stroke orders of the character are an important factor to consider which could benefit the learners in memorizing the characters and their shape [20]. Nevertheless this type of games are able to help children practicing the Chinese writing system, and has the potential of enhancing the learners engagement.

Similar to Tian et al. [20], the research by Syson et al. [18] discusses the development of a collaborative learning game. The game however focuses on teaching both kanji and hanzi characters with children and young adults as the target audience. Compared to Tian et al. [20] The game takes advantage
of the social media platform Facebook to post game results which is also a motivating factor for the learners [18], as it also makes it possible for them to review what they have learned so far.

2.5 Audio

In addition of being an essential part of a game, the usage of audio can also be used when learning kanji, and has been shown beneficial for helping students to acquire the memory skills needed for kanji competency [12]. An attempt using this method was made by Norman and Mase [12] for assisting Japanese as a Second Language (JSL) learners. A modified version of a well known kanji learning method developed by Heisig [6] was also used together with the audio learning approach. However the method by Heisig [6] was designed for the individual kanji characters and ignores the challenges that exists when learning kanji compounds [12].

In the research by Lin et al. [10] audio is combined with visual representation of the kanji for teaching and helping foreign students in learning how to write and remember the meanings of the kanji characters. The method by Heisig [6] is also used in this research and kanji compounds are omitted from this study as well. As an addition Lin et al. [10] describes a way of organizing the components that make up a kanji character in a hierarchal structure having an unique English name assigned for each component which is also a memory aid for the learners [10].

2.6 Research Opportunities

The outcomes of the literature review indicated that there existed an opportunity for conducting further research. The performed review described different HCI aspects, technologies and approaches for design and developing applications for learning vocabulary and logographic characters. However, by analyzing the design aspects of previous approaches, It provided a starting point from where additional concepts for game based compound kanji learning applications could be developed and tested in order to identify user requirements.
3 Research Methodology

Considering the research questions for this thesis the choice is to adopt a design science research method approach (DSRM) based on the method described by Peffers et al. [15], as the main method in this thesis. DSRM is described as an iterative process that focuses on the design and development of software artifacts resulting in testable products that can be used for further research. In this thesis however we identified three high level activities to follow in order to achieve the research goals, Design, Prototype Creation and Evaluation.

![Diagram](image)

**Figure 1: Iteration steps**

In order to support the proposed DSRM approach, we add an additional research method which is intended to be used during the evaluations that take place at the end of each iteration. The method of choice will be a sequential mixed method research design described in the work of Creswell [3] as a strategy for collecting data that takes both qualitative and quantitative forms to provide us with comprehensive data consisting of both qualitative and quantitative information.
3.1 Process

Regarding the research process in this thesis the mentioned activities are intended to be performed over three iterations where the first two iteration will focus on concept development and the third iteration will focus on implementing an artifact based on results from the previous iterations. During the design activity in the first iteration, brainstorming will be performed in order to generate different game concepts and designs, the concepts will be developed into testable prototypes during the second activity. Followed by an evaluation with the aims of evaluating the prototypes based on their usability and overall design. The second iteration will follow the same structure, however the concepts will be redesigned during the design activity, based on the evaluation results from previous iterations.

The evaluation in the second iteration however aims to determine the overall language learning potential of the prototypes. The third iteration will focus on the concept that received the most positive feedback in the previous iterations. The chosen concept is to be redesigned and implemented as a digital game artifact. When evaluating the artifact, the evaluations are to be performed in a similar manner, however focusing on both usability and language learning potential.

Regarding data collection the feedback from both evaluations will be collected in respect to the chosen research method. Therefore the data collection is going to be performed through a survey that consists of both open and closed questions in order to get both qualitative and quantitative data.

3.2 Ethics

Because the chosen methods for evaluation required the involvement of participants, several ethical aspects have been considered before proceeding. By following what has been stated by The Personal Data Act [19] as permitted processing of data, a consent form was created, which each participant voluntarily filled in before being a part of the study. The consent form acted as a contract to make participants aware on how their information such as comments, answers or photographs which where collected was intended to be used. Additionally through the consent form participants were also informed about their anonymity and rights of withdrawing, which had to be allowed at any time during the study [2].
4 Design and Development

4.1 Concept Development

In order to keep the concepts presented in this thesis simple and familiar to the testers, they were developed to include aspects of traditional tabletop games which were modified to include kanji. The concepts were inspired by the games Crosswords, Memory and Domino and the gameplay was modified to include kanji compounds so that the user is able to learn kanji while completing the challenges offered by the game. Since the original gameplay of the suggested concepts was designed to challenge the player by the means of a puzzle, the concepts were modified so that kanji had to be combined in order to create a compound.

