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Gamification Solutions to Enhance Software User Engagement—A Systematic Review

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ABSTRACT

Gamification is the use of video-game mechanics and elements in nongame contexts to enhance user engagement and performance. The purpose of this study is to conduct a systematic review to have an in-depth investigation into the existing gamification solutions targeted at solving user engagement problems in different categories of software. We carried out this systematic review by proposing a framework of gamifying process, which is the basis for comparison of existing gamification solutions. In order to report the review, the primary studies are categorized according to the following: a) gamified software and their platforms; b) elements of the gamifying process; c) gamification solutions in each software type; d) gamification solutions for software user engagement problems; e) gamification solutions in general; and f) effects of gamification on software user engagement and performance. Based on the search procedure and criteria, a total of 78 primary studies were extracted. Most of the studies focused on educational and social software, which were developed for web or mobile platforms. We concluded that the number of studies on motivating users to use software content, solving problems in learning software, and using real identity is very limited. Furthermore, few studies have been carried out on gamifying the following software categories: productivity software, cloud storage, utility software, entertainment software, search engine software, tool software, fitness software, software engineering, information worker software, and health-care software. In addition, a large number of gamification solutions are relatively simple and require improvement. Thus, for future studies, researchers can work on the items discovered in this review; they can improve the quality of the current gamified systems by using a wide variety of game mechanics and interface elements, utilizing a combination of contextual types of rewards and giving users the ability to use received rewards “in-game” and “out-game.”

1. Introduction

Gamification is concerned with the use of video-game mechanics and elements in nongame contexts to encourage and engage users in the context by making sense of playfulness and fun (Deterding, Dixon, Khaled, & Nacke, 2011; Domínguez et al., 2013; Farzan et al., 2008; Flatla, Gutwin, Nacke, Bateman, & Mandryk, 2011; Hakulinen, Auvinen, & Korhonen, 2013; Hamari, Koivisto, & Sarsa, 2014; Huotari & Hamari, 2012; Thom, Millen, & Dimicco, 2012; Witt, Scheiner, & Robra-Bissantz, 2011; Zichermann & Cunningham, 2011). It is an emerging research area in computer science, especially human-computer interaction (HCI) (Deterding et al., 2011; Huotari & Hamari, 2012; Mangalindan, 2010). The main function of gamification is to induce positive behavior in people, in addition to improving their motivation and engagement in a particular task. In recent years, gamification has attracted special attention and is popular among leading information technology companies such as SAP, IBM, AutoDesk, Adobe, and Microsoft as a solution to increase software user engagement (Herger, 2012; Lindner, 2011; Silverman, 2011). The usage of gamification

is not limited to a particular discipline; it is applicable in fields related to education, workplace, business, sport, health care, software, website, etc.

One of the main applications of gamification is to enhance user engagement in a specific software or website through an increase in users' motivation. According to Rouse (2014), user engagement is the amount of time users spend on the software to work, enter content, or use content. It can be said that software sustainability and the profit of software development companies are tied to the number of users and their engagement with the software. Since there are numerous software packages and websites with the same functionality, there is a need for a motivator to encourage users to use a desired software or website. The purpose of this study is to conduct a systematic review to have an in-depth investigation into the existing gamification solutions to solve user engagement problems in different categories of software. To this end, first a literature review is conducted to find all elements of a gamification solution and a gamifying process framework is proposed accordingly. This framework is used to compare gamification solutions. In this review, gamified systems

would be investigated from different aspects, including software type, software platform, type of user engagement problem, game mechanics, and game interface elements. The review would also cover evaluations of the systems' success rates to engage users in the software and motivate users to reach the purpose of the software.

The scope of this study is limited to the usage of gamification in software environment including stand-alone applications, web-based applications, and mobile apps. The aim is to investigate how gamification could increase software user engagement such as a) work with software, b) generate content and use software content, c) learn software, and d) perform a special action or task motivated by software. The study does not include the following areas of research: application of gamification out of software environment such as training classes or workplaces; studies not focusing on user engagement with software; and software used merely as an indicator for showing out-of-software gamification results such as a leaderboard to compare users' performances or students' grades (Barata, Gama, Jorge, & Gonçalves, 2013; Nikkila, Byrne, Sundaram, Kelliher, & Linn, 2013). The findings of the review can help discover gamification solutions to solve user engagement problems in different kinds of applications and websites, identify existing gaps, and suggest further studies. The main elements of this review are illustrated in Figure 1.

The remaining part of the article is structured in the next five sections. Section 2 makes a comparison between gamification and other similar concepts. Section 3 starts with a summary of the existing review papers on gamification and presents the literature gaps, and then describes the methodology of conducting the systematic review, and research questions. Section 4 contains the results of the review and the answers to the research questions. A discussion of the study results is set out in Section 5 and, finally, Section 6 presents the conclusions of the article and outlines the gaps of current studies and opportunities for further research.

2. Comparison between Gamification and Similar Concepts

There have been some debates over the concept of gamification. This has led to several researchers coining different terms for similar studies (Deterding et al., 2011). In order to have a well-defined scope of our study, concepts similar to the term gamification are described in this topic.

2.1. Game-Inspired Design

Game-inspired design is a user interface that adopts games' artwork such as game pictures, characters, and literature in nongame contexts; the aim is to draw users' attention or increase their engagement (Marczewski, 2013). These

elements can be effective especially in designing software and website for children. For instance, Wook and Salim (2013) designed a game-inspired interface to assist children in carrying out searching and browsing activities in an online library. The results proved the effectiveness of game-inspired design as there was a high level of website acceptance.

2.2. Serious Games

Serious games are similar to normal games, but they are developed with the purpose of training or conveying a message to a specific group of users in a full game environment. Full-game environment means that users play in a virtual game environment by controlling a character or an object based on defined rules to get rewards (Högsdal, 2011). The term "serious" is employed, since these games in contrast to normal games are designed with the purposes except entertainment. (Cooper et al., 2010; Deterding et al., 2011; Enders, 2013; Groh, 2012; Kapp, 2012; Marczewski, 2013). There are four different types of serious games: a) teaching game, employed to teach a concept using full-game environment; b) simulator game, which provides safe practice and testing of an entity from the real world in virtual version; c) meaningful game, which conveys a meaningful message to the player; and d) purposeful game, which creates direct real-world outcomes such as increase users' activities or evaluate users' abilities. For instance, Audenaeren et al. (2013) developed a game to predict whether a preschooler child shows high risks of developing dyslexia. Gustafsson, Katzeff, and Bang (2009) proposed a game to teach and motivate people in reducing electricity consumption. Cooper et al. (2010) designed an online biochemistry game puzzle that presents players with computationally difficult protein folding problems, and to improve players' ability to solve protein folding problems. Overall, studies showed that serious games have positive effects in educational contexts and learning performance of different groups of learners such as school students Jong (2015), high school students (Tsai, Kinzer, Hung, Chen, & Hsu, 2013), and health professions (Abdulmajed, Park, & Tekian, 2015).

2.3. Gamification

As mentioned, gamification is the use of video-game mechanics and elements in nongame contexts. The main purpose of gamification is to encourage and engage users in the context by making sense of playfulness and fun without having a full-game environment. Thus, the game mechanics and elements are not the center of the system, and they have a role as motivator (Deterding et al., 2011; Domínguez et al., 2013; Farzan et al., 2008; Flatla et al., 2011; Hakulinen et al., 2013; Hamari et al., 2014; Huotari & Hamari, 2012; Witt et al., 2011; Zichermann & Cunningham, 2011). Gamification has a wide



Figure 1. Main elements of the review.

range of applications in different disciplines. The most common contexts of gamification usage are as follows.

- Human resource: increase personnel motivation, engagement, and working performance.
- Health care and sport: increase physical activities, promote to live healthy, and motivate patients to continue their healing process.
- E-Learning: motivate students to spend more time in e-learning systems, motivate them to read learning content, and increase their virtual class activity such as asking and answering questions in the systems.
- Data collection: motivate people to participate in data collection process such as crowdsourcing for a research, survey, etc.
- Online community: increase users' motivation to participate in a specific online community like a blog, social website, and question /answer website.
- Software popularity: increase users' loyalty to use specific software for a long time, increase frequency of using software, and increase discovery-based learning.

Simple instances of gamification are mobile apps such as Nike Plus, Zombies Run, Endomondo, Four Square, and Viggie. These apps give users Points and Badges when they perform assigned tasks or special actions and show the results in a leader board. For example, in Nike Plus, Zombies Run, and Endomondo, users receive scores and badges if they run a special distance or participate in a predefined activity; in Four Square and Viggie, users receive badges if they check-in at special places. One of the best examples of gamification in productivity software context is Microsoft Ribbon Hero. Ribbon Hero is developed to help users discover new and useful features in MS Office 2010. The game follows the story of a character who is a time traveler and tries to get back home. With each time period, user should solve some challenges using Microsoft Office tools to go to the next level ("Office Labs," 2011). Since there are no experimental results in research papers for Ribbon Hero and the mentioned mobile apps, based on our exclusion criteria, they are not included in the main studies.

2.4. Difference between Gamification and Serious Games

Although both of these concepts use game mechanics and elements in serious contexts, they are fundamentally different. Gamification is about adding game mechanics to the existing entities so that they are more engaging, pleasurable to use, and enhance users' performance; this is where the line can be drawn between gamification and serious games. Serious games involve users in a full-game environment with meanings of learn and success (Deterding et al., 2011; Groh, 2012; Rughiniş, 2010; Simões, Díaz Redondo, & Fernández Vilas, 2013; Uskov & Sekar, 2014). As described above, full-game environment means that users play in a virtual game environment by controlling a character or an object; however, in gamification there is no virtual game environment and users get reward just based on their performance in the real world or an application software (Högsdal, 2011). A comparison

between gamification and similar terms is presented in Table 1.

It should be pointed out that our systematic review focuses on papers that explicitly match our definition of gamification; thus, it does not include studies of serious games, video games, and game-inspired design.

3. Methodology

In order to conduct this systematic review, the researchers followed a procedure defined by Kitchenham and Charters (2007), which is one of the most complete and suitable methods for reviewing studies in computer science. We carried out this review in three main phases: a) planning of systematic mapping; b) conducting the review; and c) reporting the review. The phases of this systematic review and the related activities are shown in Figure 2.

3.1. Phase 1: Planning of the Systematic Mapping

The planning phase has four activities intended to identify the objectives of the review. These activities are as follows: a) discovering the gap of the existing systematic reviews; b) identifying the need for the review; c) specifying the research questions; and d) identifying the relevant bibliographic databases. A description of each activity is presented in the following subsections.

Discovering the Gap of the Related Works

In this step, a comprehensive search was performed in the cyberspace to locate related review studies in gamification; some of the bibliographic databases accessed included IEEE, ACM, Science Direct, Springer Link, and Scopus. A total number of eight related papers were found including five systematic reviews (Borges, Isotani, Durelli, & Reis, 2014; Hamari et al., 2014; Pedreira, García, Brisaboa, & Piattini, 2014; Seaborn & Fels, 2014; Thiebes, Lins, & Basten, 2014) and three literature reviews (Pereira, Duarte, Rebelo, & Noriega, 2014; Rauch, 2013; Xu, 2011). The systematic review papers applied the similar research methodologies to the current study by following the preexisting research methodologies from Kitchenham et al. (2011), Jeyaraj et al. (2006), Lacity et al. (2010), and Heyvaert et al. (2013). It means that they started the research through a) identifying the research gap by reviewing the related works; b) specifying the research questions; c) identifying and searching on the relevant bibliographic databases; d) defining selection criteria; e) selecting primary studies; and f) extracting and synthesizing data; however, the literature review papers did not follow any specific

Table 1. Comparison between similar terms to gamification.

Terms	Game design style	Game elements	Full-game environment	Fun purpose	Serious purpose
Game-inspired design	✓	✗	✗	✗	✗
Gamification	✓	✓	✗	✗	✓
Serious game	✓	✓	✓	✗	✓
Game	✓	✓	✓	✓	✗



Figure 2. Phases of conducting this systematic review.

research method. The main focus of all the systematic and literature review papers was to evaluate the effects of gamification in different groups of applications including general website, health care, training systems, forums, data gathering, organizational systems, and software engineering. The review papers can be categorized into three groups based on their shortcomings:

- (1) Papers focusing on using gamification to help special disciplines, including workplace, health care, software engineering, and education (Borges et al., 2014; Pedreira et al., 2014; Pereira et al., 2014; Rauch, 2013). The scope of these papers is software environment and physical environment; therefore, the results are not limited to the usage of gamification in motivating users to perform an activity inside the software environment such as using software features or generating content. A summary of each paper is presented below.

