Gamification of Mobile-based Japanese Language Shadowing

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Abstract—**Learning second language using shadowing technique is effective, but also tends to be boring, less motivating, and has no feedback from teacher on whether the pronounciation is already correct or not. On the other hand, there are various gamification elements that can be applied such as progression, rewards, leaderboard, etc., which can provide a learning environment that continues to motivate student to achieve better result. One of the essential element is direct-feedback to determine whether the answers given by the students are already correct or not, by calculating similarity between student's speech and reference speech using Mel-Frequency Cepstral Coefficients (MFCC) feature and Dynamic Time Warping (DTW). In this study, a gamified Japanese language learning application based on mobile platform named "Shadowingu" is developed. The evaluation results showed that gamification is preferred and have significant Effect Size on student's motivation, when compared to the conventional shadowing method, as well as have positive effects on overall learning experience.**

Keywords—Gamification, Japanese Language Shadowing, Speech Similarity, MFCC-DTW

I. INTRODUCTION

Shadowing, a language learning method especially well-known in Japanese language, is a technique of hearing a recording of how to pronounce a word or sentence correctly, and try to repeat it as close as possible [1]. This technique is effective for learning new vocabularies as well as improving speaking skill which is often not focused on Japanese language school because it is not included in Japanese Language Proficiency Test (JLPT) exam materials. Even worse, pronunciation is considered to be one of the main factors that make it difficult for students to speak Japanese fluently [2]. However, practicing shadowing independently also tends to be boring, less motivating to finish learning materials, less challenging, no peer partner, and no feedback from teacher to assess whether the pronounciation is correct.

On the other hand, gamification as a technique for applying game elements in non-game context applications [3], can be applied to make a fun, interesting, and challenging learning environment that continues to motivate students to achieve better result. There are various gamification elements that can be applied such as goals, stage, rules, tracking mechanism, points & currency, time, feedback, progression, storytelling, transparency, rewards, badges, leaderboard, avatar, and information retrieval, which one of each has its own influence on students' motivation [4] [5]. One of the essential element is feedback to determine whether the answers given by students are already correct, by using a speech similarity algorithm.

In this paper, a gamified Japanese language Shadowing based on mobile platform is developed.

II. ARCS MOTIVATION THEORY

When learning language independently, student's abilities are often barely improving due to the lack of motivation in completing all learning materials, thus making motivation as one of the key points for success. Furthermore, Keller [6] describes an ARCS concept which explains that motivation can be influenced by four different components:

1. Attention: variable that stimulate curiosity, maintain focus, and make a fun learning experience. Variation on learning method (text, video, case study), providing clear examples, learning materials that encourage students to keep trying, and active participation through interactive game and elements such as avatars, storytelling, and social elements can be used to grab student's attention.

2. Relevance: variable that ensures learning objectives are achieved according to student's needs and it can be further applied in real life. This variable is closely related to the element of goals and appropriate curriculum design which shows that this material is still relevant and will be useful in the future.

3. Confidence: variable that ensures students are confident to learn and master the subject without worries. Gamification elements such as tracking mechanism, transparency, objective, progression, and feedback can help to make sure students are aware of their learning progress and outcome.

4. Satisfaction: variable that ensures students remain motivated during learning process by providing a feeling of satisfaction and pleasure. There are two types of this motivations [5]:

   a. Intrinsic: Motivation that come from the learner's intention itself, like feeling pleasure when studying. This motivation provides freedom for students to learn things that suit their interests, provide a way for mastery, and confidence in facing challenges.

   b. Extrinsic: Motivation obtained from rewards and punishments. It's useful for forcing students to do things that are not attractive or unfavorable for them and increase the pleasure and effort of learning. Gamification elements such as rewards, badges, leaderboard, virtual currency, and use of multimedia elements (text, audio, images, animations) are effective to increase this kind of motivation.

In order for a gamified learning app to be successful, it must be able to combine all of these components with the right combination.

