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# Analysis of the Impact of Gamification on Learning Efficiency on the Example of a Mobile Application

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**Abstract**

The article analyses the impact of gamification on the effectiveness of the learning process with the use of the original mobile application. Gamification methods and gamification assessments attract more and more attention from both researchers and practitioners. We present the impact of learning rules and regulations of handball on the future referees of handball and people from the handball community (players, activists, sympathizers) from the implemented mobile application in comparison with the traditional method, i.e., from books or printed regulations. The results of the knowledge test for the users of the application were much better than traditional education. The analysis showed that in the first test, the users using the application and traditional learning achieved the same results (52%). In contrast, in the second test, the users using the application achieved 73% in comparison with the group not using the app (59%). Such a result may indicate that learning from the application has a good impact on the user. The adoption of gamification in learning and teaching is very popular and stimulating student motivation, involvement, and social influence.

**Keywords:** gamification in learning, playful experiences, smartphone applications, immersive learning

## Introduction

In addition to the new technologies in mobile devices, there are also applications. Software developers are still outdoing themselves in making applications that are increasingly intuitive and easier to use. The developers have already

created apps from all areas of life, from apps supporting young chefs to apps for counting integrals. Recently, applications supporting teaching users in the form of fun and games (e.g., Duolingo) have gained particular popularity. Top-rated applications teaching languages are based on this form. Users, earning levels in the application also gain knowledge of the word of foreign languages. The games adopt mechanisms of motivation and rewards, increasing the effectiveness of user learning. In addition, such mechanisms also include scoreboards, which give users the opportunity to compete with each other.

The term gamification means using mechanisms from computer games or role-playing games in order to involve the participants more closely (Sailer, Hense, Mayr, Mandl, 2017). The place of games in our lives has not changed over the years, still people, in order to forget about the hardships of work or other aspects of life, are engaged in playing various types of games, nowadays games have especially moved to the virtual world (Dymora, Mazurek, Kowal, 2019). Gamification has a lot of positive aspects of human life. One of them is, as in chess, encouraging people to think, to take strategic steps in the game (Dymora, Niemiec, 2019; Hamari, Koivisto, Sarsa, 2014). Still, gamification not only stimulates thinking but also strengthens the bonds between people. Playing together creates common topics for conversation and increases the time spent with people. Competition between colleagues or friends can direct behavior to achieve the goal set for users (Dymora, Niemiec, 2019; Armstrong, Landers, 2012).

When used in the educational process, gamification can also be defined as gamified learning (Tkaczyk, 2011). Gamified learning is similar to the game--based learning concept. This approach implies the design of real, autonomous games. In contrast, gamified learning is a learning process that concentrates on extending or changing an established learning process to create an improved version of the learning process that users experience as game-like (Dymora, Niemiec, 2019; Dymora, Mazurek, Kowal, 2019; Hainey, Connolly, Boyle, Wilson, Razak, 2016).

The article analyses the impact of gamification on the learning process's effectiveness with the use of the original mobile application supporting learning and testing of knowledge about the rules of the ball game. After observations of other learning applications, the possibility of implementing similar mechanisms was also observed in the context of handball's learning rules. Therefore, it was decided to create applications for young handball referees. They are just beginning their adventure with the whistle, which will be able to investigate the impact of learning from the applications and the effect of learning the traditional way in a group of people from the handball referees' environment. The application can also help referees who are already at the intermediate level because they also have to pass the same exam every year. Learning the rules and questions in

the traditional way is problematic because of the need to have a whole catalog of questions and regulations. The telephone application has all the questions in the catalog and allows one to broaden their knowledge of the regulations' issues conveniently.

**Literature review**

Gamification methods and gamification assessments attract more and more attention from both researchers and practitioners in recruitment and selection. Additionally, it is recognized that the adoption of gamification in learning and teaching is very popular among students in stimulating student motivation, involvement, and social influence (Hainey et al., 2016). Any educational measure aims to improve students' ability to master educational content (Hamari et al., 2016). According to Ofosu-Ampong, Boateng, Anning-Dorson, Kolog (2019), education can leverage gamification by enhancing learning management systems to make learning enjoyable and engaging for students. The authors in (Putz, Hofbauer, Treiblmaier, 2020) showed gamification's potential in supporting the acquisition of knowledge utilizing the action research method.