Pedreira et al. (2014) conducted a systematic literature review on the application of gamification in different phases of software engineering such as requirement elicitation, project management, and software testing in order to analyze the state of gamification in this field and search out opportunities for further researches. They categorized software engineering areas that are gamified and categorized utilized game mechanics. The researchers concluded that the existing studies in the field are in the preliminary stage, and there is a lack of a structural procedure to inject gamification into software engineering process.

Borges et al. (2014) conducted a systematic review to classify the existing types of gamification researches related to education. They found that most of the studies are associated with higher education focusing on students' engagement in learning process and improving learning skills. In addition, they identified there is a lack of systematic methods to combine

gamification and computer-supported collaborative learning.

Rauch (2013) carried out a literature review to look at how gamification can be beneficial in different contexts, including enterprise organizational systems, training systems, and forums through provision of practical examples, and list the best practices of gamification implementation. He indicated successful implementation of gamification can increase personnel motivation significantly and help enterprises achieve business goals.

Pereira et al. (2014) conducted a literature review to introduce successful gamification strategies, theoretical aspects of gamification, and its potential influence on health-related contexts by providing different examples such as exercise, nutrition, weight control, medication adherence, and hands' hygiene. The review reported gamification can be an effective method to promote health care and healthy habits. Also, in order to build a successful gamification mechanism, users' feedback should be considered in all phases of the design.

- (2) Papers by focusing on enhancing user engagement in information systems and websites (Thiebes et al., 2014; Xu, 2011). These studies are not written in the systematic review format; they are analyzed game mechanics of special websites and information systems and the results are not generalizable to different software engagement problems. A summary of each paper is provided below.

Thiebes et al. (2014) performed a systematic review aiming at recognizing how gamification can increase users' motivation to use information systems. They synthesized game mechanics and dynamics in five clusters, including system design, challenges, rewards, social influences, and user specifics. From the findings of the review, they illustrated gamification can motivate users to utilize information systems and showed the elements that can be useful in designing gamification applications.

Xu (2011) carried out a literature review of gamifying websites and web applications. He provided a comparative review of various visions on the effectiveness of applying game mechanics in nongame contexts and provided examples and methods of gamifying web applications.

- (3) Papers by focusing on evaluating gamification research trend and its impact on users' motivation (Hamari et al., 2014; Seaborn & Fels, 2014). These studies examined the effects of gamification on users' motivation by reviewing a small number of papers. A summary of these two papers is presented next.

Hamari et al. (2014) analyzed empirical studies of gamification by means of a systematic review to evaluate the usefulness of gamification in different software applications such as e-commerce, education/learning, health/exercise, intra-organizational systems, and data gathering. The review covered gamification motivational affordances, psychological/behavioral outcomes from gamification, and the contexts of gamification. The paper indicated that overall, gamification has positive effects on users' motivation. However, the degree of effects depends on the gamified context as well as users' characteristics.

Seaborn and Fels (2014) conducted a systematic review on the use of gamification in studies involving interactive systems and human participants (human-computer studies). They compared the studies based on purposes and contexts, design of systems (only game mechanics and elements), and user impact, in addition to a comparison between gamification and related approaches. They concluded that "standard conceptualization of gamification is emerging against a growing backdrop of empirical participants-based research."

In addition to the mentioned shortcomings of the existing reviews, a common gap between these reviews is the lack of in-depth analysis of gamified systems, which could enable researchers to compare the structures of gamification solutions. Therefore, it can be concluded that based on the literature and to the best of our knowledge, there is no comprehensive systematic literature review that has broken down gamification solutions to their major and minor elements and categorized them based on their effects on users' engagement problems, in addition to their usage in different software applications.

Identifying the Need for a Review

In cognizance of the gap in the existing literature, we decided to conduct the current review by investigating the existing gamification solutions designed to solve user engagement problems in different categories of software. Since using a correct gamification solution can increase software popularity and solve user engagement problems, this review has a significant contribution to the body of knowledge. The results of the study can prevent software failures related to the following two aspects: a) lack of users' motivation to enter content in software/website, for example

in information systems or social websites; and b) lack of users' motivation to use software and engage in software content, for example in e-learning systems. Furthermore, this study identified opportunities for further studies by showing the shortage of current gamification solutions and under-researched software categories.

Specifying the Research Questions

The research questions we have formulated for this review attempt to delve deep into gamification solutions with the purpose of enhancing software user engagement. These questions touch topics about the types of gamified software and their platforms, gamification solutions and elements as well as gamification effects on software user engagement. The research questions are listed below:

- (1) RQ1: In what type of platform and software gamification has been implemented more?
- (2) RQ2: What are the engaged elements in gamifying process?
- (3) RQ3: What gamification solutions and elements have been used:
 - (3a) in each software type?
 - (3b) to solve each user engagement problem?
 - (3c) more frequently in general?
- (4) RQ4: Do the studies provide evidence that gamification had positive effects on software user engagement and performance?

The first research question attempts to inform readers about the areas in which gamification is used (applications and their platforms) to show the gap in software categories that the researchers can work on for applying gamification. The second research question shows the structure of a gamification solution including the hierarchy and relationship between the elements to introduce all gamification elements to readers. This research question is the basis of answering the third research questions. The third research question part A complements the first research question and explores the gamification elements that are used in each software type to inform users about the reliable gamification elements to gamify each group of applications. The third research question part B discovers the gamification elements that are applied to solve different problems that hinder users from working with an application in order to help researchers find which gamification elements are appropriate to solve users interaction problems with an application. The third research question part C summarizes the gamification elements based on their usage in the studies from most to least. This is done to show: a) the reliable elements that can be used in different systems without considering the nature of the system; b) the gap in using the elements that are not used much; and c) the opportunities for proposing new gamification solutions. Finally the fourth research question evaluated the experimental method of the current studies and the results of gamification on user performance and engagement with applications to show readers whether gamification is an effective method or not.

Identifying the Relevant Bibliographic Databases

In order to answer the research questions and find the relevant studies, we tried to select bibliographic databases that cover the majority of journals and conference papers associated with the field of computer science and gamification. Relevant bibliographic databases identified are as follows: ACM, IEEE, SpringerLink, ScienceDirect, Proquest, Scopus, Wiley Inter Science, and Google Scholar. Since gamification gained widespread usage from the middle of 2010, the year 2008 was chosen as the starting date of published papers to ensure the search would not miss any related studies. The search would include articles published up to November 2014.

3.2. Phase 2: Conducting the Review

This is the main phase of our systematic review with the purpose of selecting related studies as well as synthesis of data.

Identifying the Relevant Studies

In order to locate meaningful papers in bibliographic databases, we conducted a complete search with a combination of three categories of terms: a) synonyms for gamification; b) alternative terms for software; and c) words related to gamification effects. The construction of search terms was based on the steps described by Brereton et al. (2007). Accordingly, Boolean OR was used for alternative spellings, synonyms, or alternative terms, and Boolean AND was applied to connect the main terms. The complete list of search strings of the review is provided in Table 2.

Two additional search strategies were applied to retrieve the maximum number of relevant papers. The first strategy is reviewing the reference list of selected papers to find more related papers. The second strategy is googling the authors of selected studies to find potential related researches. A summary of the search in bibliographic databases is presented in Table 3.

Defining Selection Criteria

In order to select the primary papers, we defined the following criteria based on the purpose of our study.

Inclusion criteria.

- (1) Studies containing gamification solutions to motivate users to use a specific software.

Table 2. Search keywords.

Term 1	And	Term 2	And	Term 3
Gamification		Software		Interestingness
Or		Or		Or
Gamifying		System		Popularity
Or		Or		Or
Gamify		Application		Acceptance
Or		Or		Or
Gamified		App		Motivation
Or		Or		Or
Gamifies		Website		Engagement
		Or		Or
		Mobile		Efficiency

Table 3. Summary of the search in bibliographic databases.

Academic databases searched	Scopus Science Direct Wiley Inter Science ACM Digital Library Springer Database IEEE
Target items	Google scholar Journal papers Workshop papers Conference papers Book chapters
Search applied to	Title Abstract Keywords Content
Inclusion criteria	Gamification studies in context of software user's engagement
Language	Papers written in English
Publication period	January 2008 up to November 2014

- (2) Studies utilizing gamification in applications related to education, health care, data collection, and engineering that motivate users to generate content or enhance user engagement in software content.
- (3) Studies dealing with gamified software that motivates users to perform a special action or task inside or outside the software.

Exclusion criteria.

- (1) Studies that do not use gamification in software context.
- (2) Studies of gamification in software systems that are used only for showing competition results and not stimulating user engagement.
- (3) All serious game studies, including learning games, exergaming, games with a purpose, and gamification studies that are reluctant to serious games.
- (4) Papers available only in the form of abstracts or PowerPoint presentations.
- (5) Papers that are not written in English.

Selecting Primary Studies

The titles and abstracts of searched papers were reviewed based on the inclusion and exclusion criteria. Every paper that met at least one of the criteria and without any of the exclusion criteria was included in the review. For papers that could not be excluded based on reading of the titles and abstracts, the full texts of papers were reviewed. Through this process, 78 articles were selected from the 528 papers initially found. 281 papers were excluded only by reading the topics, 109 papers by reading the abstracts, and 60 papers by reading the full texts. The percentages of papers excluded by reading the abstracts, topics, or full texts are illustrated in Figure 3.

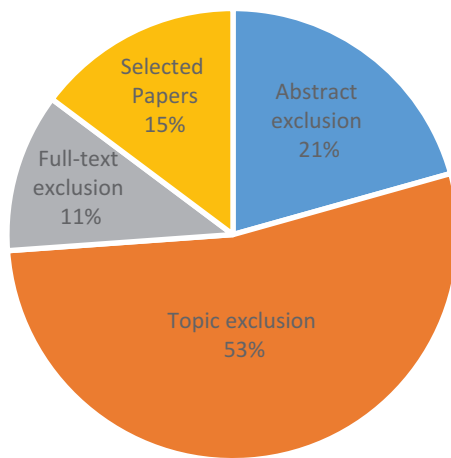


Figure 3. Percentage of papers excluded.

Validity Control of the Primary Studies

In order to maintain the quality of the selected studies, the primary studies chosen by the first reviewer were double-checked by a second author and a questionnaire was filled for each paper. This questionnaire was designed to evaluate the reviewers' level of agreement pertaining to the selected studies. The questionnaire contains three closed questions. The first two questions require an answer of yes or no and the third question an answer based on the five-point Likert scale. These evaluation questions are:

- (1) Whether a proposed gamification solution is implemented in the software context?
- (2) Whether the purpose of gamification solution is to enhance user engagement in software?
- (3) To what extent the proposed solution to enhance user engagement is a gamification solution (not a serious game solution)?

Since the questions were designed based on the exclusion criteria of the study, a "No" answer to each of the first two questions or selecting a value less than three for the third question would reject the paper. The procedure of selecting the primary papers is illustrated in Figure 4. As it can be seen in the diagram, five papers are excluded by the second reviewer.

Data Extraction and Synthesis

In order to extract and synthesize the data to answer the research questions, the selected studies are classified into five categories:

- (1) Gamified software and their platform: This categorization answers the first research question and helps find the most used type of gamified software and their platform. We divided the studies into three categories based on their platforms: stand-alone, web, and mobile. Also, based on the target software type of the studies, we divided them into

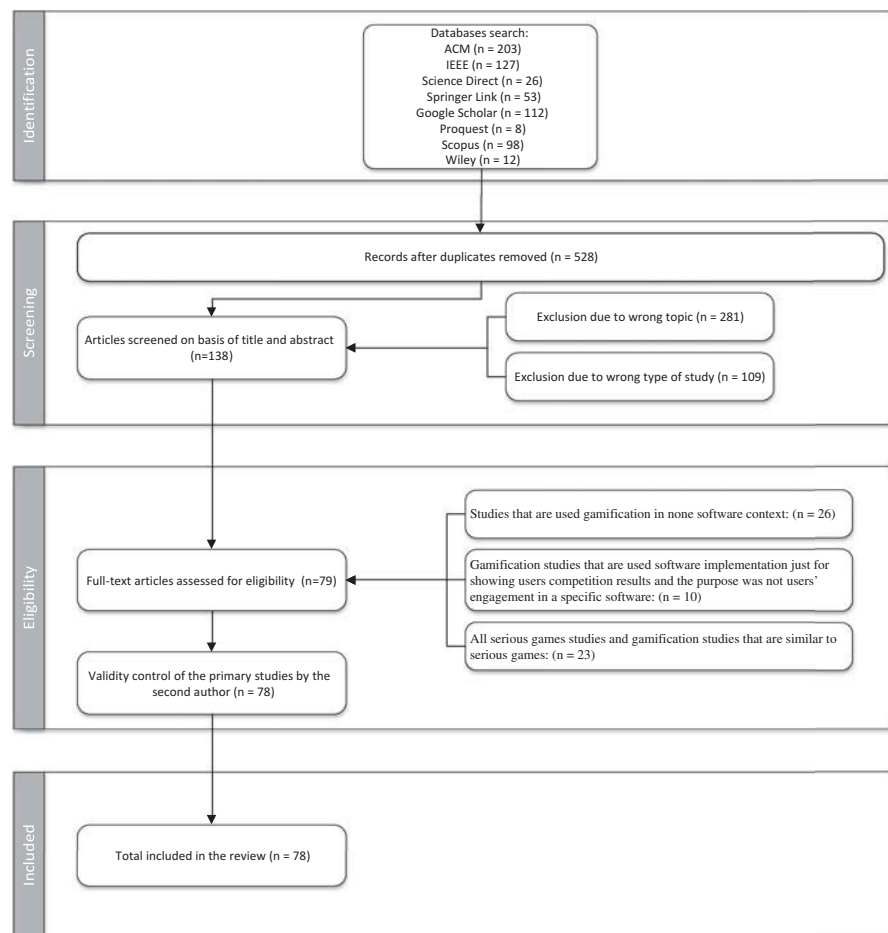


Figure 4. Selecting the primary papers.

the 12 categorizes, namely: educational software, productivity software, cloud storage, utility software, entertainment software, search engine software, tool software, fitness software, software engineering, information worker software, social software, and health-care software.