III. Related Research

There are many studies that analyze the effects of gamification elements specifically in the area of learning foreign languages as a second language and most of the results provide positive psychological and behavioral benefits on respondents as suggested by Hamari et al. [7] in his empirical study that examined more than 20 studies related to gamification. In another study, Fathoni and Dea [8] attempted to develop a gamified learning app to write Japanese kanji strokes with game simulations and quests against monsters. For each correct stroke, the monster will be defeated. This research shows that games can be used to make learning interesting. Research by Baylis [9] also shows that learning Japanese grammar can be done through game simulation against monsters by applying gamification elements such as progression, rewards, levels, and social elements using multiplayer collaborative learning.

In another study, Zhou et al. [10] created an application for learning English writing that emphasizes the elements of Rapid Feedback and Freedom to Fail in the form of grammar checking, as well as Information Retrieval to review previous learning materials. This research shows that current technological advances are able to produce new forms of feedback using Natural Language Processing, AI/ML, etc. and are no longer limited to multiple choices. Gamification can also be combined with Augmented Reality and Geolocation as Perry [11] tried for French vocabulary learning. Students are given missions on designated places around campus, to learn vocabularies according to the theme of each place.

But even though gamification does give promising result on student's behavior, a good and careful design on learning materials is also essential for a successful learning app, as suggested by Molaee and Dortaj [12] that designing materials based on ARCS components can improve learning result and motivation.

IV. Gamification Design

In this study, "Shadowingu", a gamified Japanese shadowing learning app based on Android platform was designed by following The Five Step Model Framework [13], which provides design steps to produce an effective and successful gamified language learning app. A thorough designs on gamification elements have been conducted by following game design concept [14] as well as comparing various alternatives from other researches, popular gamified learning apps such as Duolingo, and games. The final design is described on these five steps:

A. Understanding Target Audience and Context

This app is designed for helping beginner students, which are not limited by any gender, age, or certain groups. This app provides students an independent learning environment, thus it requires a quiet study place for an optimum result. The duration of each consecutive learning is short (± 2 minutes) so students can study in their spare time and feel the learning progresses.

B. Defining Learning Objectives

The main objective is to increase Japanese speaking skill and vocabularies, specifically to pronounce Japanese words accurately. In addition, it is also expected that student motivation can be improved in learning.

C. Structuring the Experience

The learning material is divided into seven lessons such as family, school, canteen, cities, and traveling, with each material consist of ten vocabularies. The first five materials were taken from the vocabulary that appeared on JLPT N5 exam (basic), while the next two material from JLPT N4 (lower-advanced), to give the sense of increasing difficulty on each stage.

D. Identifying Resources

At this stage, six gamification elements considered necessary for an effective language learning apps were designed [4] [5].

TABLE I.   DESIGN FOR GAMIFICATION REQUIEREMENTS

No.	Element	Description
1	Goals	There is a main objective for a group of materials with the same category and each material has a more specific objective.
2	Stage	There are 2 main stages according to JLPT N5 and N4. Each stage consists of multiple lessons, each with 10 vocabulary on specific topic. To be able to proceed to the next lesson, students must complete all the lessons beforehand. This is to make sure students progresses incrementally.
3	Rules	1. Students must answer the words correctly before they can proceed to the next word. However, if the student is already wrong once, then they can skip it to avoid stucks on specific words. 2. For each material, students will have Life Points (LP) that will be decrease if their pronunciation is incorrect. If LP reach zero, it will be Game Over and they have to repeat the lesson again from beginning. This design is influenced by a research [8] with some improvements.
4	Tracking Mechanism	To measure student's progress, it will be seen from number of correct answers and time to complete each lesson. Duolingo, on the other side, use a lesson's level that shows how many time a lesson is repeated. However, this kind of method doesn't really show how much students have progress.
5	Points & Currency	Experience Points (EXP) to level up that shows student's skills and Virtual Currency (GEM) that can be exchanged to buy new Avatars with different power.
6	Feedback	Direct Feedback to determine whether the pronunciation is already correct, as well as using variety of multimedia data (text, image, audio, animation) to enhance learning experience.

E. Applying Gamification Elements

Finally, ten other optional gamification elements were designed to encourage student's motivation and provide a better learning experience [4] [5].

