Motivational impact of gamification for mobile learning of Kanji

Abstract: Gamification is a growing field in education, e.g. for e-learning software on mobile devices. Gamification uses game elements in a non-game context to engage users. But it is necessary to know how this can influence learners. In a study the impact on motivation by gamification for language learning in conjunction with mobile learning was investigated. For this purpose a mobile app to learn the writing of the Japanese characters (kanji) was developed. Additionally, a second version of this app was created including gamification elements. The working prototypes were tested in two groups. Over a period of two weeks the usage was automatically logged to gain objective data. Additionally, the participants received a questionnaire after this test period, asking for the subjective emotion, with focus on the instinct motivation. The results show an improvement of motivation by gamification elements.

Introduction

Learning is something that has ceased to be restricted to the classroom a long time ago. The modern society is flooded with information. In order to handle this amount of information, it is indispensable to develop forms of learning which enable the learner to learn in a way that is adapted to the learners' daily life, or to be more specific, his/her way to seek for information. Consequently, digital media, over the last years especially smartphones have moved to the fore due to their increasing meaning in daily life in terms of seeking and providing information. One reason may be the permanent availability and widespread use of smartphones these days. Mobile learning is a logical consequence of these circumstances.

Mobile learning, as a specialization of E-learning, deals with the intelligent combination of didactic objectives and technological possibilities of mobile devices (e.g. Berge & Muilenburg, 2013; Frohberg et al., 2009). Wu et al. present results from their meta-study, identifying several research challenges (Wu et al., 2012). Mobile learning is an extension of E-learning, which is taking into account the increasing availability of mobile devices and the spread of mobile internet which enables the learning anywhere at any time (Motiwalla, 2007) that in turn offers new possibilities for learning applications. Particularly in language learning, mobile applications offer an easy access and instant learning opportunities (e.g. Chen & Chung, 2008; Kukulska-Hulme, 2009; Liu, 2009; Wang & Shen, 2012). So far, Japanese characters have hardly been subject to research in mobile learning (Dong & Liu, 2013). The main research focus is on English as a foreign language with different specializations (e.g. Kim & Kim, 2012 on screen sizes for vocabulary learning). Fewer studies have addressed other sign languages such as Chinese (Tseng et al., 2007) or Korean (Cho et al., 2004).

Despite the before mentioned technical aspects, the success of learning in fact is based on several factors. Probably the most important aspect is motivation of the learner (Deci at al., 1991). But does he or she want to learn something because of the fun while learning something like a new language? Or does he or she learn only to get a good grade or may be even avoiding a punishment for getting bad grades? The first kind of motivation is called intrinsic motivation and is presumably a good motivation for successful learning. The second one is called the extrinsic motivation (Ryan et al., 2000).

Therefore one of the goals for learning applications should be the support of the motivation of learners. E-learning focuses on the usage of digital devices for learning and this alone can give a small boost of motivation. But the author points out that this might only be the excitement of trying the new and there is no guarantee for increasing motivation. As another attempt of supporting the motivation gamification comes into play. Deterding et al present a short and striking definition for gamification: “the use of game design elements in non-game context” (Deterding et al., 2011). A popular attempt of an implementation is the usages of gaining rewards in form of badges for completing defined tasks or the usage of leaderboards to compare multiple users (Hamari et al., 2014). But gamification is more than this. The power of gamification lies in the elements that make a game engaging: accomplishing or completing something, the success of overcoming a challenge by solving problems, getting direct feedback, the storytelling and the visualization of characters. In addition games for learning should be not motivated by external awards, but by a significant learning experience (Kapp 2012, p. 93f). The goal is to let the learner have fun while learning and with this to support the intrinsic motivation (Ryan et al., 2000).

Many empirical studies have been undertaken that show a general positive impact of gamification as well as on learning in particular (Kapp, 2012; Hamari et al., 2014; Sandberg et al., 2014). One reason cited for this is the influence of motivation of the learners (Kapp 2012, p. 93ff). But the results of Hamari’s results weren’t clearly.

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Some of the studies that were examined even showed a bad impact of gamification. Some participants were precisely disturbed by gamification elements. Therefore, further researches are necessary.