- (2) Elements of the gamifying process: In order to answer the second research question and find the structure of gamification solutions, we tried to list all engaged elements in the gamifying process, find out how these elements relate to each other, and present a framework accordingly. Since there was no framework entailing all elements of a gamification solution and a gamifying process, we developed a framework based on the literature to enable us to compare gamification solutions.
- (3) Gamification solutions in each software type: This category answers the third research question part (a) and complements the first category above through an in-depth investigation of gamification type, contextual type of reward, reward usage, game mechanics, and game interface elements in each software type. It helps discover common solutions that are practical to gamify each type of software.
- (4) Gamification solutions for software user engagement problems: The output of this categorization answers the third research question part (b) through finding the common software user engagement problems and the existing gamification solutions to solve each one. The user engagement problems were divided into six items: use real identity, generate content into software, work with software /practice with the use of system, difficulty in learning software, use software content, and software interestingness to change users' behavior. Furthermore, similar to the second categorization, gamification solutions are divided into five items: gamification type, contextual type of reward system, reward usage, game mechanics and components, and game interface elements. This breakdown helps us find the existing solutions to solve each software user engagement problem and the problems that were not addressed in the reviewed studies.
- (5) Gamification solutions in general: This category answers the third research question part (c) and helps identify the most and least commonly used gamification type, mechanics, and interface elements with the purpose of software user engagement. In contrast to the second and third categorizations, this categorization is carried out without considering software type, platform, and engagement problems.
- (6) Effects of gamification on software user engagement: This category answers the fourth research question by assessing the success rate of the proposed gamification solutions to problems of software user engagement as well as the research methods and materials that are used to evaluate gamification efficiency.

4. Results of the Systematic Mapping

In this section, we report the outcomes of reviewing the selected studies and discuss the results in detail, in order to respond to the defined research questions.

4.1. Results of the Search

Through the search procedure and criteria, a total number of 78 studies are extracted. Although interest in studying gamification started in 2010 (Deterding et al., 2011), the number of primary studies obtained is quite large, which proves the popularity as well as usefulness of this science.

The distribution of the primary studies according to publishing year is shown in Table 4 and Figure 5. As it can be seen from the chart, there are very few studies available from 2008 to 2010. The number of gamification studies increased significantly from 2011 to 2013, but the number trends downward in 2014 compared with that of 2013. The reason could be due to the year 2014 being the cutoff point of publication for the current study. Since this study was conducted in 2014,

Table 4. Distribution of selected studies based on the year.

Software type	Studies
2008	(Farzan et al., 2008)
2009	(Montola, Nummenmaa, Lucero, Boberg, & Korhonen, 2009)
2010	(Burke & Mesaglio, 2010; Halan, Rossen, Cendan, & Lok, 2010)
2011	(Bell, Sheth, & Kaiser, 2011; Dencheva, Prause, & Prinz, 2011; Farzan & Brusilovsky, 2011; Landers & Callan, 2011; Law, Kasirun, & Gan, 2011; Liu et al., 2011; Sheth, Bell, & Kaiser, 2011; Tabata & Hashimoto, 2011; Witt et al., 2011)
2012	(Bista, Nepal, Colineau, & Paris, 2012; Cafazzo, Casselman, Hamming, Katzman, & Palmert, 2012; Depura & Garg, 2012; Dong et al., 2012; Duarte, Farinha, Mira Da Silva, & Rodrigues Da Silva, 2012; Eickhoff, Harris, & De Vries, 2012; Fernandes et al., 2012; Fitz-walter, Tjondronegoro, & Wyeth, 2012; Gnauk et al., 2012; Guin, Baker, Mechling, & Ruylea, 2012; Johnson, Okimoto, & Barnes, 2012; Knautz et al., 2012; Li et al., 2012; Martí et al., 2012; Rapp, Marcengo, Console, & Simeoni, 2012; Singer & Schneider, 2012)
2013	(Berkling & Thomas, 2013; Bowser et al., 2013; Brooks, Lovett, & Creek, 2013; Cechanowicz, Gutwin, Brownell, & Goodfellow, 2013; Cheong, Cheong, & Filippou, 2013; Chua & Banerjee, 2013; Denny, 2013; Domínguez et al., 2013; Donovan, O' Gain, & Marais, 2013; Eveleigh, Jennett, Lynn, & Cox, 2013; Fitz-Walter, Wyeth, Tjondronegoro, & Scott-Parker, 2013; Freeman, 2013; Hakulinen et al., 2013; Hall, Glanz, Caton, & Weinhardt, 2013; Hamari, 2013; Hori, Tokuda, Miura, Hiyama, & Hirose, 2013; Ibáñez, Di-serio, & Delgado-kloos, 2014; Jylhä, Nurmi, Hemminki, & Jacucci, 2013; Kappen, Johannsmeier, & Nacke, 2013; Keung, Lee, Lu, & O'Keefe, 2013; Lee, Ceyhan, Jordan-Cooley, & Sung, 2013; Lin, Ramakrishnan, Chang, Spraragen, & Zhu, 2013; Makanawala, Godara, Goldwasser, & Le, 2013; Massung, Coyle, Cater, Jay, & Preist, 2013; Meder, Plumbaum, & Hopfgartner, 2013; Menezes, Gusmão, & Machiavelli, 2013; Ohno, Yamasaki, & Tokiwa, 2013; Ohrström, Sandborg-petersen, Thorvaldsen, & Ploug, 2013; Rose, Koenig, & Wiesbauer, 2013; Seufert, Lorey, Hirth, & Hobbfeld, 2013; Stinson et al., 2013; Todor & Pitic, 2013)
2014	(AlRouqi & Al-Khalifa, 2014; Ašeriškis & Damaševičius, 2014; Azzopardi, Bevc, Gardner, Maxwell, & Razzouk, 2014; Browne, Anand, & Gosse, 2014; Chen & Pu, 2014; Damm, Tello, & Ritz, 2014; Goncalves, Hosio, Ferreira, & Kostakos, 2014; Horita et al., 2014; Knutas, Ikonen, Nikula, & Porras, 2014; Morrison & DiSalvo, 2014; Nevin et al., 2014; Snipes, Nair, & Murphy-hill, 2014; Su & Cheng, 2015; Sukale & Pfaff, 2014; Tursi, Deplano, & Ruffo, 2014; Ueyama, Tamai, Arakawa, & Yasumoto, 2014; Zuckerman & Gal-Oz, 2014)

some of the studies carried out in the same year might not yet be accessible by the end of 2014. Furthermore, for some of the papers only the abstract was accessible and this is why these papers were excluded from the study.

The total number of papers in each library and the number of selected papers are presented in Table 5 and Figure 6. As it can be seen, ACM, IEEE, Scopus, Springer Link, and Google Scholar contain the most number of gamification studies and a large number of our primary papers are selected from these databases. In contrast, Science Direct has fewer papers whilst

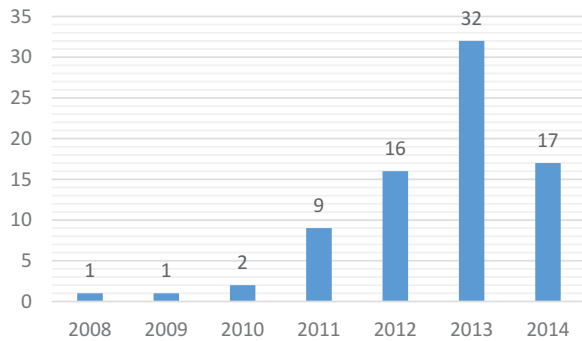


Figure 5. Distribution of primary reviewed studies per year.

Table 5. Number of papers in each library.

Library	Total number of results	Selected papers
ACM	203	(AlRouqi & Al-Khalifa, 2014; Azzopardi et al., 2014; Bell et al., 2011; Bowser et al., 2013; Cechanowicz et al., 2013; Chen & Pu, 2014; Denny, 2013; Dong et al., 2012; Donovan et al., 2013; Eickhoff et al., 2012; Farzan et al., 2008; Fitz-walter et al., 2012; Fitz-Walter et al., 2013; Gnauk et al., 2012; Goncalves et al., 2014; Hori et al., 2013; Jylhä et al., 2013; Kappen et al., 2013; Keung et al., 2013; Knautz et al., 2012; Knutas et al., 2014; Li et al., 2012; Liu et al., 2011; Massung et al., 2013; Montola et al., 2009; Morrison & DiSalvo, 2014; Rapp et al., 2012; Sheth et al., 2011; Snipes et al., 2014; Sukale & Pfaff, 2014; Tursi et al., 2014)
IEEE	127	(Berkling & Thomas, 2013; Bista et al., 2012; Damm et al., 2014; Depura & Garg, 2012; Duarte et al., 2012; Hakulinen et al., 2013; Hall et al., 2013; Ibáñez et al., 2014; Law et al., 2011; Meder et al., 2013; Ohno et al., 2013; Seufert et al., 2013; Singer & Schneider, 2012; Tabata & Hashimoto, 2011; Todor & Pitic, 2013; Ueyama et al., 2014)
Science Direct	26	(Browne et al., 2014; Domínguez et al., 2013; Farzan & Brusilovsky, 2011; Fernandes et al., 2012; Hamari, 2013; Menezes et al., 2013), (Brooks, Lovett, & Creek, 2013; Chua & Banerjee, 2013; Dencheva et al., 2011; Halan et al., 2010; Johnson et al., 2012; Landers & Callan, 2011; Lin et al., 2013; Makanawala et al., 2013; Martí et al., 2012; Ohrström et al., 2013; Zuckerman & Gal-Oz, 2014)
Springer Link	53	(Ašeriškis & Damaševičius, 2014; Burke & Mesaglio, 2010; Cafazzo et al., 2012; Cheong et al., 2013; Eveleigh et al., 2013; Guin et al., 2012; Horita et al., 2014; Nevin et al., 2014; Rose et al., 2013; Stinson et al., 2013; Witt et al., 2011)
Google Scholar	112	(Freeman, 2013)
Proquest	8	(Lee et al., 2013)
Scopus	98	(Su & Cheng, 2015)
Wiley	12	

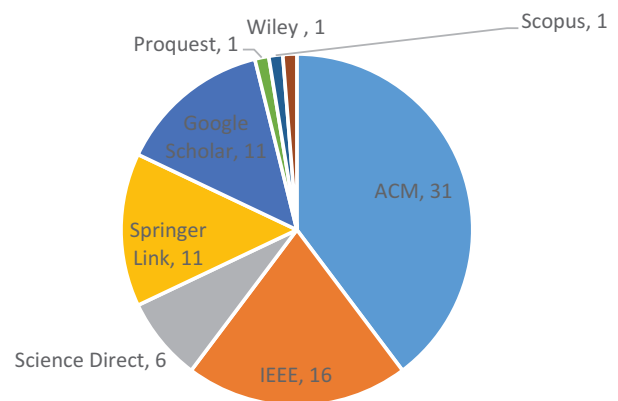


Figure 6. Number of papers in each library.

Table 6. Type of selected papers.