Gamification is used not only in the learning process but in the organization of work. In (Georgiou, Nikolaou, 2020), gamification was employed in hiring and hiring personnel, which had an impact on company selection procedures. The authors studied the reactions of applicants to this new trend. The authors pointed out that applicants report a higher level of satisfaction with the process and perceive integrity and organizational attractiveness when using the method of assessment with gamification compared to its traditional version. According to Passalacqua et al. (2020), the authors present a laboratory experiment in which two aspects of gamification, goal setting, and feedback are implemented in the wearable warehouse management system (WMS) interface to examine their impact on user involvement and performance in the task of completing items. Both indirect (neurophysiological) and explicit (self-reported) measures of engagement are used, allowing a better understanding of the user's perceived and physiological state.

In (Indriasari, Luxton-Reilly, Denny, 2020), the authors summarized the commonly used game mechanics and the context and year level of courses in which prior research has been conducted, along with the reported effects on student behavior. Despite the enormous popularity of gamification as an exciting new method of engaging students, there are also neutral ratings of this method. In some researchers, gamification raises a lot of controversy ("gamification is nonsense") and some offensive labels, such as "operational software". Authors in (Bai, Hew, Huang, 2020) studied 30 independent interventions (3,202 participants) drawn from 24 quantitative studies. They have examined the effects of gamification on student academic performance in various educational settings.

They showed two reasons for their dislike of gamification: gamification does not bring additional utility and can cause anxiety or jealousy. In (Zainuddin, Chu, Shujahat, Perera, 2020), the authors presented a summary of the empirical findings of state-of-the-art literature in the emerging field of gamification within the educational domain of learning and instruction. This study showed the novelty of gamified learning as a game-changer and critical enabler of motivation, engagement, and user experience but outlined the key challenges and barriers of gamification.

**The design of the mobile application supporting the learning process of the selected sports regulations**

The application's main functionality is the ability to solve real tests for handball referees or future referees from the official catalog given on the official website of the Handball Association in Poland. In addition to the tests, the user can practice their knowledge of the rules of handball games, which have been in use in Poland's handball competition since 2016. Additionally, the application user can practice the rules of competitions organized by the ZPRP (acronym of the Polish Handball Federation) thanks to the functionality based on the test downloaded from the ZPRP website. Another feature of the application is the possibility of examining the impact of learning from the application on the user's knowledge of the regulations. The recipients using the application and their knowledge after using the application will be compared with the users using learning by traditional means.

Java language was used to build the application. The application server is implemented with the use of a Firebase programming platform, which provides a Real-time Database product, which will act as an application database. The application server was based on the Firebase platform, which Google bought out in 2014. Firebase provides many modules to help the developer create applications: authentication, database, Storage, Hosting, Crashlist, Performance, Test Lab, Events, Standard SDK, Conversions, Audiences. Firebase also has modules supporting application development, such as In-App Messaging, which is used to send messages to more active users to increase their involvement further. In the application, the Realtime Database has been used mainly because of the access to real-time data. Without it, the use of the program and competition between users would be problematic.

**The main activities in the application**

For the user to use the application, he is asked to provide the name with which he wants to be identified, e-mail, and password. After correct registration, the user performs an initial test of his knowledge of the regulations. This test consists of 15 questions drawn from 40 questions from the Catalogue of Exami-

nation Questions made available by the ZPRP College of Referees. After answering the questions, the user uses the application five days after five days to retake the test to test his knowledge of the rules. It consists of 15 questions which are drawn from among 40 similarly as in the first test. The application consists of the "Regulations King" Quiz, which includes supplementing a given point of the regulations with a word or words from the Rules of Handball. The second quiz is "True or False". It consists of providing quick answers to the given question. Questions are randomly selected from the questions made available on the website of ZPRP as a test of knowledge of the regulations of the games organized by ZPRP. The questions should be answered, yes, or no. The third quiz is the "Training Room". It consists of answering multiple-choice questions from the catalog of questions available on the Handball Association website in Poland. The last quiz is the "Final exam", which will be unlocked only after one has earned 50 points in total from the first three Quizzes.