But after mostly positive perception of gamification, it is not surprising it is widely applied in the context of education or learning especially in the mobile field. With applications like “Duolingo” for learning languages, “Math Ninja” to practice the Elementary arithmetic or “Stack the Country” helping to memorize countries with capitals and geographic locations.

But still the question remains: how far is the gamification able to have an influence on the motivation of mobile learning? For this purpose two mobile applications for Android smartphones were developed, to learn the Japanese characters, the kanji. The main goal was to research the influence on motivation and not a possible difference in learning success.

**A mobile learning app for Kanji and its gamification**

The respective mobile learning applications were developed as prototypes for Android smartphones. Along with hiragana and katakana, kanjis are part of the Japanese writing system. Those characters were adopted from the Chinese characters from 4th to 7th century (Heisig, 2011). However the meanings as well as the readings of the characters mostly differ in each language, since the writing system as art of the language is subject to constant changes of the corresponding language development. Up to this day modern Japanese respectively Chinese are modifying, creating and rejecting characters (Hadamitzki et al., 2012, p. 42).

Due to the manner how the Japanese kanji were transfered a kanji comes with several pronunciations. They can be categorized in the so-called On-Yomi ("sound reading") and Kun-Yomi ("meaning reading"). On-Yomi is the Chinese pronunciation of the character, which was transferred to the Japanese phonetics at the time of its introduction. The Kun-Yomi is the reading based on the native Japanese word. Furthermore a kanji can have multiple readings for On-Yomi and Kun-Yomi with slightly different meanings (Hadamitzki et al. 2012, p. 54). The kanji for ‘living’ is an extreme example, it has two On-Yomi and seventeen Kun-Yomi and the meaning varies from ‘living’ to ‘birth’. Usually if a kanji stands for its own the Kun-Yomi is used. If multiple kanjis are combined the On-Yomi of the characters is used.

Besides the readings, a fixed stroke order is assigned to a kanji. When writing a kanji one has to be aware of the fact that kanjis usually are written form the left top to the bottom right. Training the writing of a kanji is important and recurring activity since recognition of a kanji does not mean the kanji can also be drawn. Especially with modern ways of writing on computer or cellphones this is becoming a bigger problem. The kanjis are set automatically after typing in the reading. Therefore more and more adults of younger age need support for writing some kanji although they can read those (Kess at al., 2000).

In the first 9 years of the Japanese school the so called Jōyō-kanji are introduced which consists of regularly used 2,136 kanjis. These kanjis are essential for reading newspapers and forms. Rarely used kanjis usually come along with a reading aid, which indicates the pronunciation (Heisig, 2011). Japanese adults know about approximately 3,000 kanjis, depending on the profession. In modern literature approximately 6,000 up to 7,000 kanji out of 20,000 kanji are appearing (Hadamitzki et al., 2012, p. 43).

The “Japanese-Language Proficiency Test” short JLPT is a standardized test to determinate the Japanese language skill level of non-native speakers. One part of this test are the kanjis, on the lowest level, called N5, the participant has to know about 100 kanjis and on the highest level N1 he or she has to know all Jōyō-kanjis. In 2010 there was a reform of the JLPT, before that there was a test content specification with lists of which kanji has to be known at which level. Since the reform the website states that learning a language shouldn’t be just memorizing words or kanjis but rather use it to communicate. However they are still referring to the old lists because the new tests are close to the ones used before 2010.

Biji – the kanji learning App will be further elucidated in the following section. The elucidation compromises of two parts: the first part will discuss the learning content; some notes about the developing of the prototypes as well as the function of the application of both versions NBiji (normal version) and GBiji (gamification version) will be addressed in detail. In the second part the special gamification elements of GBiji will be introduced. By speaking about Biji both versions are referred.

The app is designed for non-native speakers with none or little knowledge about kanji who want to start learning kanji. The learning content covers 105 kanji, which includes the 103 kanji for the JLPT N5. This comprehends the drawing of a kanji, the meaning, On-Yomi and Kun-Yomi. Biji has different functions: Learning new kanji, Training already learned kanji and a kanji lexicon that includes all kanji that are learnable in this app.