Papers type	Studies
Journal paper	(Browne et al., 2014; Cafazzo et al., 2012; Domínguez et al., 2013; Farzan & Brusilovsky, 2011; Guin et al., 2012; Hamari, 2013; Ibáñez et al., 2014; Lee et al., 2013; Lin et al., 2013; Nevin et al., 2014; Rose et al., 2013; Stinson et al., 2013; Su & Cheng, 2015; Zuckerman & Gal-Oz, 2014)
Conference proceeding	(AlRouqi & Al-Khalifa, 2014; Ašeriškis & Damaševičius, 2014; Berkling & Thomas, 2013; Bista et al., 2012; Bowser et al., 2013; Cechanowicz et al., 2013; Chen & Pu, 2014; Cheong et al., 2013; Damm et al., 2014; Dencheva et al., 2011; Denny, 2013; Depura & Garg, 2012; Dong et al., 2012; Duarte et al., 2012; Eickhoff et al., 2012; Eveleigh et al., 2013; Farzan et al., 2008; Fernandes et al., 2012; Fitz-walter et al., 2012; Fitz-Walter et al., 2013; Goncalves et al., 2014; Hakulinen et al., 2013; Hall et al., 2013; Hori et al., 2013; Horita et al., 2014; Jylhä et al., 2013; Kappen et al., 2013; Keung et al., 2013; Knautz et al., 2012; Knutas et al., 2014; Law et al., 2011; Li et al., 2012; Liu et al., 2011; Massung et al., 2013; Meder et al., 2013; Menezes et al., 2013; Montola et al., 2009; Morrison & DiSalvo, 2014; Ohno et al., 2013; Rapp et al., 2012; Seufert et al., 2013; Singer & Schneider, 2012; Snipes et al., 2014; Sukale & Pfaff, 2014; Tabata & Hashimoto, 2011; Todor & Pitic, 2013; Tursi et al., 2014; Witt et al., 2011)
Book chapter	(Brooks, Lovett, & Creek, 2013; Chua & Banerjee, 2013; Donovan et al., 2013; Halan et al., 2010; Johnson et al., 2012; Landers & Callan, 2011; Makanawala et al., 2013; Martí et al., 2012; Ohrström et al., 2013)
Workshop paper	(Azzopardi et al., 2014; Bell et al., 2011; Burke & Mesaglio, 2010; Gnauk et al., 2012; Sheth et al., 2011; Ueyama et al., 2014)
Thesis	(Freeman, 2013)

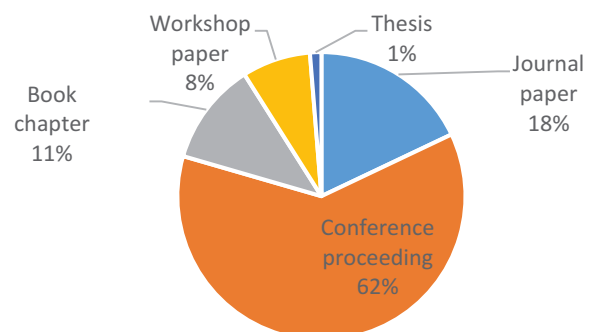


Figure 7. Type of selected papers.

Proquest and Wiley have the least number of papers related to gamification in computer science.

The types of selected papers are shown in Table 6 and Figure 7. As the classification shows 62% of the papers were published as conference proceeding, 18% as journal paper, 11% as book chapter, 8% as workshop, and 1% as thesis.

4.2. Research Questions

In this section different types of analyses were performed on the primary studies to answer the defined research questions. The answers to the stated research questions are as follows.

RQ1: In What Type of Platform and Software Has Gamification Been Implemented More?

In this part we attempt to discover the platform of gamified software and type of software that are in the core of attention of gamification developers. As shown in Figure 8, 60% of the gamified systems are web-based, 34% are developed for smartphones and tablets, and only 6% are for stand-alone software applications. A summary of each study including the study purpose, platform, software category, gamification structure, and gamification results is presented in Appendix A.

Gamified software can be categorized in educational software, productivity software, cloud storage, utility software, entertainment software, search engine software, tool software, fitness software, software engineering, information worker software, social software, and healthcare software. Based on the findings, the most common types of gamified software are developed for social and educational purposes. Social software constitutes 46% and educational software 27% of the total number of gamified software. In social software, data collection software constitutes 55% and in educational software, academic educational software constitutes 62% of the gamified software. The reason why the majority of the gamified systems are developed for web-based applications, especially social software, is the number of websites such as forums, blogs, wikis, and social sites with the same functionality and the life of each one, which depends on the number of users and the amount of data they enter into the website. Website owners need

to use different techniques to encourage users to prefer to use their website instead of the other competitors' websites. These techniques can be providing free services such as email account, newsletter, and telecommunication service or using motivational techniques like applying gamification. These days most of the companies prefer using gamification instead of providing a special service to the users. The reason that gamification got such popularity is its price in comparison with the other solutions in addition to its effectiveness for the majority of the users.

The second large group of gamified systems is web-based educational software, since it is very important to increase students' motivation and their engagement with the learning content. If the students are not keen to read the contents and answer the questions, the e-learning system would be meaningless. It is the main reason why gamification is applied in numerous e-learning systems. Furthermore, gamification can help students evaluate their own learning performance, their progress to learn a new concept, and compare their learning achievement with the others.

The third large group of gamified systems is mobile-based health-care and fitness apps. Since the purpose of these apps is motivating users to live healthier and change their behaviors, they need to use a strong motivator that encourages users to perform some tasks such as exercising or using medications, in addition to showing the users their healing progress. Therefore, applying gamification can be very beneficial for these groups of apps.

Finally, since in most stand-alone applications such as productivity software, utility software, information systems, tool software, etc. users are forced to work with the software to perform their job, the need for a special motivator to increase users' engagement is less necessary. This is why few numbers of studies exist for the stand-alone applications compared with web and mobile applications. A complete list of different types of gamified software and their subclasses is provided in Table 7 and Figures 9 and 10.

RQ2: What are the Engaged Elements in the Gamifying Process?

In order to find the structure of gamification solutions, we conducted a review to list all engaged elements in the gamifying process, find out how these elements relate to each other, and present a framework accordingly.

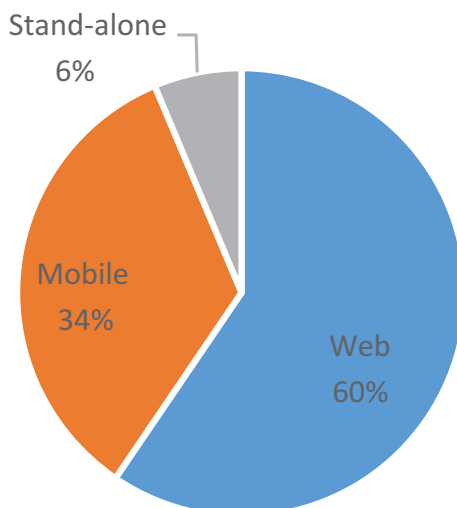


Figure 8. Platform of gamified software.

Gamification Type

There are two types of gamification: structural gamification and content gamification. In structural gamification, the software content is not game-like, and gamification is only implemented on the structure around the content. The focus of structural gamification is to motivate and engage users through rewards such as points, badges, or achievements for special actions. On the other hand, content gamification is about applying gamification on software content and working with content that is game-like (Kapp, 2012). For example, in an e-learning system that is designed based on structural gamification, the learning contents are normal and users are rewarded by reading or practicing with the system. In contrast, in an e-learning system based on content gamification, the content itself has a game-like and fun structure, in addition to rewards for reading and practicing.

Table 7. Context of gamified software.

Software type	Usage context	Studies
Educational software	School Education	(Su & Cheng, 2015; Bell et al., 2011)
	Academic Education	(Berkling & Thomas, 2013; Cheong et al., 2013; Denny, 2013; Domínguez et al., 2013; Donovan et al., 2013; Hakulinen et al., 2013; Halan et al., 2010; Ibáñez et al., 2014; Landers & Callan, 2011; Nevin et al., 2014; Ohno et al., 2013; Ohrström et al., 2013; Todor & Pitic, 2013)
	General Education	(Azzopardi et al., 2014; Browne et al., 2014; Johnson et al., 2012; Menezes et al., 2013; Morrison & DiSalvo, 2014)
Productivity software	Industrial Education	(Tabata & Hashimoto, 2011)
	Computer-aided design	(Li et al., 2012)
Cloud storage	Graphics editor	(Dong et al., 2012)
	Media sharing	(Montola et al., 2009)
Utility software	Anti-Spam	(Chua & Banerjee, 2013)
Entertainment software	Entertainment	(Tursi et al., 2014)
Search engine software	Data collection	(Knautz et al., 2012)
Tool software	Activity recorder	(Fitz-Walter et al., 2013)
	Task management	(Kappen et al., 2013)
Fitness software	Activity tracker	(Chen & Pu, 2014; Keung et al., 2013; Zuckerman & Gal-Oz, 2014)
Software engineering	Programming tool	(Sheth et al., 2011; Snipes et al., 2014)
	Software documentation	(Singer & Schneider, 2012)
	Requirement engineering	(Duarte et al., 2012; Fernandes et al., 2012)
Information worker software	Project Management	(Ašeriškis & Damaševičius, 2014)
	Customer relationship management	(Makanawala et al., 2013)
	Data collection	(AlRouqi & Al-Khalifa, 2014; Bowser et al., 2013; Burke & Mesaglio, 2010; Cechanowicz et al., 2013; Eickhoff et al., 2012; Eveleigh et al., 2013; Freeman, 2013; Gnauk et al., 2012; Gonçalves et al., 2014; Guin et al., 2012; Hall et al., 2013; Horita et al., 2014; Knautz et al., 2012; Liu et al., 2011; Martí et al., 2012; Massung et al., 2013; Rapp et al., 2012; Seufert et al., 2013; Ueyama et al., 2014)
Social software	Academic course recommender	(Farzan & Brusilovsky, 2011)
	Social network	(Depura & Garg, 2012; Farzan et al., 2008; Lee et al., 2013)
	Social guides	(Fitz-walter et al., 2012)
	Social bookmarking	(Meder et al., 2013)
	Forum/blog	(Bista et al., 2012; Brooks, Lovett, & Creek, 2013; Knutas et al., 2014; Sukale & Pfaff, 2014; Witt et al., 2011)
	wiki	(Brooks, Lovett, & Creek, 2013; Dencheva et al., 2011)
	Trading service	(Hamari, 2013)
Health care software	Transportation	(Damm et al., 2014; Jylhä et al., 2013; Law et al., 2011)
	General health	(Lin et al., 2013)
	Communication disorders	(Hori et al., 2013)
	Self-monitoring	(Cafazzo et al., 2012; Rose et al., 2013; Stinson et al., 2013)

Game Mechanics

This term refers to the rules and methods designed for players to interact with the game world such as rules of passing game levels, controlling game characters in different situations, getting rewards, and winning or losing a game

(Sicart, 2008). The most useful game mechanics in gamified software are as follows.

- Story: A scenario or theme based on a gamified system is designed (Pagulayan et al., 2003 as cited in Sweetser & Wyeth, 2005).
- Clear goal: A gamified software prompts users to perform a task or activity to reach a specific milestone or complete a mission. Usually the number of activities to complete a clear goal is specified and the next milestone is clearly stated (Federoff, 2002 as cited in Sweetser & Wyeth, 2005).
- Challenge: The definition of challenge is similar to clear goal; however, in order to perform an activity and get the reward, users are faced with some pressures like time limit to complete the tasks (Passos, Medeiros, Neto, & Clua, 2011). Since in this study we analyze clear goal and time limit separately, we consider challenge in gamified systems as missions or activities versus other users, and the situations that they compete to become the pioneer and get the rewards.
- Time limit: A time pressure to perform a special task or activity (Li, Grossman, & Fitzmaurice, 2012).
- Progression: A feature to inform users about their progress toward the final goal of a system. It can be a bar or numeral percent that displays and measures the completion degree of total goals to motivate users to continue (Xu, 2011).
- Immediate feedback: A real-time function to inform users of their success or failures (Passos et al., 2011). This feature is more often used to inform users of the correctness of their action when prompted by a system to answer a question or perform a specific task.
- Reward: The main motivator of each gamified system is its reward type and mechanism (Xu, 2011). Each reward has specific characteristics including reward type, reward trigger, contextual type of reward, and reward usage.
 - Reward trigger: This term refers to any predefined action that users should perform to get a reward. The difference between this term and clear goal is that each goal can have some reward triggers. In other words, the number of rewards users can get depends on the number of triggers. For example, answer a question, add a text or photo, or check-in in a special place (Hamari & Eranti, 2011).
 - Reward type: It is a style of presenting rewards to users. Each gamified software can use one or a combination of reward types. The most popular reward types are the following.
 - Point: A numerical value that increases for any positive users action or a combination of actions (Burke & Hiltbrand, 2011).
 - Virtual money: A kind of point users can use to buy different things in a game such as upgrading the game character or buy virtual goods.

