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Adaptable Chinese Language Learning Card Game

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Abstract: The Chinese language is one of the world's largest language groups. Mandarin Chinese, the primary branch of the language, is the basis for the Modern Standard Chinese language that we use today. However, it is difficult to learn. This project aims to create a game to simplify the learning process of the language and making it more fun. Based on GOMS, Schneiderman and Nielsen's principles, a system embedded with a completing-the-sentence mechanism is used to help users learn the language and appreciate its beauty. User testing results based on the Technology Acceptance model and heuristics evaluation are positive. Significance lies in the reuse of the mechanism for the learning of any language or for the enrichment/reinforcement of any subject for collaborative/competitive learning purposes.

Keywords: Chinese language learning, game, GOMS, Nielsen, Schneiderman's HCI principles, reuse, completion mechanism

The Chinese language is quickly becoming one of the largest language groups in the world. It is estimated that China will become the world's leading economy by the year 2050, and thus the Chinese language is expected to become even more influential then [(DayTranslations, 2018). Therefore, it is important to learn the Chinese language to remain competitive on the international stage.

The primary goal of this project is to simplify the learning process for learning the Chinese language. The following are the objectives of this project:

1. Design a game that makes it easy to learn Mandarin Chinese;
2. Incorporate cultural features of the Chinese society into the game.

1. Literature review

1.1 Statistics

According to a survey undertaken by Ethnologue (2018), the Chinese language is currently the most spoken language in the world, with about 1.3 billion speakers worldwide. Day Translations (2018) ranks the Chinese language as the second most important language in the 21st century, second only to the English language.

1.2 Language properties

The Chinese language is actually a family of languages that comprise of multiple dialects, including Mandarin, Wu, Yue, Min, Gan, and many more (About World Languages, 2018). The language is mainly divided across geographical lines Accredited Language (2010). The most widely used of the language group is Mandarin Chinese. The Modern Standard Chinese is based on the Mandarin dialect of the Chinese language (Encyclopedia Britannica, 2018). The language was standardized in a language unification program in the 1900s.

The Chinese language is a tonal language that uses logogram (The Babbel Magazine, 2018). The entire Chinese language contains about 50,000 characters (McGibney, 2018). However, only up to 2,500 characters of the Chinese language is used daily. There are two versions of Chinese characters, namely Traditional Chinese and Simplified Chinese. Traditional Chinese was first standardized in the era of the Qing dynasty. It has about 3,000 characters. Under the reign of Emperor Kangxi, about 40,500 characters were recorded. The first attempt to simplify the language happened in 1930. This attempt however failed, as it did not manage to create "basic Chinese," which can be written by the reduced number of symbols. Another attempt to introduce simplified characters in 1956 was successful, and resulted in the Simplified Chinese script that we know today. A Romanized system called Pinyin was introduced in 1958, based on the Beijing dialect of the Mandarin Chinese language. The system was adopted to make learning the language easier and to increase the spread of the Modern Standard Chinese language.

1.2.1 Difficulty

According to the Foreign Service Institute of the US Department of the State, Mandarin Chinese falls under Category III. This makes it one of the hardest languages to learn for native English speakers, requiring 88 weeks at 5 hours a day, or 2,200 class hours to become fluent in the language (Multilingualbooks, 2018). This number is equivalent to about twenty months or one year and eight months.

1.2.2 Current situation

Learning a new language requires a lot of effort, including monetary efforts. According to TakeLessons, different language learning platforms' costs vary greatly. Apps and computer programs can cost up to USD450, and classes can cost between USD100 up to USD500 (Proctor, 2018). Private language classes and language immersion by travelling and staying in targeted countries can cost even more.

1.2.3 Game-based Learning

According to the Journal of Computer Assisted learning, there are four types of learning theories, i.e., behaviourism, cognitivism, humanism and constructivism. In a similar game of memory matching for education, "A Learning Version of Memory Match Game (LMMG)", the outcome is positive and other interactive games have sparked the interest of users.

1.2.4 Summary

The Chinese language is a huge language family with a long history. Mandarin Chinese is the most widely used dialect of the language and the basis of Modern Standard Chinese. However, the Chinese language is a complex language, which requires a long time to learn. Huge monetary and physical effort are also required to be proficient/fluent in the language.