TABLE II.   DESIGN FOR GAMIFICATION ELEMENTS

No.	Element	Description
1	Time	Each lessons is designed to be completed in short time (± 2 minutes for 10 vocabularies on each lessons) so it can be played in spare time.

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No.	Element	Description
2	Progression	1. Inter-material progress, where the next material will be unlocked after the previous material has been cleared. This is to make sure that students progress gradually from basic to advance lessons. 2. Intra-material progress, where there are 10 vocabularies on each lessons that need to be shadow one by one.
3	Storytelling	Player will take role as a high school student who are fighting zombies by shadowing. If the answer is correct then the monster loses, if it's wrong then student is attacked by monster and LP decreases. Students will have to fight zombies on different scenes according to the lesson that is currently learned (home, school, canteen, city, etc.).
4	Transparency	Students can see the number of correct and fastest time for each lesson that has been cleared, so students can monitor their own progresses.
5	Rewards	Students will get EXP and GEM for every lessons cleared. EXP acquired will be increasing for each lessons (500, 750, 1000, …), while the number of EXP required to be able to level up is also increasing (500, 1000, 1500, …), thus it force students to repeat some lessons, in hope that their skills will also increase. GEM is given as a way to increase students' power by buying new Avatar. There's also alternatives by rewarding students with consumable items, weapons, etc. to help students on their journey of fighting zombies, but it's not yet implemented on this prototype.
6	Badges	There are various types of Badges that can be obtained by students after achieving certain conditions, including: • Perfecto (cleared a lesson without any incorrect answers) • Completionist (finish all learning materials) • Rich Buyer (buy new Avatar for the first time) • Maximus (reach maximum level) • Don't Give Up (Game Over for the first time). There's also a Title that will be acquired as student's level increase, namely: Kindergaten (Lv.1), Elementary (Lv.3), and High School Student (Lv.5). A Title is important because number of levels solely doesn't give enough insight on student's current skills.
7	Leaderboard	Online leaderboard to display students ranking based on their level, so that healthy competition can grow between students. Badges and Title will also be displayed on Leaderboard to give students a sense of pride.
8	Avatar	There are various avatars with different Life Points so that they can help students on their study. Avatars can be purchased using GEM.
9	Information Retrieval	There are learning feature that are accessible for each cleared lessons. So student doesn't have to repeat the whole lesson if only want to check some words kanji or meaning. Student cannot do shadowing on this feature.
10	Challenge	Students are challenged to increase their knowledge by shadowing words with correct pronunciation.

V. Implementation

Fig. 1 below shows the screenshots of Shadowingu app. This app can be downloaded from Play Store by typing the app name as keyword. For testing purposes, another app named "Shadowingu Lite" was developed to represent a conventional shadowing technique with the same material as Shadowingu, but all gamification elements were omitted. This two apps will be used for comparing the effects of gamification on improving motivation between two groups.
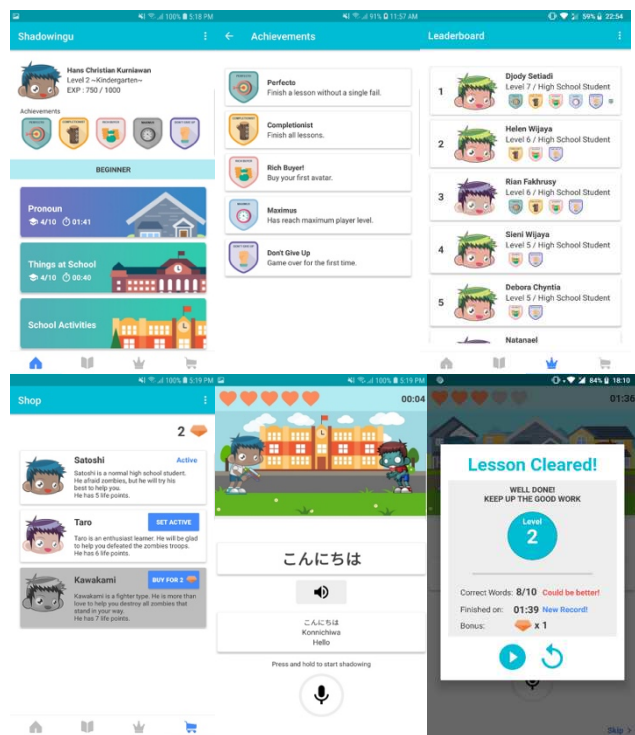