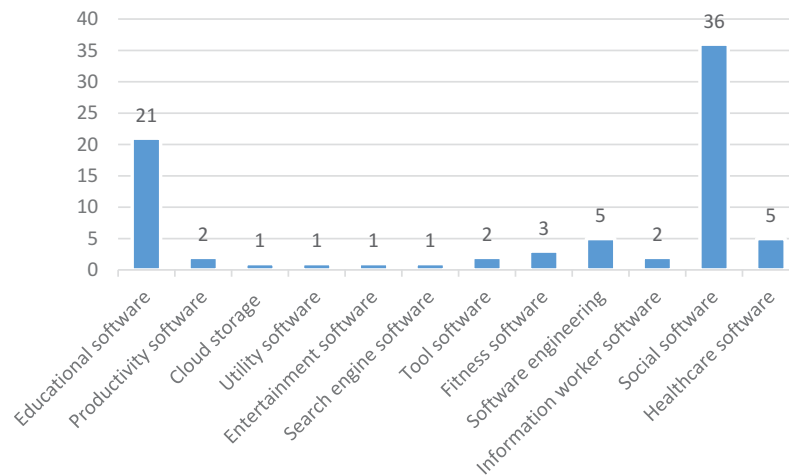


Figure 9. Software type of gamified software.

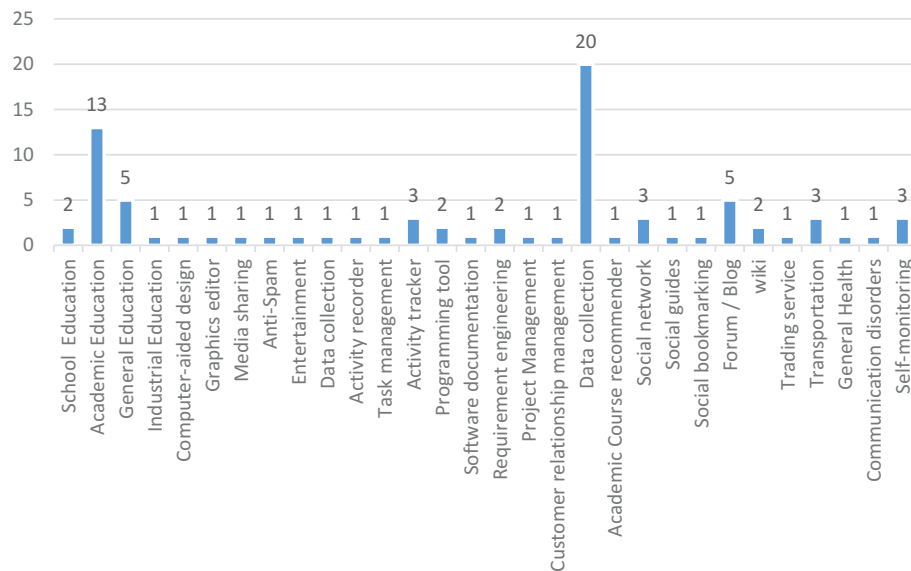


Figure 10. Context of gamified software.

- **Level:** A point-based system that usually rewards users through unlocking of higher levels or new features based on cumulated points (Gnauk, Dannecker, & Hahmann, 2012; Xu, 2011).
- **Badge:** It normally has a medal shape, and is given to users who have a special skill or completed a collection of tasks (Hamari, 2013).
- **Status:** It is a similar concept to badge; however, it assigns a rank or position to users like manager, mayor, or officer (Vassileva, 2012).
- **Achievement:** It can be anything that represents a clear activity or a task completed (Liu, Alexandrova, & Nakajima, 2011). The difference between achievement and badge is that an achievement is obtained by performing one or a small group of activities; however, a badge is obtained by performing a collection of activities. It can be said that a badge consists of a group of achievements.
- **Contextual Type of Reward:** In gamified systems, rewards can be defined in different styles including the following: fixed action, sudden rewards, random rewards, rolling rewards, prize pacing, and social rewards. In fixed action, rewards and triggers are clearly stated and users know exactly what should be performed and what the rewards are. In contrast to fixed action, the rewards and triggers of sudden rewards are not clearly specified and users are usually surprised by the rewards. Random rewards are similar to sudden rewards except the trigger is clearly shown and only the reward is a black box. Rolling rewards can be called lucky rewards since they are given by chance to a selected number of users by chance, after they have performed a specific task with a clear trigger. Prize pacing rewards are those that are broken down to sub-rewards and users have to collect all the sub-rewards to earn the main one. The last type of rewards is social rewards that are not earnable by

users' action and these rewards are only given to a user by other users (Chou, 2013).

- **Reward Usage:** In gamified systems, collected rewards can be used for three different purposes: achievement game, in-game, and out-game. Achievement game rewards are just a sign of task completion and succession, and they can be used to compare the progress of a user with himself or with others. In-game rewards mean users can use the achieved rewards in the context of a game as a credit to get a specific item. For example, it can be used as virtual money to buy special items or a prerequisite for going to the next level. Out-game rewards are related to tangible achievements users can get outside the software environment, for example, getting money prizes, getting free good, or bonus grade for students (Hamari & Eranti, 2011).

Game Interface Elements

Game interface elements have a different functionality from that of game mechanics, since they are components that manifest game information to users. The most popular game elements in gamified software are listed below.

- Fantasy:** This is using images of objects or environments that do not exist in the real world. This can make the software interface more interesting (Li et al., 2012).
- Avatar:** A character that represents a player identity in the software. It is usually customizable by users so that it is similar to the users' real style (Passos et al., 2011).
- Map:** A visual presentation of all the tasks users should perform (Morrison & DiSalvo, 2014).
- Leaderboard:** It illustrates users' rank, progress, and achievement compared with others in a game competition (Xu, 2011).

According to the above-mentioned gamification elements, we proposed a gamifying process framework that shows the relationship between all elements used in order to gamify an application. This framework shows that the first step for gamifying a system is selecting gamification type and then choosing the game mechanics and interface elements based on the selected gamification type. Furthermore, the framework illustrates the process of giving rewards to users; based on the framework the first step is to define the reward trigger for a specific task to be completed. Then we should define how we want to reward users by selecting one of the contextual type of reward, and finally we need to define the visual presentation of reward in reward type and what users can perform with the reward in reward usage. The framework of the gamifying process is illustrated in Figure 11. In addition, how gamification affects user motivation is presented in Figure 12. As illustrated in Figure 12, when users perform a task or complete a challenge in the system, they will be given a reward and this reward motivates them to continue using the system.

RQ3 (A): What Gamification Solutions and Elements Have Been Used in Each Software Type?

The findings from this section complement the first findings above ("RQ1: In What Type of Platform and Software Gamification Has Been Implemented More?"), which provide in-depth details of gamification elements in each software type, based on the framework of the gamifying process ("RQ2: What are the Engaged Elements in the Gamifying Process?"). In this research question, the type of applications and their gamified elements are investigated. This is because different applications have different purposes and different users; therefore, they need different methods to enhance users' engagement. In other words, gamification solution should be selected based on the target application and its users. For example the purpose of an e-learning system is to

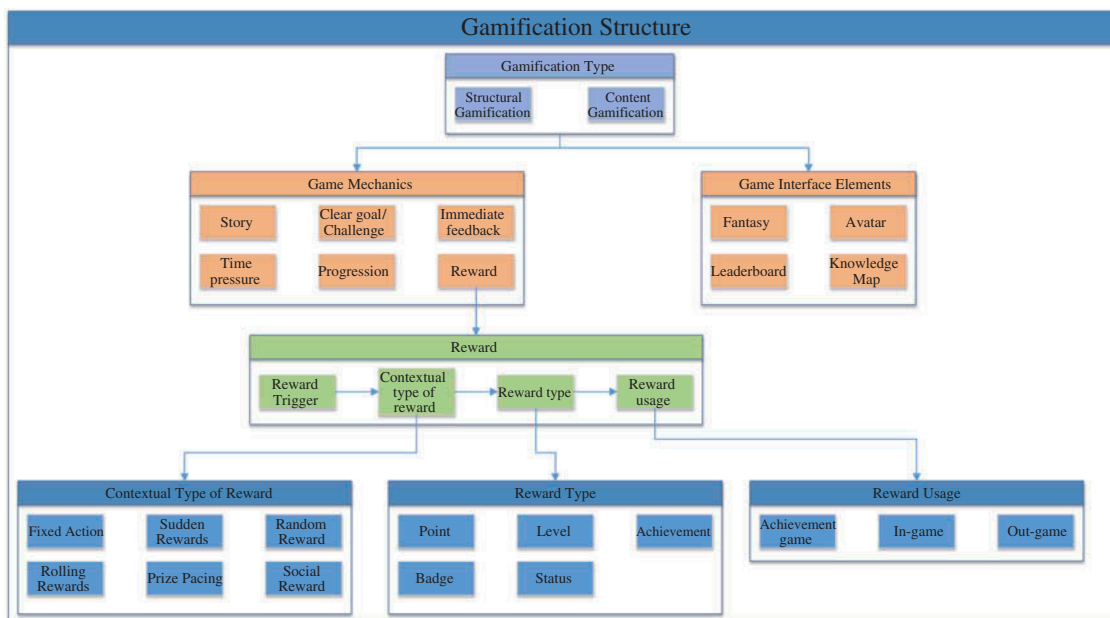


Figure 11. Framework of the gamifying process.

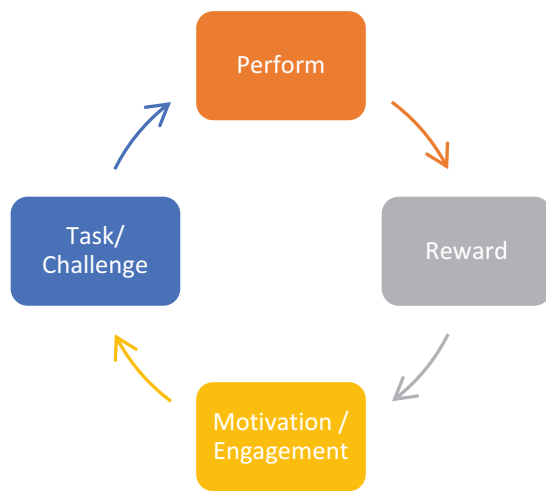


Figure 12. Gamification process.

enhance learning performance; therefore, we need a gamification solution to increase student engagement with the learning content. However, in a crowdsourcing system the purpose is to collect data from the users; therefore, the

gamified system should encourage users to enter more data into the system. Consequently, based on the purposes of each system we need to apply different mechanics and interface elements to enhance users' engagement. Figure 13 shows the most commonly used gamification type is "structural"; contextual type of reward is "fixed action," and reward usage is "achievement game" that is applied in more than 70% of each type of software. However, there are three exceptions: the most commonly used gamification type for the productivity software, the entertainment software, and the tool software is content. In Figure 13 the bigger circles with smaller numbers show the greater usage of the related elements in the studies; orange circles show gamification type, blue circles show contextual type of reward system, and green circles demonstrate reward usage. Take educational software as an example; Figures 13 and 14 show that the extent of "structural gamification" usage is greater than "content gamification."

Based on Figure 14, the following list highlights game mechanics and interface elements, which are used in more than 50% in each type of software. In few cases where none of the game mechanics or elements are used in more than 50%, we selected 40% as the border.