2. Methodology

2.1 Prototype Model (Agile methodology)

We decided to use the prototype model in the Systems Development Lifecycle (SDLC) to develop this project. In the prototype model, a prototype (an early approximation of a final system) is built to understand the requirements instead of freezing the requirements before proceeding with the design or development phase. This model works best in scenarios where not all of the requirements are known in detail ahead of time. Hence, a prototype is built, tested, and then reworked as necessary until an acceptable prototype is finally achieved from which the complete system can be deployed.

The various iterations enable us to better understand customer requirements resulting in better design, development and implementation of the requirements.

2.2 Prototyping in the Systems Development Lifecycle (Agile methodology)

We follow the agile methodology in prototyping. The agile prototyping model is more suited than a throwaway prototyping model for our objectives as the users often think that a prototype, intended to be thrown away, is actually a final system. This can lead them to expect the prototype to accurately model the performance of the final system when this is not the intent of the developers. Moreover, users may become attached to features that were included in a prototype for consideration and be uncomfortable when these features are removed from the specifications for a final system.

The steps are as illustrated in Figure 1 below.

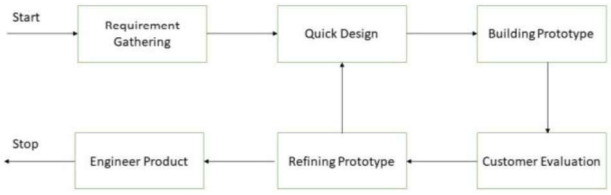


Figure 1. Prototyping in the Systems Development Lifecycle (Agile methodology)

2.2.1 Requirements Gathering

Prototyping begins with requirements analysis. Feedback from users are used to determine the requirements of the system.

2.2.2 Quick Design

A preliminary design is created after the requirements are known. It helps the developers and users visualize the important aspects/ideas of the system.

2.2.3 Build Prototype

Information gathered from the quick design is modified to form a prototype, which represents a "rough" design of the system.

2.2.4 Customer Evaluation

The proposed system is presented to the user as part of the development process. The users thoroughly evaluate the prototype noting its strengths and weakness, and the items that need to be added or removed. In this stage, the developers collect and analyse remarks from the users.

2.2.5 Refining Prototype

The prototype is refined once the user evaluates it. This step is iterated as many times as necessary, until the users are satisfied that the prototype represents the final product. The final system is then constructed based on the final prototype.

2.2.6 Evaluate the Engineered Product

The final system is thoroughly evaluated and tested followed by routine maintenance to prevent failures.

2.3 Advantages and Disadvantages of the Prototype Model (Agile methodology)

In the prototype model, users are actively involved in the development since they are required to interact with a prototype which can lead to better feedback and specifications. Thus, errors and missing functionalities can be identified earlier. Prototyping improves the quality of requirements and specifications provided to the developers, hence reducing time and costs. This is because changes cost exponentially more to implement when detected later in development.

3. Requirements gathering

The system should be straightforward and simple as it is a game to improve Mandarin Chinese language for both people who can speak Mandarin Chinese and people who cannot. Requirements were obtained through PACT analysis (Benyon, 2005) to identify user needs and how to design and develop in terms of interface design and programming. From the user requirements gathered. The PACT analysis below presents some of the design considerations/requirements.

3.1 PACT Analysis

3.1.1 People

Each person has his/her own individual taste and preferences. So everyone will have different perspectives on what is enjoyable. People of different ages may also share the same hobbies while people of the same age group may have different hobbies. People also have their own language preferences.

Similarly, some people have better learning or capabilities in languages and varying degrees of technical knowledge/skills while some do not. Hence, the prototype has to be simple and require only basic computer literacy such as how to use a touch screen on a mobile phone.

3.1.2 Activities

Designed in a question-answer completion format where the first half of a famous Chinese idiom is first presented as a question and the second half the choice of answers to complete the idiom, the game is simple, to increase cognitive access for everyone, especially the elderly.