Fig. 1. Shadowingu, a Gamified Japanese Shadowing Learning App

To provide feedback on whether the pronunciation of students is already correct, a similarity matching method using Dynamic Time Warping (DTW) is implemented by comparing Mel-Frequency Cepstral Coefficients (MFCC) between student input sound and reference pronunciation sound stored in database [15]. By using DTW, the difference on individual speech speed can be handled. Based on experimental results in this study, the average similarity distance value between input sound and all audio references is used as a threshold. Thus, if the similarity distance of current word is smaller than threshold, then student's pronunciation is considered as correct. An example of determining threshold value can be seen in Fig. 2.
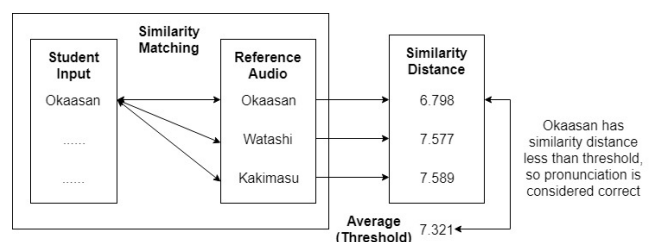

Fig. 2. Example of Speech Similarity Matching Process

VI. Evaluation

The tests carried out involved an experiment group of 25 people and a control group of 15 people, where all respondents are aged between 20-30 years, had an interest in Japan, and did not have Japanese language skills (novice students). There are five evaluations carried out to measure different parameters.

A. Skill Improvement Evaluation

Pre and Post Tests are conducted on sub-samples where respondents were asked to speak a few words, before and after shadowing. From this test, 60% of the word pronunciation have an increase in accuracy, which shows that shadowing technique is effective for practicing speaking skills and the speech similarity method used are quite capable of distinguishing the correct pronunciation, even though the accuracy level is still relatively low.

B. Comparative Evaluation of Learning Methods

The experimental group was asked to learn using Shadowingu and Shadowingu Lite apps, then followed by filling questionnaire. The questionnaire result shows that 92% of respondents preferred Shadowingu app as a better learning tool. Furthermore, a qualitative test was conducted by categorizing the reasons for choosing Shadowingu app into three categories, which is because there are Direct Feedback (N=8), the app is more Challenging (N=4), and Interesting / Fun / Motivational (N=19). Note that every respondent can provide more than one reasons.

Whereas for 8% of respondents who prefer non-gamification app, they reasoned that they wanted to focus on learning and the addition of gamification elements actually disrupted the learning process. Thus, it can be concluded that they have different preferences than the majority of other respondents.

C. Comparative Evaluation on Students' Motivation

This test compared motivations between experimental group who learn Japanese using Shadowingu app, and the control group who learn using Shadowingu Lite app. Both groups are required to fill out Instructional Materials Motivation Survey to measure student's motivation based on the ARCS components [6].

The result on Fig. 3 below shows an increase in average motivation in experimental group on all ARCS components.
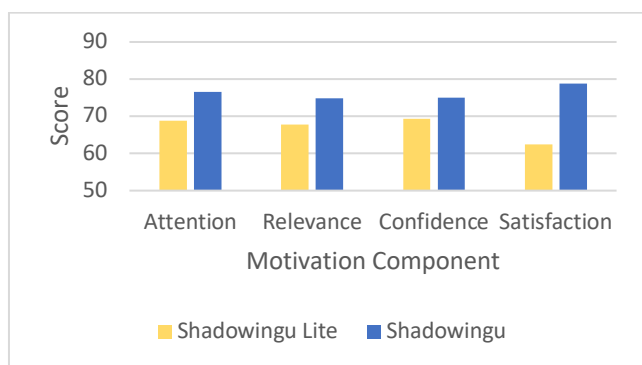

Fig. 3. Comparison of ARCS Motivation Results

The conducted Levene Test shows that although the two groups have different sample sizes, they are both homogeneous, so they are feasible to be compared. Thus, to provide a quantitative insight, an Independent Samples T-Test is conducted because the data are distributed normally based on Saphiro-Wilk Test. With 95% confident factor, three components including Attention, Relevance, and

Satisfaction has a significant mean difference (Sig.<0.5), as shown on Table III.