In order to identify the user requirements and needs the concepts had to be evaluated. Therefore three different paper-based prototypes representing each concept were developed. The prototype creation process started off by creating a frame similar to a tablet device, which was cut out from three different pieces of colored A3 paper. The elements which were used as a part of the interface and gameplay were designed using the software balsamic mockups. The UI elements were also printed, laminated and cut out from separate sheets of A4 paper. The prototypes were developed with the main focus on letting the user combine different kanji when playing the game and included several interface representations of game specific features.

Figure 2: Paper prototypes representing our game concepts
4.2 Technology

The technology used for the implementation of the artifact was determined after analyzing some of the possible choices among the wide range of available tools. Since the aim was to develop the artifact as a throwaway prototype which is build as fast as possible and used for evaluating the concept and requirements with [4], the chosen tools and programming language had to be simple to work with, efficient and able to provide features in the android platform.

The decision was to build the artifact in Java together with the game development framework LibGdX, as java runs efficiently on the Android platform and also provides access to most native interfaces that the system has. As shown in Table 1 LibGdX can be used to support the development process by letting developers debug the code on the computer without requiring a device. It also provides high-level abstractions of multiple components such as gesture detection and mathematical operations which are required when building a game application for tablet computers.

Using HTML5 together with phone gap was also considered as it is a well-known approach for cross-platform development. We acknowledge that there is a possibility of achieving the same result using both approaches. Considering Table 1, it shows that developing an HTML5 app requires using web technologies, which makes it unable to run natively on the Android platform. It has also been shown that a web based approach is not suited for apps which require hardware interactions such as digital games or E-learning applications [7], while applications that are written for acceleration tools such as phonegap have limitations compared to a solution that is written for a specific platform[22]. Therefore in this thesis Java and LibGdX were considered to be the most reliable approach for developing the artifact with.
<table>
<thead>
<tr>
<th>Features</th>
<th>Java with LibGdx</th>
<th>Html 5 and Phonegap</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cross Platform</td>
<td>• Cross Platform</td>
<td>• Cross Platform</td>
</tr>
<tr>
<td>• Written with the platform SDK</td>
<td>• Written with web technologies.</td>
<td>• Written with web technologies.</td>
</tr>
<tr>
<td>• Runs natively on the Android platform</td>
<td>• Can run both locally or on a web server</td>
<td>• Can run both locally or on a web server</td>
</tr>
<tr>
<td>• Provides access to hardware components, google play services, text to speech and other android native interfaces.</td>
<td>• Access to Accelerometer, Camera, Geolocation, Notifications.</td>
<td>• Access to Accelerometer, Camera, Geolocation, Notifications.</td>
</tr>
<tr>
<td>• Supports high level abstractions of advanced mathematical operations, asset loading, gesture detection.</td>
<td>•</td>
<td></td>
</tr>
<tr>
<td>• Provides a desktop, Android and iOS version from the same code.</td>
<td>•</td>
<td></td>
</tr>
<tr>
<td>• Debug and test application on desktop or device.</td>
<td>•</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Comparison of Html 5 and LibGdx.

### 4.3 Android Application

The artifact was developed as an Android application using the concept that received the highest rating from the participants during the previous evaluation. When developing the Android game the a part of the requirements which were identified in previous iterations were included. More specifically the artifact was developed to support the usage of audio for pronouncing the kanji which was provided by the Google Text To Speech engine through the android API. The application also included a dictionary that provided
visual and audio pronunciations for each kanji in the dictionary list. Additionally the overall gameplay was designed to put the kanji compounds in a meaningful context.