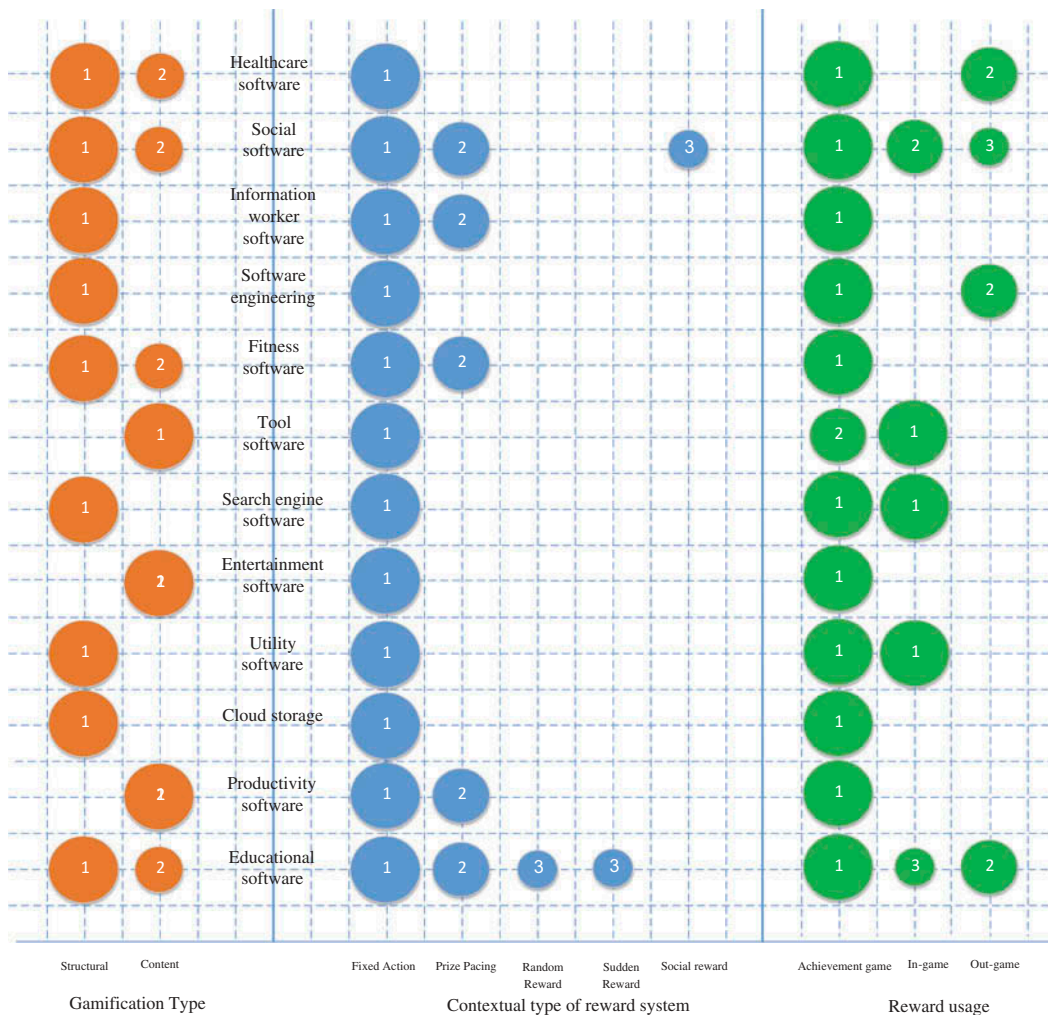


Figure 13. Gamification solutions to solve software user engagement problems in each software type.

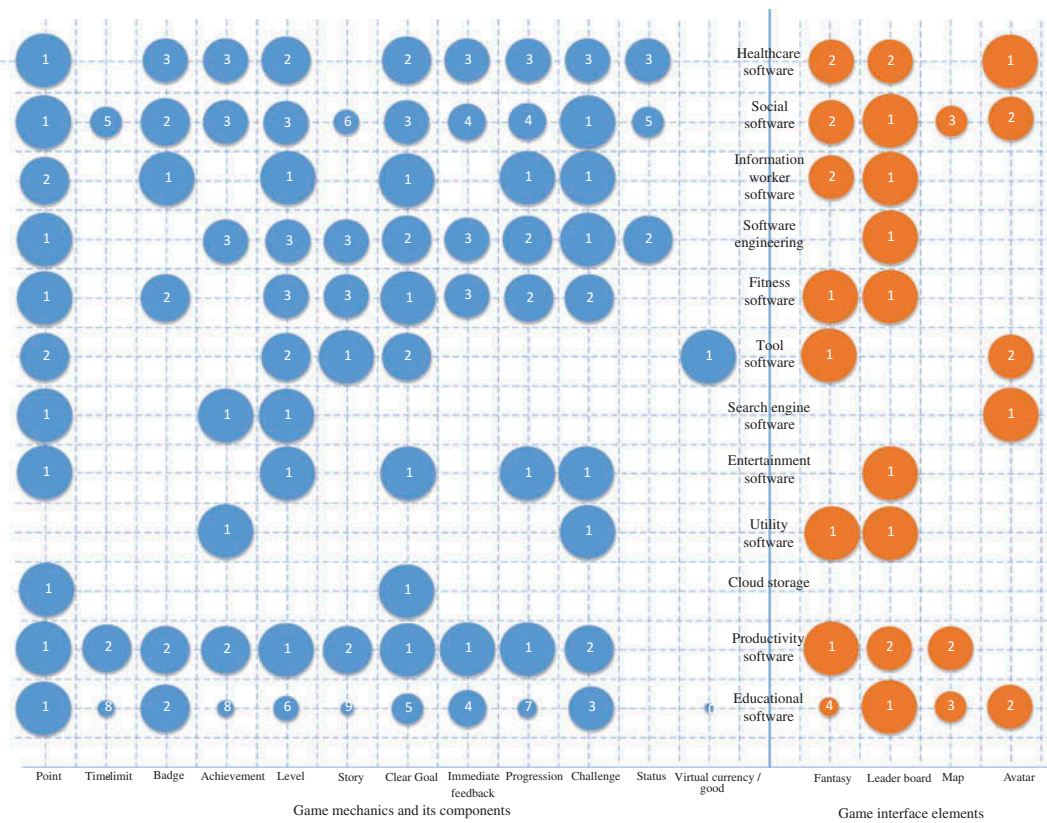


Figure 14. Game mechanics and interface elements to solve user engagement problems in each software type.

- Educational software: Game mechanics are point, badge and challenge; and game interface element is leaderboard.
- Productivity software: Game mechanics are point, level, clear goal, immediate feedback, and progression; and game interface element is fantasy.
- Cloud storage: Game mechanics are point, and clear goal, with no game interface element.
- Utility software: Game mechanics are achievement, and challenge; and game interface elements are fantasy and leaderboard.
- Entertainment software: Game mechanics are point, level, clear goal, progression, and challenge; and game interface element is leaderboard.
- Search engine software: Game mechanics are point, level, and achievement; and game interface element is avatar.
- Tool software: Game mechanics are story and virtual currency; and game interface element is fantasy.
- Fitness software: Game mechanics are point, badge, progression, challenge, and clear goal; and game interface elements are fantasy and leaderboard.
- Software engineering software: Game mechanics are point and challenge; and game interface element is leaderboard.
- Information worker software: Game mechanics are badge, level, clear goal, progression, and challenge; and game interface element is leaderboard.
- Social software: Game mechanics are point, badge, and challenge; and game interface element is leaderboard.

- Health-care software: Game mechanics are point, level, and clear goal; and game interface element is avatar.

Since applying the mentioned game mechanics and interface elements produce positive results, it can be concluded that they can be used as reliable elements to gamify the related software group. Specially, using the most used game mechanics and interface elements in each software group for gamifying the same applications is recommended. However, it does not prove other game mechanics and interface elements would have negative effects on user engagement and could not be used. A complete list of gamification elements in different types of gamified software categories is shown in Figures 13 and 14.

RQ3 (B): What Gamification Solutions and Elements Have Been Used to Solve Each User Engagement Problem?

The success of any software depends on the number of users and their engagement with the software, but there are issues that can cause software failures. Based on the review, we have grouped user engagement problems into six categories as follows.

- Generate content into software: The life of many software such as forum, blogs, and information systems is tied with the amount of information put in by users. However, users normally do not have any inclination to work and enter information into unpopular systems.

- b. Software interestingness to change users' behavior: A group of applications is designed for motivating users to perform a task including sport or special behavior outside the software environment. If these applications do not have an acceptable level of interestingness, they cannot motivate people to run the app and follow the guidelines.
- c. Work with software /practice with the use of system: A group of e-learning systems is designed to offer users practices or exam-like questions as a complement to class curriculums. These kinds of systems need a strong motivator to encourage students to open the system and engage in the practices.
- d. Use software content: The main purpose of developing applications such as e-learning or forums is presenting information to users and teaching them a concept. However, when users find the content uninteresting, they are reluctant to spend their time reading it.
- e. Difficulty in learning software: Learning a new software is difficult for many users, especially those with limited computer literacy. If users find it difficult to learn a software, they will ignore it and switch to other similar software.
- f. Use real identity: In some applications, users do not like to use their real identities or photos to login into a system. There are different reasons for this behavior; for example, some users are shy to post comments or answer questions in e-learning systems or forums when they are uncertain about the correctness of their answers.

Software designers have proposed different gamification solutions to prevent software failure and enhance user engagement. As illustrated in Figure 15, 52% of the solutions are intended for motivating users to enter more content into software; 21% for enhancing software interestingness to change users' behavior; and 18% for encouraging users to work with software. Finally, 5% of the solutions are designed

for motivating users to use software content, 3% for solving problems in learning software, and 1% for using real identity.

In order to analyze the nature of each gamification solution, we broke down each solution into different parts based on the framework of the gamifying process ("RQ2: What are the Engaged Elements in the Gamifying Process?"). As can be seen in Figure 16, the most commonly used gamification type is "structural," contextual type of reward is "fixed action," and reward usage type is "achievement game"; these are applied in more than 70% of each group of user engagement problem. The exception is problem related to learn difficult software, where "content gamification" is the most commonly used gamification type. Furthermore, "prize pacing" is the next rank in contextual type of reward system for all the user engagement problems; "in-game" is the next rank in reward usage for generating content into software; and "out-game" is the next rank in software interestingness to change users' behavior.

Based on Figure 17, the following list highlights the game mechanics and interface elements that are used in more than 50% of gamification solutions for each group of engagement problems:

- a. Use real identity: It does not use any game mechanics and only avatar is used as a game interface element.
- b. Generate content into software: Game mechanics are point and challenge; and game interface element is leaderboard.
- c. Work with software or practice with the use of system: Game mechanics are point, badge, and challenge; and game interface element is leaderboard.
- d. Learn difficult software: Game mechanics are point, level, clear goal, immediate feedback, and progression; and game interface element is fantasy.
- e. Use software content: Game mechanics are point, clear goal, and badge; and game interface element is map.

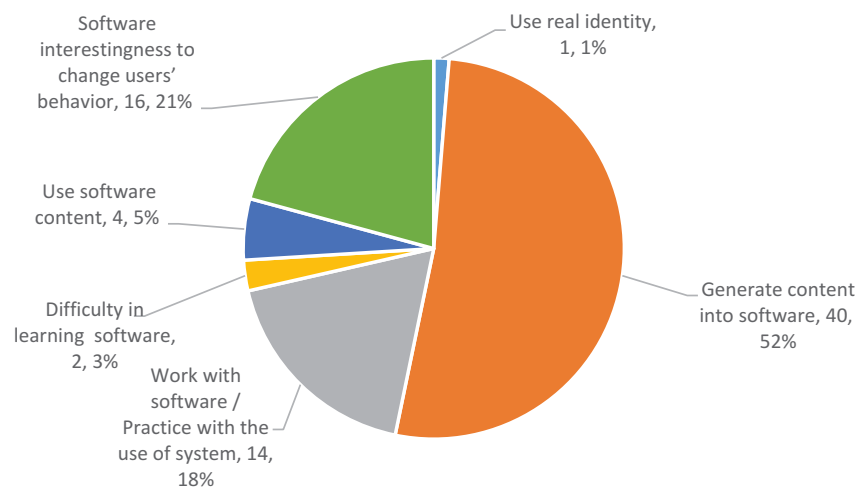


Figure 15. Percentage of gamification studies for each user engagement problem.

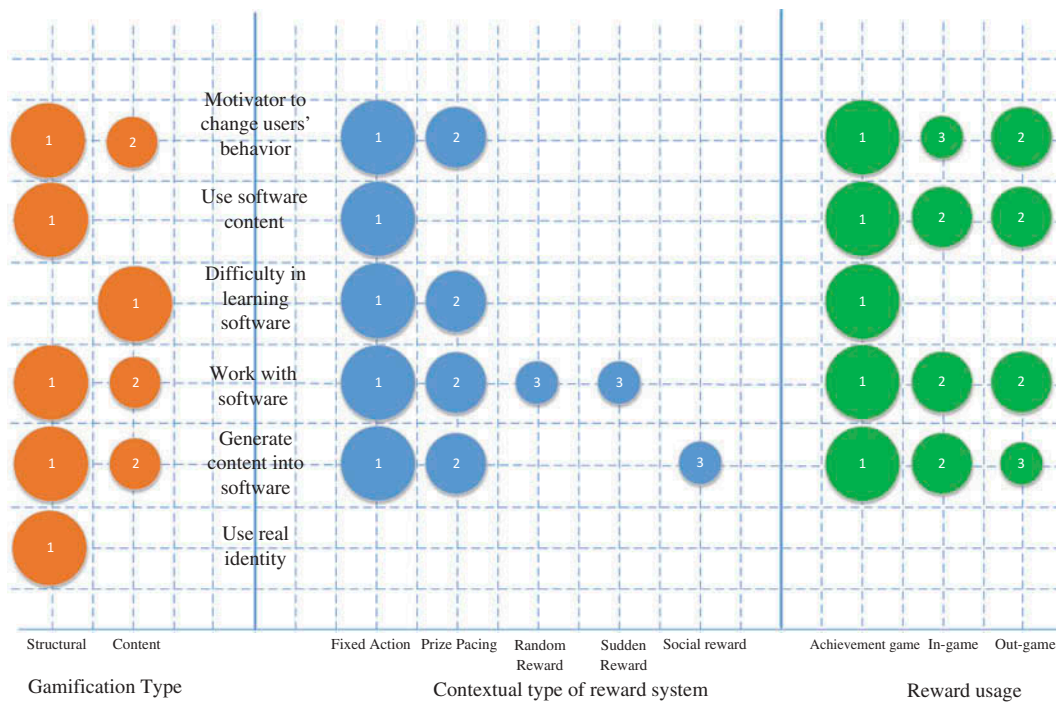


Figure 16. Gamification solutions to solve user engagement problems.