In terms of processes/steps, the game will first display an instruction page and upon choosing the start button, the game will start. If the users would like to end the game, they can close the game dialog. With start, choose, and close as the main actions, the game is easy to follow even if the user, especially the elderly, is not familiar with technologies. Minimization of processes to only the essential is due to the Goals, Operators, Methods and Selection (GOMS) model (Card, Moran & Newell, 1983), Schneiderman, Plaisant, Cohen, Jacobs, Elmqvist, and Diakopoulos' (2016) 8 golden rules for interface design and Nielsen's (1995) usability guidelines provide consistency, reduce error and reduce cognitive load. GOMS and the 8 golden rules thus encourage efficiency and reduction of error or confusion. Some functions are abstracted from the users to ensure the game runs smoothly. These functions are the controller aspects of the system.

The consequent design considerations are:

1. colour, to reduce eye strain due to long exposure;
2. font size and colour for easier recognition, even for the elderly;
3. loading speed as the game has a time limit;
4. ease of play for users with low knowledge in technologies.

3.1.3 Context

The traditional game targets not only the elderly. Everyone is able to play the game, allowing cultural traditions to spread and pass on instead of being forgotten when the older generation pass on. Modern children are reluctant to play old games with board and cards but are more than willing to learn an old game that is incorporated with devices. This makes teaching traditional games to children easier.

The factors considered are: portability (fast loading, even in areas with slow Internet connection), accessibility (not cognitively/physically taxing, available on mobile and Web).

3.1.4 Technologies

The concept of the website is to incorporate old traditional games with technologies. Webpages can be accessed with different operating systems and the game graphic is very minimal which can be played even with a very outdated device. The type of device also does not affect the game such as using a PC or smartphone or tablet.

The game is also easily updated. It is easy to create a new set of questions and answers. Incorporated with touch screen technologies, the user would be able to play the game with similar movements as when playing the physical game.

3.2 Functional and non-functional requirements

From the PACT analysis, the development team brainstormed scenarios with personas and use cases. The team members thought of some scenarios such as the ethnicity of the persona and how well-versed they are in Mandarin Chinese. Thereafter, the systems requirements specifications decided on are as follow:

3.2.1 User requirement

- The application should be able to cater to people who knows Mandarin Chinese.
- The application should be able to cater to people who has minimal understanding of Mandarin Chinese.

3.2.2 *Functional requirement*

- The application should be able to start the game when the user clicks the start button.
- The application should be able to countdown when the game has started.
- The application should be able to allow users to select the answer of his/her choice.
- The application should be able to ask new questions every turn when the users manage to answer correctly.
- The application should be able to detect whether the answer is correct or not in relation to the question asked.
- The application should allow users to restart the game when they lose.

3.2.3 Non-functional requirement

- Graphical interface with interchangeable states that are triggered when certain conditions are met.
- Clean and minimalistic aesthetics.
- Clear representation of buttons and ordering of the answers displayed on screen.
- Language of the game in Mandarin Chinese, using Traditional Chinese characters.

3.2.4 Usability requirement

- The application’s interface should be instinctive for users to handle without much instructions required.

3.2.5 Data requirement

- Players are not able to tamper with the questions and answers data within the game.
- No information of the user will be kept when the game is running or after exiting the game.

4 Design

The system architecture of the game maps to the Model-View-Controller (MVC) architectural pattern. It can be considered a Single Page Application as well because the game runs on a webpage. There is only 1 page with multiple states implemented into the Web application. With each user interaction to the system, the users' actions will affect the controller to change within the code querying. Then the controller will update the model with new value changes. After changing the values, the model would notify the changes to the controller which would proceed to update the view for output on the interface

The system flowchart is illustrated in Figure 2.