Figure 3: High-level class diagram of the artifact

Figure 2 presents a high-level class diagram of the artifact and illustrates the connection between the components and how the artifact was implemented. The game was divided into four different screens where each screen encompassed their own logic. The screen manager component was responsible for performing screen switches while the asset manager was called when the program started so that all assets such as images could be loaded. The TTS manager provided an interface that enabled access to the TextToSpeech component in the android launcher.
5 Evaluation And Results

This chapter describes how we evaluated three concepts and a digital game artifact and also presents the results from each evaluation. The concepts and the artifact were evaluated based on their usability and learning potential together with two groups of participants. The first group of participants had a background in interaction design while the second group had a background in the Japanese language. However regarding the second concept evaluation, participants in the second group were not available on site and the evaluations were performed using an online method instead.

5.1 Evaluating Usability

The usability evaluation was performed together with four participants that had a background in interaction design. The participants had no previous experience with kanji nor the Japanese language, however they were assigned a task to solve a puzzle in each prototype and then to fill out a survey where they provided detailed feedback on the concepts. After each participant tested the concepts, he/she was asked questions regarding the experience.

![Testing the prototypes](image)

The results show that there was an overall positive response to the three concepts and all participants thought that at least one of the game concepts was interesting. The results indicates that the majority of the participants preferred the domino concept over the memory and crosswords concepts. The participants also provided verbal feedback about their experience and what they thought could be improved. Using audio for providing a pronunciation of the kanji was a feature that all the participants thought could be very useful. Regarding the User Interface (UI) the dictionary which was on a
separate sheet of paper was mentioned as a good addition to the game and was suggested to be integrated in future versions so that users are able to open it by performing a gesture or tapping a button.

**Summarized key comments from the respondents**

- The memory game felt as the most complete game
- The ui of the domino game is clean and is just what i choose to put in
- UI wise the memory and crosswords needs to be cleaner
- I like the puzzles but i did not feel that i was translating when playing.
- It is more fun to learn when playing together.
- The domino game is probably more nice when you play it in multiplayer

Table 2: Key comments identified during the usability evaluation

All participants mentioned that they saw the compounds as images with no specific meaning. Were one participant mentioned that he/she did not get the feeling of translating anything. The same participant suggested to redesign the gameplay of the concepts so that user is playing a game that has a purpose and puts vocabulary in a context. The crosswords game was not mentioned as frequently in the survey results, however during the evaluations several participants suggested that the interface could be improved as it was confusing. The cells need to be divided into smaller groups with a clear border for making it easier to distinguish between different compounds that are created on the screen. Based on the key comments five usability requirements where identified and are presented in Table 3.

The first requirements U1 and U2 was derived from feedback regarding the usage of audio and dictionary integration. U3, U4 and U5 where identified
through the key comments presented in Table 2, where U3 identified from the participants comment regarding a clean user interface, U4 was identified from the participants comments regarding the gameplay, which did not enable the player to translate the kanji and was considered to remove the game purpose. U4 was derived from the key comments about learning together with another player to enhance the experience and make it more fun.

<table>
<thead>
<tr>
<th>Usability Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1 Use audio to pronounce the kanji compounds.</td>
</tr>
<tr>
<td>U2 Include dictionary for the current game session, as a help for new learners.</td>
</tr>
<tr>
<td>U3 Use a minimal and clean user interface.</td>
</tr>
<tr>
<td>U4 Consider using a gameplay that fills a purpose.</td>
</tr>
<tr>
<td>U5 Provide support for two or more users.</td>
</tr>
</tbody>
</table>

Table 3: Identified usability requirements.

5.2 Evaluating Language Learning

During the second iteration the previous concepts were improved based on the key comments and requirements from the usability evaluation. Three new concept prototypes were developed by using the software Balsamic mockups. By using Balsamiq several images for each concept were created, one image representing an event in the game. The prototyping tool Solidify was used to develop three different interactive prototypes by defining several points of interaction on each image to link them together.

The feedback from the participants was given through three online surveys which were sent together with the prototypes by email. Based on the results we were able to identify three additional requirements for the game concepts and determine which concept to proceed with for the next stage.