In technical terms the prototype was developed for Android 3.0 Gingerbread. The implementation is designed for using the app in portrait mode on smartphones. For the kanji drawings a character-recognition was used.
to compare the user input with the correct drawing of this kanji. This character-recognition is based on the project “leafdigital kanjirecog” (Copyright 2011 Samuel Marshall under the GNU Public License v3), a free java library for comparing a drawing input with the path information of a scalable vector graphic (SVG). This project comes with an Android application based on this library. This application was adapted and modified to fit the requirements of Biji.

Put simply the algorithm, used in “leafdigital kanjirecog”, checks the starting points and end points of each stroke after a drawing is finished. For each stroke one of eight possible directions is calculated. This direction can be seen in [figure 1]. This method has the benefit of giving the user some freedom while drawing the kanji. The drawing doesn’t have to have the same proportions as the original. Therefore it is possible to trick the algorithm and gain good results for obviously false drawn kanji. On the bottom row of [figure 1] are some examples for an input and the results given by the used algorithm. However it is assumed that the motivation to learn something is greater than to win the game by cheating.

![Figure 1: character-recognition of the kanji for ‘sun’. Upper row includes the direction of each stroke, the bottom row are four examples of an input with the result calculated by the character-recognition algorithm. The two examples on the left are a correct and a false drawing of the kanji detected as such by the algorithm. The examples to the right are false drawn kanji, which are detected as correct.](image)

As comparison for the character-recognition the “kanjiVG” project (under the Creative Commons Attribution-Share Alike 3.0 license) came into hand. It is a collection for SVG of kanji. Besides to the kanji itself it displays numbers next to each stroke to indicate the right stroke order. In order to be able to display this SVG the free library “AndroidSVG androidsvg-1.2.0” (under Apache License 2.0) was used. Additionally the “ShowcaseView” library (Copyright Alex Curran under Apache License 2.0) from an overlay can be created to highlight a specific spot on the screen. The ability of displaying text next to the highlight, this library was used for realizing a tutorial.

![Figure 2: Screenshots of Biji, main screen, drawing kanji with full help, drawing kanji with only starting points, kanji exam, kanji lexicon (from left to right).](image)

In order to learn new kanji, the kanji are divided in lessons with five kanji each in Biji. When learning a new lesson the user will be shown the On-Yomi, Kun-Yomi and the meaning in German as well. Then he or she has to
write the kanji with the proper stroke order. If he or she finishes the drawing of a kanji another kanji from the lessons appears randomly. Depending on progress of the user different kinds of help for the drawing is provided to him or her. In the beginning the whole kanji with the correct stroke order is shown (see [figure 2] second picture from the left), after a successful drawing the stroke order will disappear. Afterwards only the starting and ending points of the strokes will be shown, than only the starting points (see [figure 2] third picture from the left) and finally no help is shown at all. If the user makes a mistake, the next time this kanji will appear again with more help. After the successfully drawing of a kanji without any help, this kanji is considered as learned and won’t appear again. If all five kanji are learned a lesson is over.

Next to learning new kanji the app has a function to train already learned kanji. For this training Biji is organized like a flash-card learning box. This means, every learned kanji is assigned to a box from 1 to 5. When it is learned it will be put into box 1, after it was trained successfully it will go further to the next box in line. If the user couldn’t remember the kanji or made a mistake the kanji was put back into the previous box or in case of box 1 it will stay there. Depending to which box a kanji is assigned to it will appear more frequently in training sessions. Kanji in box 1 will appear more often than kanji in box 2, kanji in box 2 will appear more often than kanji in box 3 and so on. If a kanji from box 5 was successfully drawn in a training session this kanji will be considered as mastered and therefore only appear occasionally in the training sessions.

The lexicon shows all 105 kanji of Biji in a list (see [figure 2] last picture from the left). By tapping one item of the list the Details for it will be shown. Next to the stroke order, the meaning in German and the different readings, additional information are shown, this includes some user statistics. The actual box of this kanji, a counter how often it was drawn, the success rate and the date on which the kanji was last drawn is displayed.