In the quizzes, just like in the "Training Room", the user answers questions from the catalog of questions, but the questions are 40, in the same way as in the real exam on the handball referee. Apart from the last quiz, each of them ends after giving the wrong answer. If the score for a particular Quiz was higher than the previous one, it is updated. By providing the correct answers, the user will increase their experience, increasing their level. Additionally, after giving the correct answer, the user receives a bonus in the form of a "golden whistle", which can be used to continue playing after choosing the wrong answer. The application contains a tutorial that is activated after the first installation and then can be called up. It explains how to use the application. The application also has a scoreboard that contains user records in individual quizzes and their levels.

**Implementation of the user reward system in the application**

The application uses a mechanism based on gamification, in which the user receives rewards and gains new levels by achieving new levels. Thanks to the applied algorithm, the user is able to learn the rules of the handball game more beneficially.

The algorithm for every good answer after the end of the game (i.e., after giving the wrong answer) converts every good answer into bonuses: 1 "golden whistle" bonus or ten experience points.

The experience is then converted into a level of excellence. The level of user experience in the application is associated with an increase in the game level, in addition, when the correct answer is given, the user receives a bonus in the form of a "golden whistle", which can be used to play further after choosing the wrong answer. In addition, the reward in the form of a golden whistle can be used to continue playing despite the wrong answer. In order to continue playing,

you need 10 “golden whistles”. Analysis of the effectiveness of learning with implemented gamification mechanisms on the example of a course of referees qualifications.

**Research methodology**

In the beginning, the research scenario assumed finding 20 handball referees or people who would like to be handball referees in the future and people interested in handball, active players, players after their careers, having an Android device version 6 or higher. The referees participating in the study were among the referees who had category A referees' licenses: Ladies and men's super league, 1st league of men and women, 2nd league of men and women, Category B referees' licenses, Category C referees' licenses.

In the next step, a group of 20 people was divided into two subgroups:

1. The first group of 10 users had the task of learning the rules from the application after the first test of knowledge about the rules would be group A.

2. After the verification test, the second group of 10 users had the task of learning the regulations traditionally, i.e., from the paper regulations, it will be group B.

After five days, each user performs a knowledge test. The test starts automatically when the user selects an application.

**Analysis of the first verification test**

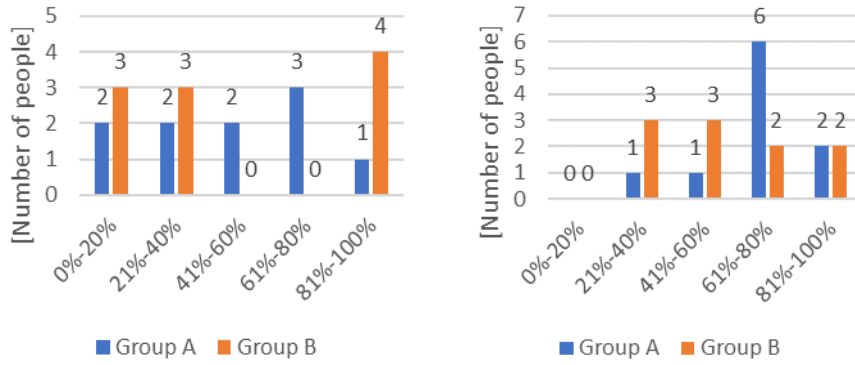
After completing the questionnaire, each participant received a link to download the application. The application was sent in a `.apk` file. The user often had problems installing the application on his phone because the user had to mark in his phone in system options the possibility of installing applications from unknown sources. Every phone with Android has such functionality so that every user could install applications on his device after this action. Then users were divided into two groups of 10 people:

- Users learning handball rules from the application (group A),
- Traditional learning from books etc. (group B).

After installing the application and registering, each of the users has undergone a test. Traditional learners took only the first test, and the next (after five days of starting the application) went to the second test. The users learning from the application took the first test, used the application, and took the second test also after five days. The questions of the examination concerned the rules of handball.