TABLE III.   RESULT FOR INDEPENDENT SAMPLES T-TEST

Independent Samples Test						
				t-test for Equality of Means		
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Attention	Equal variances assumed	2.384	38	.022	7.75556	3.25256
	Equal variances not assumed	2.385	29.655	.024	7.75556	3.25133
Relevance	Equal variances assumed	2.278	38	.028	7.05185	3.09602
	Equal variances not assumed	2.165	25.154	.040	7.05185	3.25715
Confidence	Equal variances assumed	1.902	38	.065	5.60000	2.94444
	Equal variances not assumed	1.694	20.504	.105	5.60000	3.30629
Satisfaction	Equal variances assumed	3.870	38	.000	16.3556	4.22632
	Equal variances not assumed	3.639	24.297	.001	16.3556	4.49426

Finally, an Effect Size calculation is performed using Cohen's d and the result can be seen on Table IV.

TABLE IV.   EFFECT SIZE OF ARCS MOTIVATION COMPONENTS

No.	Component	Effect Size	Category [16]
1	Attention	0.7789	Medium-to-Large
2	Relevance	0.7243	Medium-to-Large
3	Confidence	0.5833	Medium
4	Satisfaction	1.2235	Very Large

The results are very promising, especially for Attention and Relevance component which have Medium to Large effect, and for Satisfaction component with Very Large effect. This shows that gamification elements, good learning material design, app usability, and the use of multimedia such as audios, wordings, and animations have successfully increase student's motivation.

D. Evaluation on the Effects of Gamification Elements

Based on the respondent survey results using Likert scale of five with 1=very negative effects (making learning difficult, troublesome, etc.), 3=neutral, and 5=very positive effects (fun, interesting, motivational, challenging, etc.), all 15 gamification elements that were applied had a positive effect on overall learning experience. But there are three elements (Rules, Story, and Avatar) that only get an average value between 3 and 4, which means it only gives a few positive effects. The reason for this is there are some respondents who felt that those three elements make their learning process more difficult instead of easier. The rules stated that the game is over when Life Points, which depend on the type of Avatar used, were used up. However, the majority of respondents still feel that those elements can provide more challenges and make overall learning experience more interesting. Fig. 4 shows the effects of each gamification elements.
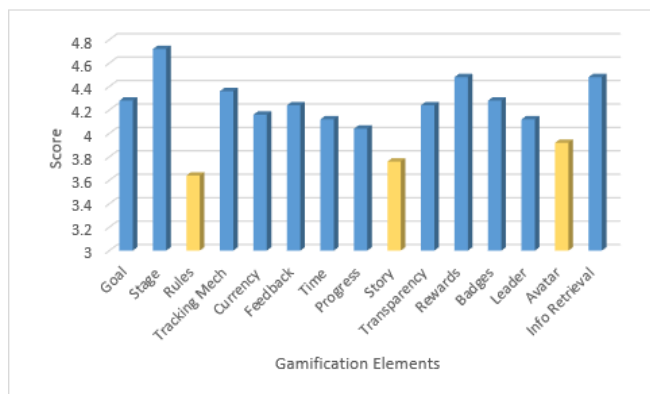
Fig. 4. Gamification Elements Effects on Overall Learning Experience

E. Application Usability Evaluation

Usability test were conducted using System Usability Scale (SUS) survey [17]. The result shows that 80% of respondents gave a score above 68, with a mean of 77.1 or equivalent to the value of C - "Good" according to the SUS comparison table [18]. Thus, Shadowingu app is proven to have good usability and can be used as an effective and efficient learning tool.