GBiji is, despite many other gamification concepts for learning not only about collecting points or achievements or unlocking new features. Within the app there is a storyline: The user wants to enter the kanji-Temple to become the champion of kanji. And to become a champion of kanji means to fight with them. To enter the temple he or she has to pass the entrance exam and to become the champion to pass the midterm and the final exam. Between these exams the user has to stand against a rival which also wants to become a champion.

So it is not only about drawing a kanji with the right stroke order but about fighting with them. To draw a kanji correct will release magic. This magic can used to fight against another kanji drawer. The damage a kanji will make is influenced by three parameters. The first is the accuracy of the drawing. The second is time, as faster the kanji is finished the higher is the damage. The third is the level of the kanji. In GBiji the term box for the earlier mentioned flash card learning system is changed for the word level. So with the training sessions the kanji will gain more power for the fights.

The exams are fights against the headmaster of the temple. A fight looks similar to learning or training kanji and is shown on the fourth picture from the left on [figure 2]. On the top are three bars, the two green/orange ones of them are showing the health points of the user and the headmaster, the blue one is the progress bar of the headmaster. The progress bar shows how fast the headmaster is with the finishing of a drawing. Each time a kanji appears an algorithm calculates the accuracy and the speed of the headmaster. After passing the exams the user will gain a new title. He also is rewarded a new brush color, to change the appearance of the app. After winning the regularly fights against the rival the user only gets a new brush color.

Furthermore the user is able to collect some kind of badges. For each kanji he or she is able to master in the training sessions the user gains a star. This star will be shown in the lexicon and in the kanji details.

There are also some other differences between GBiji and NBiji. One is the changing of specific terms. Next to the usage of ‘level’ instead of ‘box’ other terms were changed like ‘training’ for ‘practice’ or ‘library’ for ‘lexicon’. The GBiji main screen has another difference, as seen on [figure 2] as the first picture from the left, has only the three buttons in common. Next to the different terms NBiji doesn’t have the top part with the name and title of the user shown or the progress bar to display the learning progress.

**Evaluation methodology**

For the evaluation the participants were divided into two groups of which each group got one application. As Biji was developed for non-native speaker with only barley knowledge of kanji the participants were chosen from Japanese beginner classes of the local Community College classes. Nine persons got the normal version and ten the gamification version. The participants were asked to install the app on their own smartphones. With the help of “Google Analytics” data of the usage of the function inside of the app were logged for the period of two weeks. After this time period all participants got the same questionnaire to gather subjective emotions toward the usage of Biji and some additional information about the user.

With “Google Analytics” different kind of data were collected in the test period. Besides general
information like the user and session counter, specific events can be defined. For Biji four different events were created: 1. Learn new kanji or Start a fight (depending on version and the progress), 2. Practice of already learned kanji and 3. kanji library. Also for every try of a kanji the drawn kanji is logged, also if the drawing was a success or a failure.

With the questionnaire three different kinds of information were gathered. The first group of questions was about the previous kanji knowledge and learning methods of the user and his/her reasons for kanji learning to get an idea about the basic motivation for kanji learning of the user. The intention of the second group of questions was to gather information about the intrinsic motivation. For this purpose the “Task Evaluation Questionnaire” from the “Intrinsic Motivation Inventory (IMI)” was used. This is a well-tested questionnaire developed by psychologists (McAuley, 1989). In the last part of the questionnaire the participants could give free comments about the app and they were asked if they were frustrated by anything. Also the question was asked, if they would use an advanced version of this app with more kanji.

Evaluation results

<table>
<thead>
<tr>
<th></th>
<th>NBiji</th>
<th>GBiji</th>
</tr>
</thead>
<tbody>
<tr>
<td>User count</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Average Session per user</td>
<td>7.25</td>
<td>6.4</td>
</tr>
<tr>
<td>Average session duration (min)</td>
<td>8:36</td>
<td>9:01</td>
</tr>
</tbody>
</table>

Table 1: Showing the basic motivation of the participants of Biji.

The general information “Google Analytics” showed that GBiji had with five users one more than NBiji. Even if the average sessions of NBjii were higher, GBiji has longer average session duration. By looking onto the distribution over the whole test period it is noticeable that the usage of NBiji was high on the first few days but after one week decreased to nearly no usage at all. In contrast the sessions of the gamification version were stable after a peek of higher usage in the beginning.