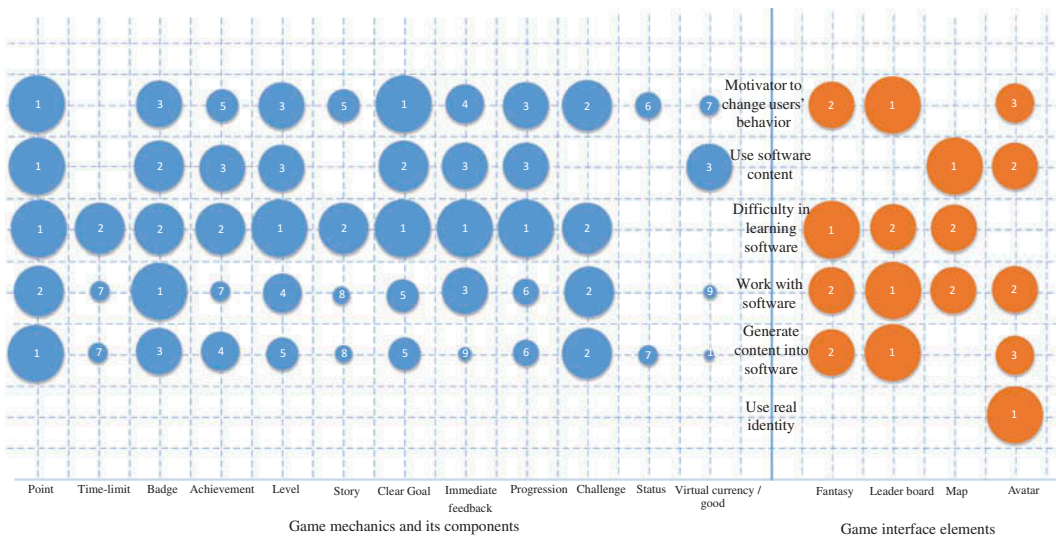


Figure 17. Game mechanics and interface elements to solve user engagement problems.

- f. Software interestingness to motivate users to change their behavior: Game mechanics are point, challenge, and clear goal; and game interface element is leader board.

Therefore, it is concluded that the mentioned game mechanics and interface elements for each group of user engagement problem can be used as a reliable solution to solve the related problems. However, it does not prove other game mechanics and interface elements would have negative effects on user engagement and could not be used. A complete list of the elements of gamification solutions can be seen in Figures 18 and 19.

RQ3 (C): What Gamification Solutions and Elements Have Been Used More Frequently in General?

This research question explores the elements used in all gamification solutions regardless of the problems users faced and the application purposes. The answer of this research question can help gamification designers find: a) the elements that can be used in every application without considering the application type; b) the elements that are used less often; and c) the opportunities for proposing new gamification solutions. As can be seen in Figure 18, the most commonly used type of gamification in the studies is "structural" with 78%, contextual type of reward system are "fixed action" and "prize pacing"

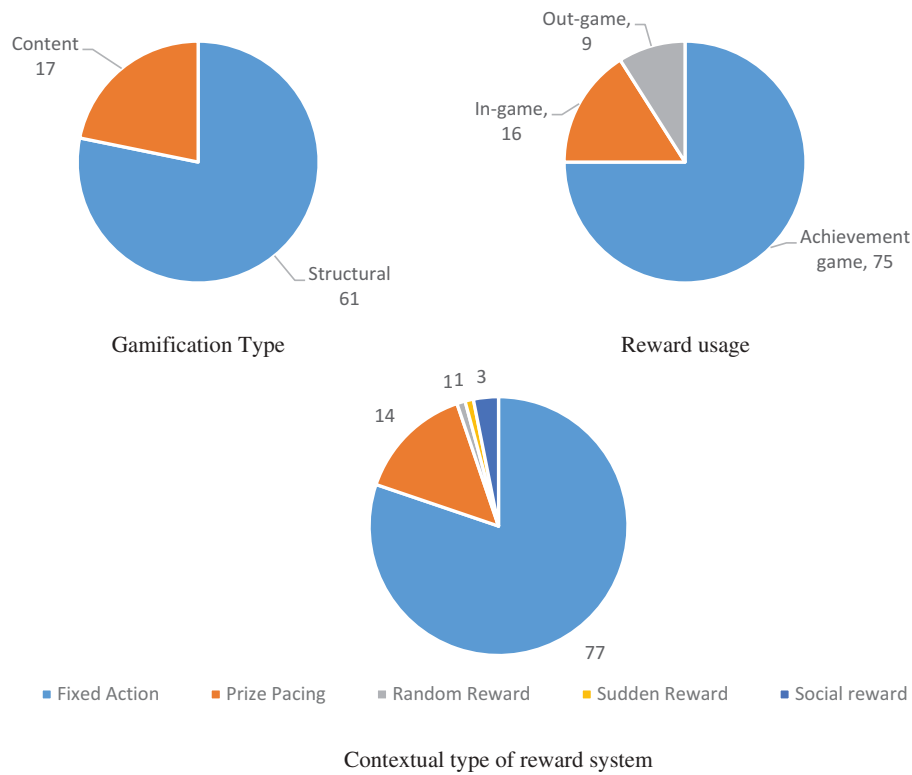


Figure 18. The most commonly used gamification solutions.

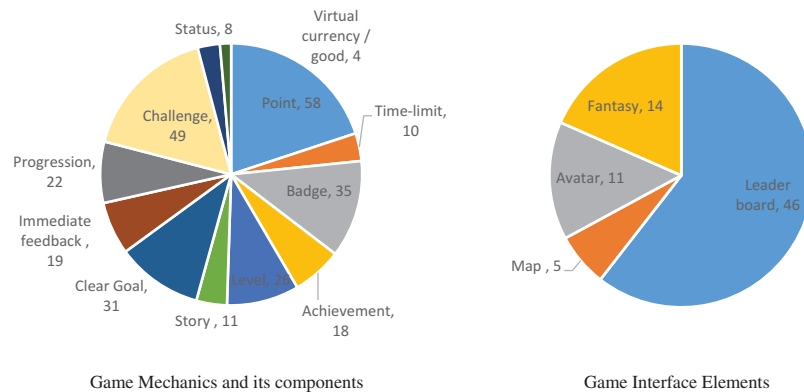


Figure 19. The most commonly used game mechanics and interface elements.

with 99% and 18%, respectively, and type of reward usage is “achievement game” and “in-game” with 96% and 20%, respectively.

As can be seen in Figure 19, the most commonly used type of game mechanics and components in the studies are point, challenge, badge, and clear goal with 74%, 63%, 45%, and 40%, respectively; and game interface element is leaderboard with 59%.

RQ4: Do the Studies Provide Evidence That Gamification Had a Positive Effect on Software User Engagement?

In total 62 of the primary studies examined their gamified system on users for different purposes and with different instruments. The four main purposes of experiments are as follows.

- Collect users’ opinions: users’ feelings about the mechanics and elements of gamified systems and gamification effects to enhance software interestingness.
- Evaluate user engagement: the effects of gamification on the usage frequency of software.
- Evaluate user’s performance: the degree of gamification could affect users in reaching the purpose of the software, such as learning a concept or performing an activity outside software.
- Evaluate software usability: evaluate the ease of use of gamified software and the effects of game elements and game-like interface on usability.

As can be seen in Figure 20, collect users’ opinions and evaluate users’ performance are the target of most of the

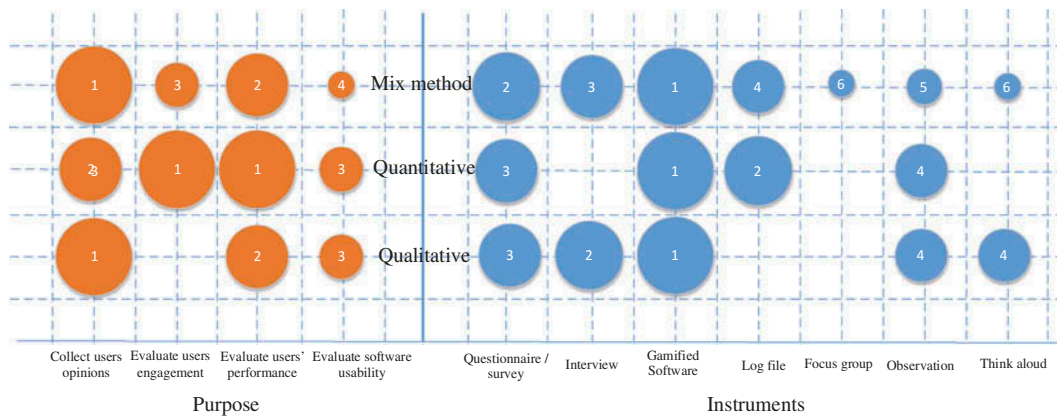


Figure 20. Experiment design and instruments.

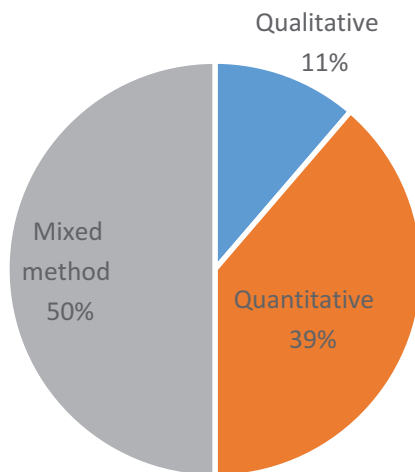


Figure 21. Research design.

studies with the mixed method and qualitative method. Evaluate users' performance and engagement are the targets of most of the quantitative studies. The most popular instrument in all the studies is developing and using gamified systems; for collecting users' data, the most frequently used instruments are questionnaire in mixed method, system log file in quantitative method, and interview in qualitative studies. As shown in Figure 21, the research design of 50% of the studies is mixed method, 39% quantitative method, and only 11% is qualitative method.

As shown in Figure 22, the experimental results of 81% of the gamified systems are completely positive, 11% partially positive, and 8% neutral with no negative result.

5. Discussion

This section provides a discussion of the results obtained from answering the research questions, in order to identify the gaps and opportunities for future studies.

5.1. Development of the Gamification Researches

As can be seen from the results of Section 5.1, 70% of the studies had been published for the purposes of conferences or workshops and just 30% of them were published as journal

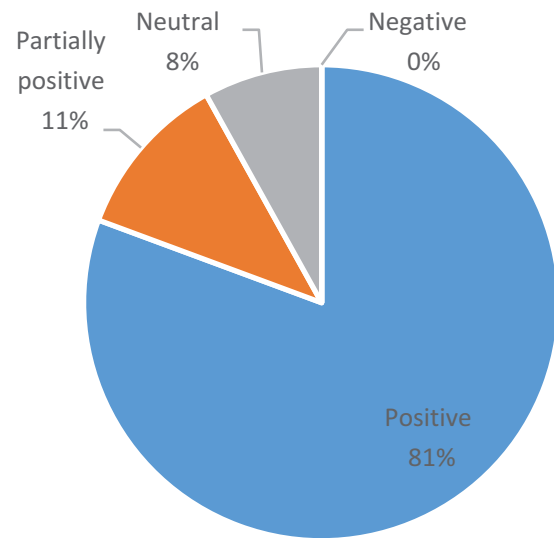


Figure 22. Gamification results.

articles, thesis, or book chapters, which indicates the status of the research is still preliminary. This result is in line with that of the systematic review conducted by Pedreira et al. (2014).

5.2. Gamified Software Types and Platforms

According to the results of the first research question, most of the gamified systems are implemented for web and mobile applications and there are a few studies available for stand-alone software including productivity software, utility software, tool software, and information worker software. In addition, most of the gamified systems are implemented in educational and social software and there are a few studies conducted for other types of software such as cloud storage, entertainment software, search engine software, fitness software, software engineering software, and healthcare software. Therefore, gamifying stand-alone systems and under-researched software types can be good topics for further studies.