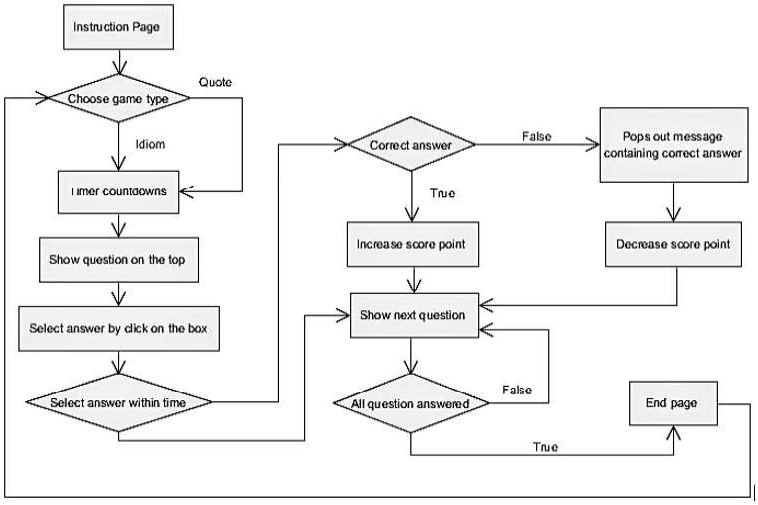


Figure 2. System flowchart

5 Development

The system was developed by using the React.js programming framework. The tools used to support the development are Node Package Manager (NPM), Node.js and Yarn. High-fidelity simple designs are developed to suit the style of Single Page Application to allow users to test and provide feedback and for developers to refine the system. Subsequently, users' feedback is evaluated and the system refined.

Traditional Chinese fonts are from free open-source websites. The Traditional Chinese characters font style looks like Chinese calligraphy. This font type is chosen due to the aesthetic pleasing feel as people who want to learn Mandarin Chinese can feel some aspects of the Chinese culture as well.

Two difficulty levels have been created: idioms are easy and thus forms Level 1, while famous quotes are difficult and thus forms Level 2 (Figure 3).

Figures 3. Game snapshot

There are two parts to the Chinese idiom. The question is the first half of the famous Chinese idiom. A set amount of time is allocated for the user to select the answer to each question (Figure 4). In Figure 4, open slots are used due to object-orientation, enabling easy instantiations to anything.

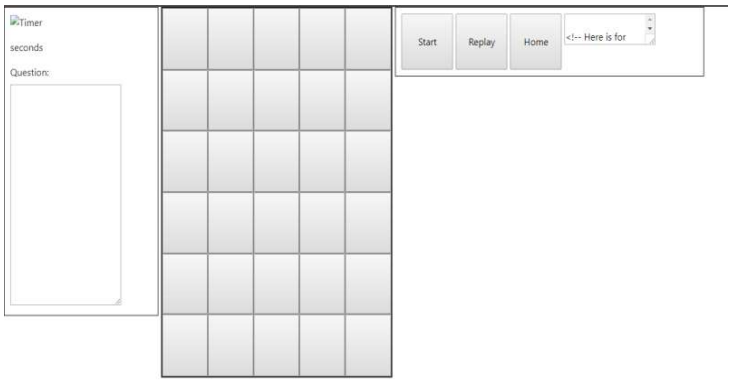
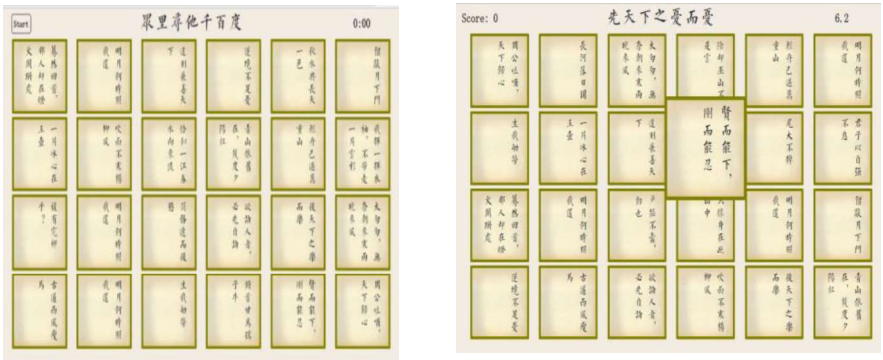


Figure 4. Game page of the website

Users can choose the answers from the randomly-generated answer list. They are placed with uniform spacing and the contents are clearly defined within their own boxes with solid black line borders that can be distinguished easily (Figure 5a). With every question, 24 possible answers will pop up. The number of answers is intentionally designed this way to slightly overwhelm the users to test their knowledge of famous Chinese famous quotes.

The timer is also to test the users' time taken to answer the question. The question appears at the top. The cards below in multiple boxes contains the second half of the famous Chinese idiom. When the user moves the mouse to the answer, the card will pop-up/enlarge (Figure 5b). If the user chooses the correct answer within the time limit, then the user can proceed to the next question. If the user chooses the wrong answer, then a pop up will appear indicating that it is the wrong answer and display the correct answer in a different colour. If the user does not choose any answer within the time limit, the next question will pop up instead.