The logged events triggered by using the three main buttons, as seen on [figure 3], revealed two things. First, for each usage of the button ‘next day’ in GBiji the ‘training’ button was used twice. And second, the user of the gamification version used the library nearly four times as often as the user of the normal version the lexicon.

Figure 3: Bar chart with the defined events for the three functions of the main navigation.
The event ‘try’ for the drawing attempt of a kanji is interesting in multiple ways. On one side it is an indicator for the learning effort for drawing kanji. On the other side it can show possible problems with specific kanji. But it doesn’t reveal if this problem is based on a wrong character-recognition or because a kanji is complicated. This can only be guessed. If it is an easy kanji with a small stroke count, a character-recognition problem can be assumed. But if the kanji is complicated, with many strokes, it could be both. In both cases the problems can have a negative influence towards the motivation. [Figure 4] shows all tries of both versions each within the test period.

A high failure rate with a flowing decrease of tries doesn’t appear. But if we have a closer look on the success rate for each kanji that was learned by the users, like it is on [Figure 5] something stands out. For most of the kanji on both versions the success rate is over 80%, but with a slightly better outcome in the gamification group. As expected the success rate for kanji with only a few strokes is higher as for the ones with many strokes. But for one kanji in the gamification group this rule doesn’t apply, with only five strokes the success rate is under 60 %. This fits with the statement of one participant in this group. The participant sent an e-mail within the first week of the test period and mentions the strange behavior of this very kanji. Most of the drawings of this kanji were identified as a failure, even with an accurate correct drawing. Further research revealed this as a problem of the character-recognition that so far only appeared on this single smartphone for this very kanji. Besides this special event no problems appeared and thus no indicators for a negative motivation can be found.

<table>
<thead>
<tr>
<th></th>
<th>NBiji</th>
<th>GBiji</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average number of Reasons</td>
<td>2.67</td>
<td>1.8</td>
</tr>
<tr>
<td>Average number of learning methods</td>
<td>2.33</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Table 2: Basic motivation towards kanji learning of the participants of Biji.

Of the nine users Biji had only one NBiji user didn’t fill out the questionnaire. All participants completed the whole questionnaire.

All eight participants knew already 1% up to 25% of the kanji that appeared to them in Biji. No difference between both groups. Asked for the reasons, the participants could choose up to five different reasons (like to participate at the JLPT N5 or completing the knowledge of the Japanese language) and an additionally blank text field. In average the NBiji users had nearly one reason more to learn kanji. When asked for the learning methods (like repeated writing or using mobile applications for learning kanji) four different reasons were selectable and again an additional blank text field. Again the NBiji participants chose more options. Thus indicates that the test persons of the normal versions had a bigger basic motivation for learning kanji.
The “Task Evaluation Questionnaire” contains of 22 questions to ask about the feelings and emotions while the usage and giving them a score from 1 ‘not true at all’ to 7 ‘very true’. With the answers it is possible to calculate four subscales, described as: ‘interest/enjoyment’, it is considered in the scale description of the IMI as “the self-report measure of intrinsic motivation”, ‘perceived choice’ and ‘perceived competence’ both values are theorized as “to be positive predictors of both self-report and behavioral measures of intrinsic motivation” in the IMI scale description. The fourth value ‘pressure/tension’ is assumed “to be a negative predictor of intrinsic motivation” as said in the scale description of the IMI as well.

The results showed that the values for ‘interest/enjoyment’, ‘perceived choice’ and ‘perceived competence’ were nearly the same but for ‘pressure/tension’ the gamification group has higher values. The results of a performed t-test confirmed the presumption that based on the small number of participants; these results are statistically not significant. Even the t-value for ‘pressure/tension’ which is close to the 90%-quantile has a 17.7% probability of error.

Having a closer look to the 22 questions in detail, three things can be mentioned: First of all every single user answered the question about feeling anxious while the usage of the app with ‘not true at all’. Also all Biji participants had fun during the usage and were not bored. At last the questions with the biggest different answers were obviously the questions related to the ‘pressure/tension’ value but also the one about the perceived competence. This in fact indicates that the GBiji participants felt more competent.