Each participant completed three surveys, one for each concept, the surveys covered three closed questions which were used to rate the concepts on a Likert scale from one to five regarding the gameplay, motivation factor and usefulness. In addition, the survey also included several open questions where each participant provided their written feedback. The final score for each concept is shown in Figure 6 and was determined by calculating the mean value of the overall score for each concept.
Figure 5: Online prototypes in the solidify tool
The participants qualitative feedback on the concepts are presented in Table 6, Table 7 and Table 8 in Appendix A and presents multiple suggestions on how the concepts could be improved. Based on the feedback in Table 6, Table 7 and Table 8 we were able to identify three additional requirements which are shown in Table 4.

<table>
<thead>
<tr>
<th>Language learning Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
</tr>
<tr>
<td>L2</td>
</tr>
<tr>
<td>L3</td>
</tr>
</tbody>
</table>

Table 4: Identified language learning requirements.

Based on participant feedback L1 was identified which indicates that additional text such as the sentences which are present in the domino con-
cept should be written in Japanese Hiragana or Katakana. Hiragana and Katakana are also syllabaries included in the Japanese writing system, and form a basic component in the Japanese language. Hiragana and Katakana are also used alongside the Kanji system. However in this thesis using English is required when evaluating with participants that have no experience in Japanese. The second requirement L2 was also identified through the participant comments and is similar to requirement U4 from the usability evaluation which indicates that kanji should be put into a context to make it more vivid and help the user to gain a better understanding on how the vocabulary could be used. L3 was suggested in the comments as a feature to make learning more effective. It should remove kanji compounds that are known or mastered by the users to slowly introduce them to new compounds in order to remove repetition and make them advance in their learning process.

5.3 Evaluating the application prototype

The third evaluation aimed to test the digital game artifact which was developed based on the results of the usability and language learning evaluations of our game concepts. The digital game artifact was also evaluated from a usability standpoint with five participants that had a background in interaction design, and from a Language learning perspective with three participants that where learners and experts in the Japanese language.

The participants that took part in the evaluation tested our tablet game during ten minutes. The game provided the users with multiple sentences that consisted of several empty spaces. The main objective in the game was to place the a kanji in the correct space to complete the sentence, the kanji was provided to the users as bricks that were located at the bottom of the screen. After the evaluations participants provided verbal feedback regarding the artifact and its features. All participants also answered a survey regarding the usability of the game, however, participants that had experience in Japanese completed an additional survey regarding the language learning aspects of the game. Additionally participants with no previous experience in Japanese used the English version of the game to test the usability while participants that had previous experience used a Japanese version of the game.
The artifact evaluation shows positive results in terms of both usability and language learning potential. The following diagrams illustrate how the participants responded on the survey regarding the usability of the artifact.

Figure 5 presents four diagrams that show the response rate on four closed question from the usability evaluation survey. Each diagram is labeled with the corresponding question number, the answer to the following questions was provided by the participants through a Likert scale from 1 to 5.

- Question1: Hearing how the whole sentence is pronounced was a good feature?
- Question2: The built in dictionary helped me to progress in the game?
- Question3: The game provides a good interface for vocabulary learning?
- Question4: Overall the game was easy to use and understand?
Analyzing the diagrams in figure 7 shows that the majority of the respondents thought that the game was easy to use and understand, and also provided a positive response regarding the usage of audio, dictionary and overall gameplay. Nevertheless even if the majority of participants did provide positive answers regarding the artifact, the results also indicate that some participants did remain undecided by providing a neutral answer to all questions, additionally 14.3% of the participants did also disagree on 4) by providing a negative answer.

Figure 8 presents the response rate on three closed questions from the language learning evaluation survey and corresponds to the following list:

- **Question1**: Using kanji compounds for building sentences is a good way of remembering and learning their readings?
- **Question2**: I think the game could help learners to stay motivated while learning?
- **Question3**: Overall how good do you think this game is for learning and remembering kanji compounds?
When evaluating the artifact based on its language learning ability only three respondents that had a background in Japanese were able to test the game. Based on their answers an overall positive response is shown towards the gameplay and motivation factor of the artifact. However regarding the overall performance shown in diagram 3) the participants provided a neutral answer which is considered as an undecided answer. Qualitative data from both evaluations are presented in table 8 in Appendix A.