Most of the participants achieved results below 75% during the first test. Seven users from both groups achieved results that would indicate that one user had passed the trade union exam, while there was little to be had, as it reached 73%. Many users achieved results below 50%, which may be due to the fact that, according to the Firebase platform in the Analyses functionality, the users spent

about 2 minutes on the first test, which gives an average of 8 seconds per question, which is definitely not enough to analyze the question and answer well. There are questions that users are able to respond very quickly, such as about the size of the gate or the size of the pitch, but there are questions in which the user has to play the role of a referee from the question, for which they need to spend more time. There are also questions in the test that need to be analyzed and reminded of a particular point in the rules. This leads to the user having to take a moment to accurately assign a point from the game rules to the given question.




**Graph 1. Result comparison of the first test (left side) and the second test (right side) of both groups (group A – using the application and B – not using the application)**

As shown in Graph 1, four users from group B (not using the application) achieved results from 81% to 100% after the first test. But in contrast, the rest of the users had much lower results. Group A (using the application) had three people who achieved results from 61% to 80% and two people from 41% to 60%, which indicates that their results were not high. Most of them reached the limit above 50%, which cannot be said about group B. In both groups, users reached 52% on average.

**Analysis of the second verification test**

The second verification test of users' knowledge was no different from the first one. The user was to answer 15 questions drawn from the first 40 questions from the ZPRP's catalog of questions. The questions concerned the first point of the Rules of Handball and the second point. The user performed the test after five days after registration if he performed the first test. The registration date was recorded in the database, so the program knew when the given period would pass.

Half of the users using the application achieved a score of more than 75%, which indicates that the exam was passed. But a large part of them, because three

people achieved a score of 12 points, which gives 80%, so if they made a mistake one more time the exam would be considered as not passed. In the group of people who do not use the application but learn in the traditional way, only three people passed the exam. Still, one of them received 12 points, which is 80%, so if one made a mistake again, the exam would be considered unsuccessful.

**A comparative analysis of learning outcomes of both groups – individual results**

In the beginning, the results of both tests were presented for the group of respondents who used the application during their studies (Table 1). The majority of application users achieved better results compared to the first test. The percentage of user progress varies from – 17% to even 600%, and the average improvement was 110%, which indicates that some users of the second test went much better than the first. In the group of users who did not use the application, the progress was also visible, but much smaller compared to the group of users who used the application ranged from – 15% to 300%, on average 63% of the progress.

The distribution of the correct answers obtained in the first test for the group of the application users ranges from 3 points to 13, and for the group of users not using the application from 1 to 15. After having familiarized with the application and its operation experience, the results are significantly improved, as shown in Graph 1. The distribution of the correct scores in the second test for the group of users using the application is in the range from 9 points to 14, and in the group of non-app users from 4 to 15. The users of the non-application group (group B) achieved better results in the first test as well as in the second one because some of them reached the maximum score, i.e., 15 points. In the group using the application (group A), nobody achieved the maximum score in the first and second tests.

**Table 1. The individual results of users using the application from both tests**

| User | First test | Second test | Variation | User | First test | Second test | Variation |
|---|---|---|---|---|---|---|---|
| | Good answers | Good answers | | | Good answers | Good answers | |
| a1 | 3 | 12 | +300% | b1 | 14 | 12 | –14% |
| a2 | 11 | 10 | –9% | b2 | 3 | 5 | +67% |
| a3 | 12 | 10 | –17% | b3 | 6 | 7 | +17% |
| a4 | 5 | 5 | +0% | b4 | 2 | 6 | +200% |
| a5 | 7 | 12 | +71% | b5 | 15 | 14 | –7% |
| a6 | 4 | 9 | +125% | b6 | 6 | 8 | +33% |
| a7 | 2 | 14 | +600% | b7 | 14 | 15 | +7% |
| a8 | 13 | 14 | +8% | b8 | 1 | 4 | +300% |
| a9 | 12 | 11 | –8% | b9 | 13 | 11 | –15% |
| a10 | 9 | 12 | +33% | b10 | 5 | 7 | +40% |
| Min | 2 | 5 | –17% | Min | 1 | 4 | –15% |
| Max | 13 | 14 | +600% | Max | 15 | 15 | +300% |
| Average | 8 | 11 | +110% | Average | 8 | 9 | +63% |

The analysis shows that in the first test, the users of the group using the application (group A) and the users (group B) achieved the same results on average (52%). In contrast, in the second test, the users using the application (group A) achieved better results. On average, the user achieved 73% compared to the group not using the application (group B), where each user achieved 59% on average.