<table>
<thead>
<tr>
<th>Value</th>
<th>NBiji M</th>
<th>s</th>
<th>GBiji M</th>
<th>s</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>interest/enjoyment</td>
<td>40,33</td>
<td>6,66</td>
<td>39,00</td>
<td>4,74</td>
<td>0,335</td>
<td>0,749</td>
</tr>
<tr>
<td>perceived choice</td>
<td>21,00</td>
<td>8,00</td>
<td>22,60</td>
<td>3,94</td>
<td>0,377</td>
<td>0,711</td>
</tr>
<tr>
<td>perceived competence</td>
<td>29,33</td>
<td>3,21</td>
<td>28,40</td>
<td>5,22</td>
<td>0,275</td>
<td>0,793</td>
</tr>
<tr>
<td>pressure/tension</td>
<td>7,00</td>
<td>1,73</td>
<td>11,40</td>
<td>4,67</td>
<td>1,529</td>
<td>0,177</td>
</tr>
</tbody>
</table>

Table 3: Results of the t-test for the four values of the “Task Evaluation Questionnaire”.

\[ M – \text{mean, } s – \text{standard deviation, } t – \text{t-value, } p – \text{probability of error.} \]

Going on to the results of the last part of the questionnaire it can be said that none of the participant had big problems with Biji. Asking for reasons of possible frustration during the usage, the participants didn’t mention anything or only some small things. Those referred to changes of already implemented functions (character-recognition) or additional functions (like the integration for the Android flash card application “AnkiDroid”) which would be nice to have. But it was also said that those things didn’t have influence on the learning process or stopped them form using the app. The only thing more than one participant mentioned was the desire for a more accurate character-recognition. Asking if the users would use a further development of Biji with more kanji seven would do it without any limitations. One GBiji participant would only use it if in this version a better character-recognition would be included.

The results can refer to different outcomes: On the first sight less usage with more users in the GBiji group means less motivation by gamification. But after a closer look on the basic information it is noticeable that the users of NBiji had a higher basic motivation and thus could explaining the higher usage of the normal version over the first few days. After one week the usage for NBiji went down. In contrast the usage of the gamification version stayed on a constant level – after a high peak at the beginning – until the end. Also the gamification group used the app for a longer time in every session.

None of the gamification users were disturbed by the gamification elements. Instead the higher usage of the library and the more frequent usage of the training are showing that the gamification elements indeed can influence the behavior of the usage. The more often usage of the “training” function in relation to “learning new kanji” can even be an indicator for a bigger long-lasting learning success.

The results of the IMI questionnaire are showing a difference in tempting the pressure. The IMI itself is only guessing that this might be a bad indicator for the motivation. Additionally Kapp (Kapp 2012 S.49) mentions that gamification is stressful. This is based on the challenge the gamification should provide and this in fact is a good thing.
Conclusions

The data showed that gamification caused more emotions toward the usage of the software and it indeed had an influence on the motivation. With the usage of gamification it is possible that the students’ motivation to use mobile learning software can be supported and expanded. But the gamification is not able to replace a lack of basic motivation. In addition there were indications for other positive effects and it might be that the learning success can be increased as well. But these results are only based on a low number of participants and the significance of this conclusion has to be confirmed with a bigger test group.

Also the success of the concept of a Biji with the repeatedly drawing practice can be confirmed. Moreover used gamification seems to be successful. The feedback was mostly positive with some constructive suggestions mainly about the character-recognition. Therefore it makes sense to develop the prototypes further. This includes general functions as well as the one used. Generally some functions could be added like more basic languages next to German. The learning content should be extended with more kanji to learn but also other content like a bigger focus on learning the different readings. Possible additions for the gamification could be the introduction of achievements for specific tasks.

As already mentioned the results may be more accurate with a bigger test group. The outcome could show that the positive emotions triggered by gamification can be even stronger. By expanding the test-period even the long-term motivation could be observed. Furthermore by expanding the defined events for the logged data and the questionnaire data plus adding some knowledge tests at several points over the test period it is possible to gain more specific data. With this it might be possible to show a more successful learning-rate with the usage of gamification.

Overall this study showed that gamification is a good way to motivate users and thus this is a great tool to use in mobile learning software.

References


