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Gamification in Software Development Projects

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***Abstract* – Gamification is one of the many ways to motivate employees and introduce more fun in daily activities. The aim of the paper is to analyse the impact of gamification method on the software development projects. The paper contains results of a literature review about application areas of gamification, methods, positive and negative effects on projects. The paper also presents an overview of the gamification tools used in software development projects and attempts to answer the question about benefits of gamification usage: whether gamification in the project leads to the desired results and increases the employee productivity and motivation.**

***Keywords* – Gamification, gamification at work, gamification in software development, gamification tools, software development projects.**

I. Introduction

One of the tasks of project management (PM) is to create a calm and comfortable atmosphere where participants are involved and interested in working on the project [1]. To engage and motivate employees in the project, the recent trend has appeared to use a technique of play – gamification, which encourages employees to work through the components of the game and mechanics.

In software development (SD) projects, the required task must be completed as quickly and efficiently as possible. Developers accomplish similar tasks on a day-to-day basis and spend a lot of time in the workplace on procrastination. New tasks in the work process over time also increase the experience of developers. The more experienced the employees, the more skills they have, so doing their tasks becomes a routine. Routine reduces employee motivation, so the project manager needs to find mechanisms to motivate project team members [2], [3], [4].

To increase employee motivation and productivity, there are a lot of methods, such as the emphasis on the promotion of personal development, rewards, preserving work-life balance, participation in conferences, team consolidation measures and others [5]–[7]. One of the innovative ways to increase productivity and motivation for employees is to bring gamification into the project [8], [9]. In practice, companies that use this method achieve increased productivity, greater involvement of employees in the project and, in some cases, better team integrity [5], [8].

The aim of the paper is to analyse the impact of gamification method on the SD projects. Based on principles of systematic literature review, sources have been identified and explored that describe the use of gamification in practice and provide conclusions about its advantages and disadvantages in the SD processes.

The rest of the paper is structured as follows: Section 2 describes the purpose of gamification and provides the definition of gamification and its use; Section 3 presents the literature review process and how it was held. Section 4 shows the results of literature review and answers the questions about gamification use and SD process. The open questions are shown in Section 5; this is the field that can be researched in future. Conclusions and limitations are discussed at the end of the paper.

II. Gamification

Gamification is the use of game mechanics and elements in a different context [10]. Various game mechanics are used in the work environment, training, healthcare, sales, politics and technology design, which promote improvements in these areas [8]. At present, the most successful and widespread use of gamification is training. Gamification allows people to learn new material and gain practical knowledge by performing certain activities. There are a large number of studies on how gamification affects training outcomes [11].

Gamification in the learning area motivates, helps one learn the material more easily, motivates persons to learn on a regular basis [12]–[14]. In the workplace, it is used directly to teach employees how to use the new software or modified work process [8], [15].

The gamification includes the game dynamics (e.g., storyline, emotions, relationships), game mechanics (e.g., challenges, competitions, winning/losing status, resource sharing), and components of the game (e.g., roles, points, achievements, unblocking content, level, leaderboards, etc.) [1].

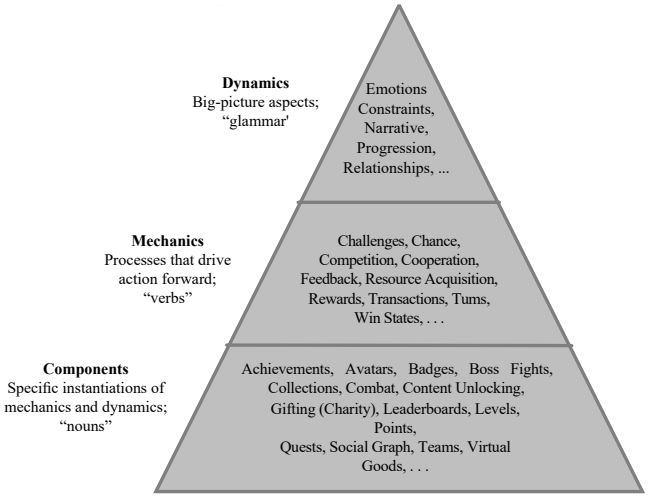

Fig. 1. Gamification concept.

The most common components of the gamification are points that are convenient for realisation and understandable for the players. For each executed action, the user receives a point [3]. In some cases, more points are given for complex activities and

fewer points – for the easiest tasks [16]. This technique also has one disadvantage: competing users are more likely to perform less challenging tasks to get more points, so the most difficult tasks will not be done.

Often the points are used together with leaderboards that bring the mechanics of the competition [6], [17]. The leaderboards show the number of points collected by each user in the specified period. There are some variations such as open and closed leaderboards. In the open leaderboards, users see other names and surnames and places in ranking; the closed user sees only their place and in some cases the number of points of their closest opponents [18].