Figures 5a and 5b. Game snapshots (normal view and pop-up view)

For consistency, the process and display are consistent for every set of questions-answers. However, sometimes the number of words for the answer box might not fit the container. Besides speed/time limit, the challenge lies in the positioning of the Q&A type of scoring. The answers are clustered so that users would not be able to perceive the answer quickly.

6 Evaluation

For usability testing, we asked random students within the university to be this system's test subjects with their approval. The test subjects varied in ethnicity. Most of them were capable of understanding

Mandarin Chinese but weak in forming more difficult sentences as not all Chinese in Malaysia are from formal Chinese streamed schools.

We carried out two iterations to refine the design and system. The same questions and requirement gathering method were performed with the test subjects. The test subjects were asked to use the application from the same laptop. Then, after the test, they were asked to evaluate based on a Technology Acceptance Model [15] rating/feedback questionnaire.

For each iteration, 10 students took part. The data obtained were both qualitative and quantitative. These data could be meaningful to our next iterations to improve the next design.

6.1 Interview questions and answers

The questions asked during every interview session (qualitative data) are presented in Table 1.

Table 1.
Questions and answers during usability testing

Questions	**Answers**
1) Do you find the game interface pleasing?	*Iteration 1*: 70% said yes. *Iteration 2*: 60% said yes.
2) Did you feel yourself involved despite the short experience?	*Iteration 1*: 60% said yes, *Iteration 2*: 90% said yes.
3) What did you like the most in this game?	Challenging, clean interface
4) What would make the game more fun?	More multimedia, more personalization

6.2 Quantitative data was collected via the Technology Acceptance Model.

The Technology Acceptance Model (TAM) (Figure 6) is concerned with the perception of the users towards ease of use and usefulness of the system.

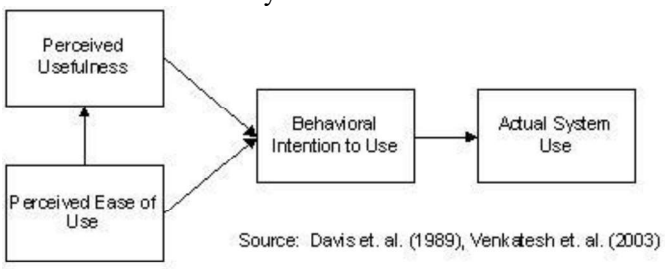


Figure 6. Technology Acceptance Model

Outcomes are positive as there is improvement in iteration 2. Figures 7a and 7b present user feedback on perceived ease of use and Figures 8a and 8b on perceived usefulness. Details are as follow.

6.2.1 Perceived ease of use

What do you think about how the game was designed?

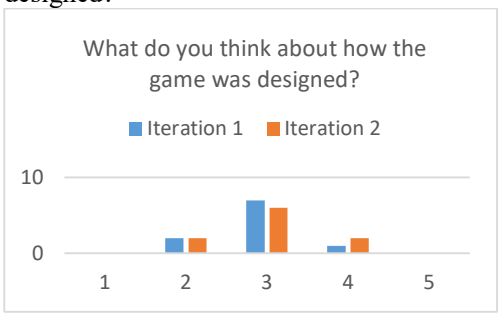


Figure 7a. Users feedback about the game's design

How was your overall experience with this game?