The results from the artifact evaluation indicated that the participants overall provided a positive response towards the artifact and the features it included. By considering the results and feedback which was collected from the performed iterations during the design process, four emerging guidelines were identified.
Table 5: Identified guidelines

<table>
<thead>
<tr>
<th>Guidelines</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>Use audio to provide pronunciations to visual kanji representations.</td>
</tr>
<tr>
<td>G2</td>
<td>Include dictionary for the current game session, as a help for new learners.</td>
</tr>
<tr>
<td>G3</td>
<td>Use a minimal non invasive user interface.</td>
</tr>
<tr>
<td>G4</td>
<td>Put vocabulary into a meaningful context.</td>
</tr>
<tr>
<td>G5</td>
<td>Combine kanji with hiragana or katakana characters.</td>
</tr>
</tbody>
</table>

The guidelines presented in Table 5 were derived implementing and testing the requirements that were identified during the prototype evaluations in the first and second iteration in the digital game artifact. The five guidelines in Table 5 were determined by the results in Figure 8 and Figure 9 which were achieved by evaluating the Usability Requirements U1, U2, U3 and Language Requirements L1 and L2. However due to several constraints, this thesis was not able to cover all the listed requirements therefore not all eight requirements could be tested and selected as guidelines.
6 Conclusions and Future Work

6.1 Conclusions

This master thesis was mainly set out to answer the research question RQ1: *What features and aspects of a tablet based kanji learning game are preferred by non-native speakers for remembering the readings and meanings of different kanji compounds?*

We were able to answer our question RQ1 by following an iterative process of design and creation which was based on the work of Peffers et al. [15]. Through our literature review we were able to find relevant information on previous approaches that has been created for learning vocabulary and logographic characters. The results from our review provided us with a starting point from which we developed and prototyped three game concepts that where evaluated at the end of each iteration in our process.

The findings were based on the results from two evaluations that were performed together with interaction designers, learners and experts in the Japanese language. The results helped us to identify five usability and three language learning requirements and decide which concept to use as a base model for our digital game artifact. By evaluating the implemented artifact, we were able to determine which features in our game artifact had the most potential of supporting the learning of kanji compounds. Additionally we were also able to identify five emerging design and implementation guidelines for compound kanji learning games.

6.2 Discussion

Since the focus of this research was on achieving the desired goals through an iterative process of design and creation, we believe that the chosen methods for this research defined a clear structure for the process which we intended to follow, and also provided us with a good idea on how each iteration should be performed. However we believe that our process and research outcomes could have been improved if more iterations were performed. The choice of technology which we used for developing our digital game artifact with was sufficient for the purpose of this project, and was also able to provide us with the necessary tools for implementing our artifact with the required features. The developed artifact was very limited considering its functionality and visual appearance, however the artifact was still usable and good enough for
testing our requirements with. Regarding our outcomes we were able to
determine guideline G1 and G4 as sufficient in terms of validity. Neverthe-
less we consider these guidelines as merely a starting point for future work to
build upon. In relation to previous researches we are able to identify applica-
tions which we could connect our guidelines G1 and G4 to. The multi-modal
approach by Norman and Mase [12] uses what has been described by G1,
representing kanji both visually and through spoken audio. Additionally we
can connect G4 to the research presented by Ochi et al. [13], Kiiia and Kiy-
oharu [9] where the user is able to learn kanji when the character is placed in
a meaningful context such as in sentences and paragraphs located in online
documents or in the real world. Nevertheless we consider guideline G2, G3,
and G5 as not sufficient in the current state of the research, since we were not
able to fully test them during our last iteration. Therefore additional eval-
uations are required, as well as an formal validation together with a larger
population.

6.3 Future Works

Regarding future works a full evaluation of our guidelines G2, G3 and G5
with a larger population is required. We will also perform a full evalua-
tion regarding requirement U5 and L3. Regarding the artifact the plan is
to implement a complex prototype that encompasses a more sophisticated
algorithm and generates quizzes based on the users interests or Japanese
language level. Since the artifact currently provides the same vocabulary for
every game session we also plan to implement the usage of an online dic-
tionary for providing a more dynamic and challenging learning environment
within the game.
References


[8] Julien, Q. and Ulrich, A. [2005], ‘Does learning how to read japanese have to be so difficult , and can the web help ?’.