Badges and achievements have a similar mechanism. For specified actions, users are rewarded with badges or marked a certain achievement [17], [19]. A user can also see what actions should be executed to receive a badge or achievement record. This mechanism has shown itself to be not very motivating, because its achievement requires patience, and for every activity, the user does not immediately receive the necessary feedback from the progress.

The use of feedback is also of major importance. The experiment participants considered feedback to be a quick feedback link [20] and the historical data of work achievements, which motivates and helps one see productivity over time, which assists in providing a better self-assessment from the user for their work.

Using components such as levels, roles, and challenges makes gamification even more exciting for the team.

III. Literature Review Process

The aims of the literature review are to provide an insight into the use of gamification in the SD process and to determine the advantages of this method. The description shows gamification techniques and software tools that are used to implement gamification in the SD process.

A. Research Issues

Gamification in SD has recently been used by development companies and teams that simulate SD projects for research purposes. Gamification is also used by SD teams to achieve different goals, where the main purpose is to use it to improve team motivation. The tasks of the present study are to find out whether gamification helps one make the development process better, to identify the stages that are improved by means of gamification, to determine problems and benefits gained through real projects, and to reveal methods and tools used in the gamification.

B. Research Questions

The primary aim of the literature review is to answer basic questions about the use of gamification in SD projects and its impact on the development team.

The following research questions have been formulated for the literature review:

1. At which SD phases is the gamification used?
2. What kind of gaming techniques are used in SD projects?
3. What are the benefits of using gamification in SD projects?
4. What problems are encountered when gamification is implemented?
5. What applications/software tools are used for the implementation of gamification principles?

C. Literature Search Strategy

To identify the related literature sources, the systematic literature review principles have been used, which include a definition of a search query for searching in scientific databases and selecting sources that correspond to certain rules.

The search query has been defined using the main keywords “gamification” and “software development”, and their synonyms:
(“gamification” OR “gamifying” OR “game elements” OR “game methodology”) AND (“software development” OR “software engineering” OR “project management” OR “testing” OR “requirement management” OR “software integration” OR “software management” OR “scrum agile” OR “waterfall”).

According to this search query, the literature sources have been searched in SpringerLink, IEEE Xplore Digital Library, Web of Science, ScienceDirect and EBSCOhost electronic databases.

The following rules have been applied to filter search results:

- Literature source is an article published in conference proceedings, books, journals, or another scientific publication or a professional forum. Websites with news about technological innovations or collective blogs have not been used.
- The search is related to a field of computer science.
- The article has been published in the period from 2008 to 2016 (inclusive).
- The article describes a real project or a test project used for simulation and evaluation.

IV. Literature Analysis

In the initial search, 136 articles have been selected from electronic databases by searching according to the above-defined search query. After the annotation study, articles that do not relate to the SD process have been removed. The articles that contain only general information on the application of the gamification method have also been removed. Thus, the number of articles has been reduced to 51 articles.

Only 17 articles have been chosen for a detailed analysis, which include the introduction of gamification in a real project or a test project, or which analyse the impact of gamification method on productivity and the response of participants to the application of the method. Only open-access articles have been studied.

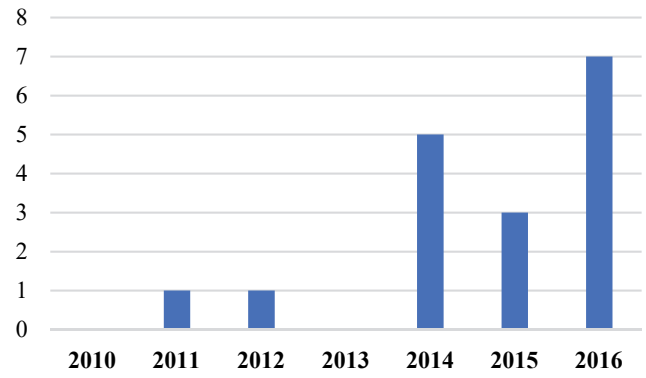

Fig. 2. Abstract classification by year.

The use of gamification in SD has recently been studied. The first articles on this topic appeared only in 2011. The classification of articles by year is demonstrated in Fig. 2. The number of studies in the field of gamification increases each year, and the gamification topic becomes interesting for more and more researchers in the SD field.

This section further provides and discusses answers to the five questions mentioned above concerning the use of gamification.

A. Software Development Phases at which Gamification Is Used

Several project phases are defined in the SD, such as definition of requirements, requirement analysis, design, coding and testing [21].