VII. CONCLUSION & DISCUSSIONS

This study successfully proved that gamification elements which combined with careful application design and right learning materials, could revolutionize conventional learning methods to be more effective in increasing students' motivation and learning experiences especially in the area of learning Japanese as a second language.

However, this study has not yet examined whether the effects of gamification are the same over long-term period or only due to its novelty. It needs further research combined with variations of learning materials such as kanji, grammar, and writing so that students remain engaged. Several elements such as Rules, Story, and Avatar can also be further investigated to find a better design that could give more positive effects. In addition, based on the results of experiments and respondents' survey, the speech similarity method used is still not accurate, so it is necessary to find a technique for determining the dynamic threshold that is more appropriate, and consider several other variables such as noise reduction and the variation of devices used.

REFERENCES

[1]. H. Sumiyoshi, "The Effect of Shadowing Practice: A Case Study of Japanese Language Learners in an Australian University, Master's Thesis, Macquarie University, 2014.

[2]. J. Peterson, "A Japanese Pitch Accent Practice Program and L1 Influence on Pitch Accent Acquisition", *Proceedings of the Linguistic Society of America*, vol. 3, pp. 1-12, 2018.

[3]. K. Werbach and D. Hunter, "For The Win: How Game Thinking Can Revolutionalize Your Business", Philadelphia: Wharton Digital Press, 2012.

[4]. J. Figueroa, "Using Gamification to Enhance Second Language Learning", *Digital Education Review*, vol. 21, pp. 32-54, 2015.

[5]. K. Kapp, L. Blair, and R. Mesch, "The Gamification of Learning and Instruction Fieldbook: Ideas into Practice", San Fransisco: Wiley, 2014.

[6]. J.M. Keller, "Motivational Design for Learning and Performance: The ARCS Model Approach", London: Springer, 2010.

[7]. J. Hamari, J. Koivitso, and H. Sarsa, "Does Gamification Work? – A Literature Review of Empirical Studies on Gamification", *47th Hawaii International Conference on System Science*, 2014.

[8]. A.F. Fathoni and D. Dea, "Gamification of Learning Kanji with Musou Roman Game", *1st International Conference on Game, Game Art, and Gamification*, 2016.

[9]. C. Baylis, "Player VS Language: The Effect of Multiplayer in Gamified Learning Environment", Master's Thesis, University of Massachussets Amherst, 2016.

[10]. L. Zhou, J. Yu, C. Liao, and Y. Shi, "Learning as Adventure: An App Designed with Gamification Elements to Facilitate Language Learning", *HCI in Business, Government and Organizations, Interacting with Information Systems (HCIBGO),* Lecture Notes in Computer Science, 10293, Springer, Cham, 2017.

[11]. B. Perry, "Gamifying French Language Learning : A Case Study Examining a Quest-based, Augmented Reality Mobile Learning-tool", *Procedia – Social and Behavioral Sciences*, vol. 174, pp. 2308-2315, 2015.

[12]. Z. Molaee and F. Dortaj, "Improving L2 Learning: An ARCS Instructional-Motivational Approach", *Procedia – Social and Behavioral Sciences*, vol. 171, pp. 1214-1222, 2015.

[13]. W.H.Y. Huang and D. Soman, "A Practitioner's Guide to Gamification of Education", Research Report Series: Behavioral Economics in Action, Rotman School of Management - University of Toronto, 2013.

[14]. E. Adams, "Fundamentals of Game Design 2nd Edition", London: Pearson Education, 2009.

[15]. B.J. Mohan and R. Babu, "Speech Recognition using MFCC and DTW", *International Conference on Advances in Electrical Engineering*, 2014.

[16]. S. Sawilowsky. "New Effect Size Rule of Thumb", *Journal of Modern Applied Statistical Method*, vol. 8, no. 2, pp. 467-474, 2009.

[17]. J. Brooke, "SUS - A Quick and Dirty Usability Scale", Usability Evaluation in Industry, London: Taylor and Francis, 1996.

[18]. A. Bangor, P. Kortum, and J. Miller, "Determining What Individual SUS Score Means: Adding an Adjective Rating Scale", *Journal of Usability Studies*, vol. 4, no. 3, pp. 114-123, 2009.