[22] When to use PhoneGap versus developing a native iOS app [2014].
URL: http://roadfiresoftware.com/2014/04/when-to-use-phonegap-versus-developing-a-native-ios-app/
A Appendix

Survey Questions

1. Was there any games you feel would have been better to play alone or together with another player?

2. Which games did you feel most comfortable with? Which worked better for you?

3. Was there anything you found satisfying or exciting when testing the game concepts?

4. Do you think that the gameplay and rules of the different games were easy to understand?

5. Can the gameplay be improved in any way? To make it more clear and easier for you?

6. Are the elements and features of the games consistent? Do they make sense?

7. Are there any elements or features that you would like to add or remove from the different games?

8. Are there any elements or features you would like to combine to create a better game?

Figure 10: Survey used for the usability evaluation of the paper prototypes
Figure 11: Survey for the domino concept

<table>
<thead>
<tr>
<th>Question</th>
<th>Rating Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you think combining kanji through the domino game is a good way for remembering the kanji compounds and their meaning?</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Do you think this type of game can help students stay motivated when learning?</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Overall, I think the game concept can be a useful tool for learning kanji compounds.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Are there any features or elements of the game concept that you especially like or found useful?</td>
<td></td>
</tr>
<tr>
<td>Are there any features you would like to improve or add to the game concept?</td>
<td></td>
</tr>
<tr>
<td>Do you have other comments or thoughts about the game concept?</td>
<td></td>
</tr>
<tr>
<td>I would like to rate this game as</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Bad 0 1 2 3 4 5 Excellent</td>
<td></td>
</tr>
</tbody>
</table>
Do you think combining kanji through a game of crosswords is a good way for remembering the kanji compounds and their meaning?

1 2 3 4 5
Strongly Disagree ⬤ ⬤ ⬤ ⬤ ⬤ Strongly Agree

Do you think this type of game can help students to stay motivated when learning?

1 2 3 4 5
Strongly Disagree ⬤ ⬤ ⬤ ⬤ ⬤ Strongly Agree

Overall, I think that the game concept can be a useful tool for learning kanji compounds.

1 2 3 4 5
Strongly Disagree ⬤ ⬤ ⬤ ⬤ ⬤ Strongly Agree

Are there any features or elements of the game concept that you especially like or found useful?

Are there any features you would like to improve or add to the game concept?

Do you have other comments or thoughts about the game concept?

I would like to rate this game as

1 2 3 4 5
Bad ⬤ ⬤ ⬤ ⬤ ⬤ Excellent

Figure 12: Survey for the crosswords concept
Do you think combining kanji through a memory game is a good way for remembering the kanji compounds and their meaning?*

1 2 3 4 5

Strongly Disagree ○ ○ ○ ○ Strongly Agree

Do you think that this type of game can help students stay motivated when learning?*

1 2 3 4 5

Strongly Disagree ○ ○ ○ ○ Strongly Agree

Overall I think that the game concept can be a useful tool for learning kanji compounds?*

1 2 3 4 5

Strongly Disagree ○ ○ ○ ○ Strongly Agree

Are there any features or elements of the game concept that you especially like or found useful?


Are there any features you would like to improve or add to the game concept?


Do you have other comments or thoughts about the game concept?


I would like to rate this game as*:

1 2 3 4 5

Bad ○ ○ ○ ○ Excellent

Figure 13: Survey for the memory concept
What is your Japanese language level?
- No experience
- Beginner
- Intermediate
- Expert
- Native

I think that using kanji compounds for building sentences is a good way of remembering and learning the readings:

  1  2  3  4  5

Strongly Disagree ◯ ◯ ◯ ◯ ◯ • Strongly Agree

Do you that the game can help learners to stay motivated while playing?

  1  2  3  4  5

Strongly Disagree ◯ ◯ ◯ ◯ ◯ • Strongly Agree

Overall, how good do you think this game is for learning and remembering kanji compounds?

  1  2  3  4  5

Very Bad ◯ ◯ ◯ ◯ ◯ • Very Good

Was there any parts or features in the game that you think are helpful when learning vocabulary?


Do you have any other thoughts or comments about the game?


Do you have any suggestions for improvements?


Figure 14: Survey for language learning evaluation of artifact
What is your Japanese language level?
- No experience
- Beginner
- Intermediate
- Expert
- Native

What do you think about the concept of using the kanji compounds for building sentences?

After completing a sentence, I think that hearing the pronunciation was a good feature.