Defining requirements includes the collection of requirements from the client, requirement analysis, requirement reviewing and, in the event of uncertainty, requirement clarification and supplementation. The requirements are documented for further transfer to the development [10], [22]. Gamification is used in requirement definition stage that helps one find out more requirements and improve their quality.

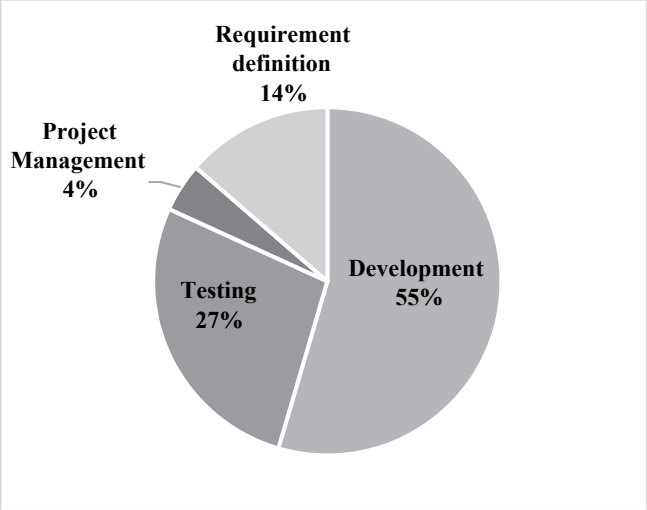

Fig. 3. Gamification at the project development phases.

The design involves designing a software project and defining the system's intrinsic properties. Coding is the direct development of software that builds on the predefined requirements and software design results. Gamification motivates coders to make tasks, allows comparing results with another team [23].

Testing is the software validation and verification, according to certain criteria defined at the time of claim retrieval and documented. Testing takes place after documentation, taking into account system functional and non-functional requirements. In the event of errors, the functionality is redirected to the development in order to correct errors. Gamification helps one test at a better quality and motivates testers [19], [24].

In the identified articles, in 55 % of cases gamification has been used at the development phase [5], [6], [11], [16], [25], [26]. The testing phase takes the second place where the majority concerns directly the automatic testing and testing traceability improvement [11], [19], [24]. One article depicted the use of gamification in the PM [10]. Classification of the articles by the SD phase at which gamification is used is illustrated in Fig. 3.

B. Gaming Techniques Used in Software Development Projects

The game mechanics and game components are used to gamify the process, so every use of gamification in real life is different, and its impact on the process is also different.

The articles identified eight types with the use of game components in gamification such as:

- Levels [12], [18];
- Leaderboards [12], [17], [20];
- Badges [17], [18];
- Achievements [11], [18], [27];
- Challenges [13];
- Feedback [6], [17], [20];
- Points [9], [11], [28];
- Roles [18], [16].

The popularity of game components is shown in Fig. 4.

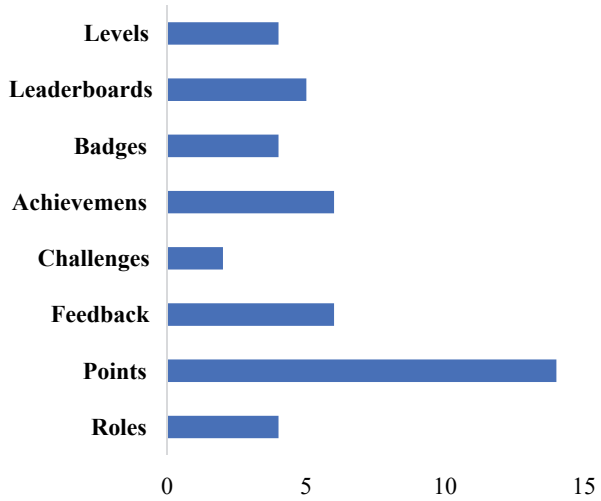

Fig. 4. Use of game components.

Developers made a gamification tool in one case using gamification mechanics that is a game world called DEV.rpg [1], [11] which gives a real look and mechanics of the game to a tool.

C. Benefits of Methodology Use in Software Development Projects

The use of the gamification technique contributes to the improvement of productivity in working conditions, employee motivation and interest in the work. In the articles [13], [18], employee motivation was mentioned as a key to the benefits of gamification.

At the stage of defining the requirements, there are improvements such as an increase in the number of ideas, an increase in motivation, an improvement in the quality of claims, and an increase in creativity, which contribute to the improvement of this process [22].

During the development phase, code quality improvements, the number of processed applications, the smallest number of errors, and the increase in the rate of error prevention have been observed [23], [23]. Participants note the increase in motivation by seeing the feedback about the work done, which in turn allows evaluating productivity [17]. Playing also allows learning from others by using some methodology that involves evaluating other people's work and transferring their work to ratings [14].