Analyzing the provided results, it can be said that all users achieved poor outcomes in the first verification test (52% on average). This may result from the fact that some of them had first encountered this type of question because, among the respondents, there were people who do not referee actively, so they may not know about this type of issue. Another argument for a weaker result in the first test could be that users made decisions too quickly or responded too quickly, resulting in a wrong answer. Some of the respondents are active referees to have already encountered this type of question, so they may have answered, thinking that they remember the answers without thinking about them. The first and second tests relatively contained easy questions to compare with the rest of the catalog questions, so the referee shouldn't have that much trouble. Users who use the application spent about nine minutes a day on it, which is far too little time to practice the handball rules properly. The respondents would undoubtedly be more willing to use the application if they were to pass the union or district exam on the referee in the near future. Then they would use the application longer than nine minutes a day. Users were most likely to use the quiz based on the question catalog. This is understandable because these are real questions edited by the European Handball Federation (EHF) and translated by people from the Handball Association in Poland (ZPRP). Therefore, many practical things can be learned for the referee. The users benefited to a lesser extent from quizzes based on handball rules and questions about the test of games organized by ZPRP. This situation probably occurred because users prefer to learn more practical things that can happen on the pitch than events from the rules described theoretically. Only one user took the fourth quiz, which is an exam. This could be due to the fact that users did not manage to reach the given limit of 50 points in a total of all three quizzes. Five days might have been too short a time to achieve such a result, bearing in mind that users spent little time on applications.

The results of the knowledge test for the users of the application were much better. In the first test, out of 10 respondents, only three people passed, while in the second test, five people passed. This gives half of the respondents (average 73%). In turn, in the group of respondents not using the application, in the beginning, four people passed (52% on average), and in the second test, only three people passed (average reached 59%). The progress was 7% on average, which seems to be a poor result. It may be a matter of the fact that the respondents did not spend enough time learning from books. The time of 15 minutes a day, as they said, is too short to learn the rules entirely. Another consequence of the

weak result may be that the respondents started to get tired of learning from books, which resulted in less effective learning. Such a result may indicate that learning from the application has a good impact on the user and can help the user better pass the exam. As the research shows, traditional learning, in this case, has a worse effect on the examined person. Learning from a book can be annoying for the respondent, and learning from an application containing scoreboards, records, bonuses, or levels will undoubtedly make it more attractive. If one knows that they are competing with colleagues, the respondent is motivated to learn not only in the form of a goal-oriented vision of passing the exam but also in the way of winning with friends. Reaching for the smartphone is much easier than printing a few dozen pages of questions.

## Conclusion

The article presents the impact of handball's learning rules and regulations on the future referees of handball and people from the handball community (players, activists, sympathizers) from the implemented mobile application compared to the traditional method, i.e., from books or printed regulations. The respondents were referees and people who would like to be handball referees in the future and people interested in handball, active players, players after their careers so that it could impact poor test results. Not all players playing handball know the rules of this sport in detail. In the first test, the respondents from both groups achieved lower scores; many of them did not reach the 75% threshold of passing the test. In the group of people who were supposed to use the application in the first test, only three people passed in turn, those who were not supposed to use the application passed four people. After five days of learning, the group learning from the application achieved a better result. Six people improved their score from the first test, and from the group of 10 people, the second test was already passed by five respondents.

The developed application had two tests to examine users and four quizzes to help the user learn the handball rules. The program had implemented gameplay methods, which were supposed to activate users to access the application more often and help them learn handball rules more effectively. The application used user scoring, records, and bonuses on every excellent response. Thanks to scoring, the user could compare with other application users on the scoreboard. Users of the application did not use it often enough to improve their results significantly.

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