1 2 3 4 5

Strongly Disagree ○ ○ ○ ○ ○ Strongly Agree

I think that using the built in dictionary helped me to progress in the game.

1 2 3 4 5

Strongly Disagree ○ ○ ○ ○ ○ Strongly Agree

I think the gameplay helps to provide a good interface for vocabulary learning.

1 2 3 4 5

Strongly Disagree ○ ○ ○ ○ ○ Strongly Agree

Overall, how easy do you think the game was to use and understand?

1 2 3 4 5

Very Difficult ○ ○ ○ ○ Very Easy

Do you have any suggestions for improvements?

Figure 15: Survey for usability evaluation of artifact
Summarized Responses

| Crosswords | • I like to approach that this game focuses on teaching kanji through vocabulary.  
• The game encourages watching the characters.  
• Being able to choose from more than one kanji is both challenging and fun.  
• It is rather vague and I am skeptical whether this kind of game will actually aid the student. This game only harness a passive kanji skill, the knowledge can be acquired in any kanji textbook.  
• Too many clicks needed.  
• Looks good to me. The more the study of kanji can be varied the better in my opinion! Making a crossword yourself would be kind of pointless since you know all answers right |

Table 6: Summarized feedback for the Crosswords concept
• It is necessary to add a function that makes mastered compounds show up in the game less frequently. The structure should be adjusted to the learning process. Words without context are also difficult to learn and may often be understood.

• I found the little dictionary section at the end to be a very good addition as it shows possible combinations of kanjis and their meanings. It is another way of learning rather than just clicking random kanjis together and hope for a good outcome.

• It is a very good concept and as a Japanese student I have come to realize that learning kanjis as a set - one or two words with the various meanings - help a lot more rather than just learning one kanji.

• I would like to see all the various ways that a kanji can be pronounced when it is being clicked as it is such a large part of being able to understand them.

• There is an abundance of memory supporting software and it is questionable if this adds anything new. A drawback of this kind of game is that compounds that are already mastered will still be in the game every time one takes it. This will result in waste of time and will make the user bored. A system will be necessary to adjust the contents of the game to the players’ learning process. Problems may also occur when several different compounds are possible with the same character.

• I believe the concept is great. I have mainly studied kanji this far by reviewing them and copying them on a blank paper, or by using ANKI (cardback program). This would be a much more enjoyable way of studying. The addition of sound is good.

Table 7: Summarized feedback for the Memory concept
<table>
<thead>
<tr>
<th>Domino</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The vocabulary becomes more vivid when put in a meaningful context.</td>
</tr>
<tr>
<td>• Seeing the English word and then finding the Japanese equivalent is a really good way to associate the 2 words in both languages.</td>
</tr>
<tr>
<td>• I enjoy the competition and being able to play with others. It is motivating, and when it comes to practice on your own that is the most important thing for me.</td>
</tr>
<tr>
<td>• Maybe a time-limit would make it more thrilling. But I like how simple it is right now too.</td>
</tr>
<tr>
<td>• The best one so far! Turning kanji practice into both a game and a friendly competition would certainly make me more interested.</td>
</tr>
<tr>
<td>• Make the sentences in Japanese, learning Japanese words in English is only harnessing a passive skill, like learning algebra in high school, you only learn it on the paper but never use it.</td>
</tr>
<tr>
<td>• I’d like to have some sound and more kanji alternatives. I think it is better to hear the whole sentences.</td>
</tr>
</tbody>
</table>

Table 8: Summarized feedback for the Domino concept
• Filling vocabulary in blanks is a good idea as a method of language learning.

• I think it is really good as the prototype app had visuals, sound which made it easier to remember.

• I think it is good for learning kanji

• Very interesting and useful, a creative way of learning a new language.

• The dictionary was helpful when you can’t remember the kanji

• Interesting way of learning kanji, when I learn kanji I write it 100 times but then I forget it when I can’t place it in a context.

• Allow the user to create a list of the kanji they want to learn.

• Maybe a gameplay that quizzes one sentence at the time would be better.

• It would be nice to hear the pronunciation and the translation when holding down the finger on a kanji compound.

• Using a slower voice and real voice actors could be good.

Table 9: Summarized artifact feedback