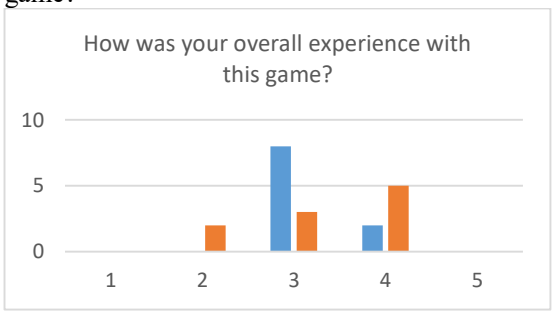


Figure 7b. Overall experience with the game

6.2.2 Perceived Usefulness

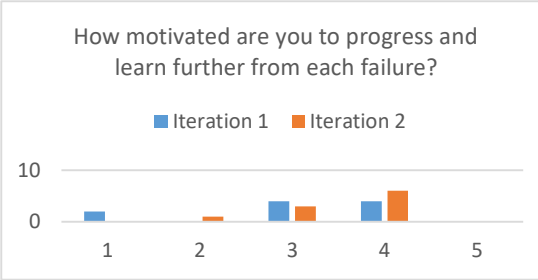


Figure 8a. Users' motivation after playing the game

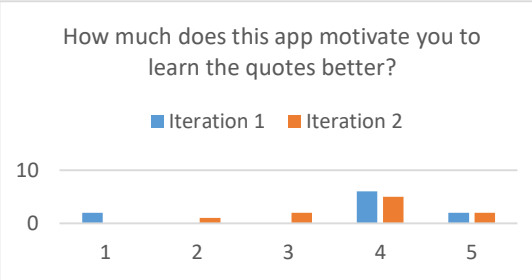


Figure 8b. Feedback on learning famous quotes from the game

6.3 *Evaluation based on Nielsen's usability heuristics*

In addition to the interview session, at the third iteration, evaluation is performed using Nielsen's (1995) ten usability heuristics and the results are presented in Table 2. These are: 1) visibility of the system status, 2) match between real world and system, 3) user control and freedom, 4) consistency and standards, 5) error prevention, 6) recognition rather than recall, 7) flexibility and efficiency of use, 8) aesthetics and minimalistic design, 9) help users recognize, diagnose and recover from errors, 10) help and documentation. Five experts took part in the evaluation.

From the experts' comments, cognitive load is the most crucial issue. Hence, the questions and number of answers need to be shortened and reduced respectively, colour needs to be more attractive and the answer cards somehow need to differentiate so that it is easier to find and match the answer. Furthermore, error feedback is important. These findings support that of prior research on cognitive load.

These have been addressed as in Figure 9 for an adaptation to Chinese idioms.

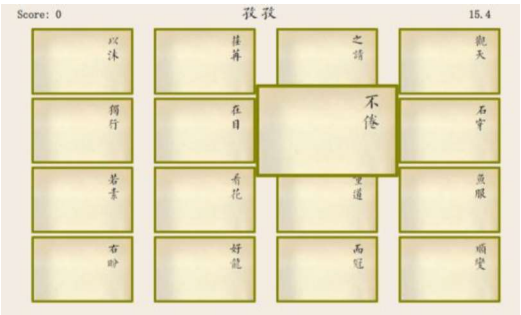


Figure 9. Example of Chinese idioms

By looking at the gathered data, we find that the first prototype is improved after applying the TAM evaluation model resulting in the second prototype. Users find the game easy to use mainly due to the minimalistic designs and the low number of actions required to start, play and end the game. The perception of users towards the usefulness of the system is determined by the extent the objective of this game and the users' objectives are achieved. Furthermore, GOMS (Card, Moran & Newell, 1983), Schneiderman, Plaisant, Cohen, Jacobs, Elmqvist, and Diakopoulos' (2016) and Nielsen's (1995) user interface/interaction guidelines are useful to elicit useful insights towards better performance and technology acceptance.

The game has motivated them to learn Chinese famous quotes better. After performing the evaluations, we find that language learning users the importance of cognitive load, support for preference for minimalist designs and short steps towards achieving their goals. Score comparisons with other users, multimedia elements, personalization and differentiation among answer cards are also preferred. This finding contributes towards the design of media richness but with simple lean designs. Frustration would arise more due to their own sense of personal achievement towards further self-improvement.

The most important significance is that the JSON file is easily editable even by young children. So they can create or modify their own JSON files to create new games (questions and answers), share the JSON files with their friends and compete if they want to. To modify, they can also collaborate in teams.

We have concluded that we have managed to achieve the objectives of this project. Therefore, we can conclude that this project is a success. There are still many ways to improve this game to make it a better one. In the future, this game can also be modified to be suit learning of other languages and other purposes such as the learning of Science through questions and answer, using pictures and/or words. The game can also be modified for up to 2-player to play against each other. However, the online capacity would require more resources and time with a dedicated domain name and server if it were to be implemented.

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