At the testing phase, improvement in product quality, code quality (automatic testing) and learning from others (introducing story reviewing sessions) have been identified [8].

All participants of research described in [6], [9], [18], [22], and [24] mentioned the best motivation to work, the opportunity to track work progress, better communication among team members, the consolidation of the team and the ability to view their and colleagues' achievements through the use of certain game components, for example, leaderboards, badges or point tables.

In general, the use of gamification positively influenced the results of the work group in the development process as well as the test group that imitated the development process.

D. Problems Encountered during the Implementation of Gamification

The use of gamification in most cases does not cause problems to users and does not make the process complicated, in contrast to the standard process. Research [18] summarises disadvantages of gamification – the existence of increased stress and tension in the work process where gamification is used. While working together, the working group felt tension and stress, which in the long term could badly affect the productivity of the whole team.

One of these problems is the implementation of gamification in the project [18]. It is a very time-consuming process that involves employee engagement, the ability to choose the right tool and the ability to implement it during the process. Often, standard tools are not selected, but specific solutions for a particular process are difficult in terms of development and implementation. Gamification before implementation requires specific analysis, awareness of employees' ability to participate, proper tool selection, and time to adjust the development process [1].

Research [12] describes that the team faced the impossibility of introducing the tool into a real project, but could only investigate the effects of gamification on the test group in the short term (up to 5 months) by simulating the SD process and usually working with 2 work groups. One of the groups worked using the playing elements and the other worked without gamification techniques, then the productivity, motivation and other parameters of the two groups were compared [28]. Consequently, it can be stated that there is little research that provides information on actual use of gamification.

E. Applications/Software Tools Used for the Implementation of Gamification Principles

Papers [13]–[28] describe how various tools were developed or studies[5], [24]–[26] provide an insight into the prototypes. Each tool was designed to perform specific tasks: scoring, displaying leaderboards, etc. Some of the tools or their prototypes were not used in the development projects, but they were studied using the test team – students or other volunteers who mimicked [6], [8], [9] and [29] the development process. In this way, the impact of gamification on the team was explored through experiments.

The use of standard tools, such as Jiraffe [30] plugin for Jira or Get Badges [31] gamification application, was not found.

F. Summary of the Analysis

On the basis of the above-mentioned considerations, one can conclude that gamification is currently used mainly at the development phase of the project, i.e., coding and testing phases. The most common gamification mechanisms are points, achievements, winning tables and feedback links. Special software is developed for every work process, where the most difficult process is the introduction of the game tool into the project and the willingness of the working group to change the work process by adapting it to this tool. With the introduction of the gamification into the working group, it increases the employee motivation, improves productivity, shows the progress of the participant's work and the amount of work compared to other members of the team.

V. Open Questions

The analysis has been performed on the use of gamification in small work groups at some time during the period, with the aim of retrieving feedback from the participants about the impact of gamification on the work process. Specially developed tools have been used, which in some cases have been adapted to the characteristics of the participants. This has led to a number of uncertainties that have not been discovered in the literature review:

1. Long-term effects of gamification: In the reviewed literature, gamification was used for a short working process of up to 5 months. No examples have been found of the use of gamification in the long term, and no research examined the long-term effect of gamification on employees. It is assumed that, in the long term, the use of gamification will lose momentum and cease to have a positive impact on the development process.

2. Gamification effects using standard tools. Several standard tools have already been developed for the SD process.

Standard tools can be modified for the required work process and applied to the work team. Since no examples of standard deployment have been found in the research, the issue of the use of standardisation in SD projects remains open.

VI. Conclusion

The use of gamification in development projects is becoming more and more popular, and many researchers have been devoting special attention to the issue. The articles reviewed within the framework of the research describe different attempts to use gamification in SD projects, and the results show that gamification helps motivate employees and improve the quality and productivity of work.

Most often, gamification is used at the development phase, which helps encourage developers and testers to do their work better. The use of gamification not only facilitates work, but also assists in learning, provides feedback on work done, and helps compare work productivity over time.

The most common game components used in SD projects are the points along with leaderboards that are comfortable to import and produce successful results in the implementation of the methodology. Existing components such as roles, tokens, achievements, etc. also yield positive results in terms of employee productivity but are difficult to use in the SD project context.

When introducing the methodology of gamification in the project, specially designed tools for specific purposes are used. No research article brought the standard gamification tool to the work group. The use of gamification in the SD project in the short term (up to 5 months) produces successful results, promotes employees, gives them the opportunity to learn and make work achievements more transparent. The project teams that used this methodology were satisfied with the results achieved and would use this method or its modifications in the future.

As mentioned in Section 5, some open questions are still left. The future study could assess the gamification effects on the working group in the long term, and reveal the tools that could improve work process with gamification.

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