5.3. Engaged Elements in the Gamifying Process

As we showed in the proposed framework in the second research question, the main engaged elements in each

gamification solution are gamification type, game mechanics, and game interface elements. There are two types of gamification, namely “structural” and “content,” that are based on choosing game mechanics and interface elements. The main member of game mechanics is reward, which consists of four parts, namely reward trigger, contextual type of reward, reward type, and reward usage. In order to motivate users, the reward process grants one type of reward to the users when they complete a task for which a reward trigger is defined and the contextual type of reward defines on what basis the reward should be granted to the user. After being granted a reward, users can use the reward for different purposes based on the defined reward usage.

5.4. Existing Gamification Solutions

Most of the existing gamification applications (software and websites) used simple elements, which are “structural gamification type” with “fixed action” for contextual type of reward, and “achievement game” for reward usage. Furthermore, many studies just used a few game mechanics and interface elements such as points, challenge, level, clear goal, and leaderboard, and the elements including story, virtual currency, time limit, status, map, and avatar are not utilized in most of the studies. Although employing the most commonly used game mechanics and interface elements in each group of software is a reliable solution to gamify the related software group, the solutions that use a wide variety of mechanics and interface elements can decrease the boringness of the system and enhance users’ sustainability. For example, if the only mechanic of a system is point or badge, after a while, increasing point or badge would be uninteresting and boring for users. However, using a combination of various mechanics can decrease the trend of boringness, especially when the gamified system uses a combination of contextual type of reward and users can use the received reward “in-game” and “out-game.” It should be added that using different contextual types of reward is one of the most effective parameters to keep users’ engaged. Since when all types of them, especially sudden rewards, prize pacing, and rolling rewards, are applied, users can get more reward in various stages and any progress would be tangible for the users. Among the existing gamification solutions, the professional solutions can be found in productivity software, fitness software, and a few educational, social software, and health-care software. In these kinds of studies, researchers used the “content gamification type” and applied a great number of mechanics and interface elements with a combination of different types of contextual type of reward, and reward usage.

5.5. Gamification Solutions to Solve Software User Engagement Problems

A gap identified based on the results of the third research question part (b) is the lack of studies and gamification solutions to solve a group of software user engagement issues including motivating

users to use software content, resolving difficulties in learning software, and using real identity. Especially, the solution to the issues related to using real identity is quite simple and needs improvement. Although there are solutions to problems of using software content and difficulties in learning software, only four studies are related to using software content and two studies to resolving difficulties in learning software. The number of these studies is really small in comparison with the number of studies for other issues such as generating content into software, work with software, and software interestingness to change users’ behavior. Hence, gamification solutions to problems of using real identity, using software content, and difficulties in learning software are good areas of further studies.

5.6. Gamified Software Experimental Results

Finally, the results of the last research question show that users of gamified systems have a positive opinion about gamification and it is a suitable solution to enhancing user engagement and performance. In addition, it does not have any negative effect on software usability.

6. Conclusions and Future Work

In this article, a systematic review has been conducted to provide a thorough analysis on the existing gamification solutions in different disciplines. The focus of this systematic mapping is on gamification applied to the software environment, and thus we excluded those works focusing on the application of gamification out of software environment or studies on serious games and game-inspired designs. We have started the study by proposing a framework of gamifying process, which is the basis for comparison of existing gamification solutions. The most significant discovery of this review is that gamification is a suitable solution to enhancing user engagement and user performance. As described before, “structural gamification type” with “fixed action” for contextual type of reward and “achievement game” for reward usage are the common solutions found among most of the studies. In addition, designers applied a small number of game mechanics and interface elements. The game mechanics used include points, challenge, level, clear goal, and leaderboard, and the elements include story, virtual currency, time limit, and status; map and avatar are not utilized in most of the studies. Therefore, future works can improve the quality of the current gamified systems by applying more complicated gamification solutions such as utilizing a combination of contextual type of reward and giving users the ability to use the received reward “in-game” and “out-game,” in addition to the use of a wide variety of game mechanics and interface elements.

Most of the gamification solutions were developed for web and mobile applications and there were few studies for stand-alone software. In addition, a large number of gamified systems were implemented for educational and social software and there were few studies for other types of software such as productivity software, cloud storage, entertainment software, search engine software, fitness software, software engineering software, and healthcare software.

Consequently, gamifying stand-alone systems and the under-researched software types are good topics for further studies.

In analyzing the purpose of the current gamification solutions, we found most of the solutions were developed for motivating users to enter more content into software, encouraging users to work with software, and enhancing software interestingness to change users' behavior. Little attention had been paid to motivating users to use software content, resolving difficulty in learning software, and using real identity in software; thus, opportunities abound for researchers working on these three areas. Especially working on finding a comprehensive gamification solution for learning software by users with limited computer literacy is strongly suggested. Since it is not easy for these users to learn new software easily, particularly when they want to learn a productivity application that provides many features, the unfamiliar and complex structure of applications' interface can increase cognitive load and make the application incomprehensible for users (Reis et al., 2012; Fang, Luo, & Xu, 2011). Since all of the studies just measured the effect of gamification on users' motivation and engagement, evaluating the effect of gamification on cognitive load during learning is suggested in future studies.

Finally, the outcome of the current systematic review can serve as a reference for further developments in the field of gamification. It is worth noting that this systematic mapping was carried out as a part of a wider research project to explore the application of gamification in productivity software. In the main project, new gamification solutions for learning productivity software will be developed based on the results of this study.

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Appendix A. Complete list of all primary studies included in the study.

Paper number		Software information					Gamification solution				Results				
		Software platform	Software type	Usage context	Software engagement	Gamification type	Game mechanics and its components	Game interface elements	Contextual reward type	Reward usage	Reward trigger	Research design	Evaluation purpose	Evaluation instruments	Results
1	Increase students' activity in classroom	Web	Educational software	Academic education	Students shy to use software with their real identity	Structural	—	Avatar	—	—	—	Qualitative	Collect users' opinions about the gamified software and its effect on users' Class activity performance	Gamified software, Questionnaire	Positive
2	Increase students' learning efficiency	Web	Educational software	Academic education	Lack of users' motivation to practice with system	Structural	Challenge, Point, Achievement, Badge, Progression	Leaderboard	Fixed Action, Prize Pacing, Random Rewards,	Achievement game	Introduce a question or evaluate peers' questions	Mixed method	Collect users' opinions about the gamified software and its effects on users' engagement and learning	Gamified software, Questionnaire, Interview	Positive
3	Learn to use AutoCAD	Stand-alone	Productivity software	Computer-aided design	Software complexity for users to learn	Content	Clear Goal, Story, Level, Achievement, Point, Progression, Immediate Feedback	Fantasy, Map, Avatar	Fixed Action, Prize Pacing	Achievement game	Perform a predefined task	Mixed method	Collect users' opinions about the gamified software and its effects on learning	Gamified software, Observation, Questionnaire	Positive
4	Encourage developers to make more commits during software development process	Web	Software engineering	Software documentation	Lack of users' motivation to make commit in version control system	Structural	Point, Clear Goal, Challenge	Leaderboard	Fixed Action	Achievement game	Make a commit	Qualitative	Collect users' opinions about the gamified software	Gamified software, Interview	Partially positive
5	Encourage people to participate in survey	Web	Social software	Data collection	Lack of users' motivation to fill the survey completely	Content	Achievement, Story, Progression	Fantasy, Avatar	Fixed Action	In-game	Answer a set of questions	Quantitative	Number of filled survey forms	Gamified software, System log file	Neutral
6	Increase the number of course ratings in a course recommender system	Web	Social software	Academic course recommender	Lack of users' motivation to rate course-related information	Structural	Achievement, Progression	—	Fixed Action	Achievement game	Rate course-related information	Quantitative	Number of courses that are rated by users	Gamified software, System log file	Positive
7	Increase students' learning efficiency	Web	Educational software	Academic education	Lack of users' motivation to practice with system	Structural	Point, Time Limit, Challenge, Immediate Feedback	Leaderboard	Fixed Action	Achievement game	Answer a set of questions in a time limit	Mixed method	Collect users' opinions about the gamified software and its effects on their engagement and learning	Gamified software, Questionnaire, Interview	Positive
8	Increase personnel interaction	Web	Social software	Social networking	Lack of personnel motivation to enter content and use the information of organizational social network	Structural	Point, Badge, Status, Challenge	Leaderboard	Fixed Action, Prize Pacing	Achievement game	Add text, photo or comment	Mixed method	Collect users' opinions about the gamified software and its effects on users' engagement and activity performance	Gamified software, System log file, Interview	Partially positive
9	Make new students familiar with university	Mobile	Social software	Social guides	Lack of software motivator to encourage new students to discover campus	Structural	Achievement, Clear Goal, Challenge, Immediate Feedback	Leaderboard	Fixed Action	Achievement game, out-game	Check-in in special places, add a friend	Quantitative	Collect users' opinions about the gamified software and its effect on usability and campus exploration	Gamified software, Questionnaire	Positive
10	Motivate students to create exam-style questions and share them with class	Web	Educational software	Academic Education	Lack of students motivation to enter and answer questions in the software	Structural	Point, Badge, Challenge	Leaderboard	Fixed Action	Achievement game	Add or answer a question, put comment on others' questions	Quantitative	Collect users' opinions about the gamified software and its effects on engagement	Gamified software, Questionnaire	Positive
11	Learn to use Photoshop	Stand-alone	Productivity software	Graphics editor	Software complexity for users to learn	Content	Clear Goal, Badge, Point, Time Limit, Level, Challenge, Immediate Feedback, Progression, Time Limit	Fantasy, Leaderboard	Fixed Action	Achievement game	Perform a predefined task	Qualitative	Collect users' opinions about the gamified software and its effects on learning	Gamified software, Think Aloud	Positive
12	Teach literacy to adults	Mobile	Educational software	General Education	Lack of users' motivation to practice with system	Content	Time Limit, Achievement, Badge, Level, Immediate Feedback	—	Fixed Action, Prize Pacing	Achievement game	Perform a predefined practice	Mixed method	Collect users' opinions about the gamified software and its effects on learning and usability	Gamified software, Questionnaire, Survey, Interview	Positive

(Continued)



Appendix A. (Continued).

Paper number	Software information					Gamification solution				Results				
	Software platform	Software type	Usage context	Software engagement	Gamification	Game mechanics and its components	Game interface elements	Contextual reward type of reward	Reward usage	Reward trigger	Research design	Evaluation purpose	Evaluation instruments	Results
13	Enhance students' ICT learning motivation and efficiency	Web	Educational software	Academic Education	Problem Lack of users' motivation to practice with system	Structural Badge, Level, Achievement, Challenge	Leaderboard	Fixed Action, Sudden Reward	Achievement game	Perform a predefined practice	Mixed method	Collect users' opinions about the gamified software and its effects on learning and engagement	Gamified software, Questionnaire	Partially positive
14	Persuade user participation in the conversational modeling for virtual humans patient	Web	Educational software	Academic Education	Lack of users' participation in development of software knowable base	Content Story, Time-Limit, Challenge, Point, Progression, Immediate Feedback	Leaderboard	Fixed Action	Achievement game	Ask an appropriate question from the system	Quantitative	Evaluate gamification effects on users' engagement and performance	Gamified software, Observation	Positive
15	Encourage users to upload their photos on the image cloud	Mobile	Cloud storage	Media sharing	Lack of users' motivation to enter content in the system	Structural Point, Clear Goal	—	Fixed Action	Achievement game	Upload a photo, sound, scenes created	Mixed method	Collect users' opinions about the gamified software and its effects on users' engagement	Gamified software, System log file, Interview	Partially positive
16	Encourage students to solve exercises	Web	Educational software	Academic Education	Lack of users' motivation to practice with the system	Structural Badge, Clear Goal, Immediate Feedback	—	Fixed Action	Achievement game, out-game	Perform an exercise based on the defined conditions	Quantitative	Evaluate gamification effects on performing exercises	Gamified software, System log file	Positive
17	Type handwritten pages	Web	Social software	Data collection	Lack of users' motivation to enter content in the system	Structural Story, Status, Challenge	Fantasy, Leaderboard	Fixed Action	Achievement game	Type a text	Qualitative	Collect users' opinions about the gamified software	Gamified software, Interview, Survey	Partially positive
18	Increase users motivation to enter idea in an online idea community	Web	Social software	Forum	Lack of users' motivation to enter information in the website	Structural Point, Challenge	Leaderboard	Fixed Action	Achievement game	Write an idea, comment, or leave a message to other ideas	Quantitative	Collect users' opinions about the gamified software and its effects on users' engagement and performance	Gamified software, Questionnaires	Positive
19	Motivate users to participate in crowdsourcing for error detection in public health researches	Web	Social software	Data collection	Lack of users' motivation to enter information in the system	Structural Point, Challenge	Leaderboard	Fixed Action	Achievement game	Number of questions answered, match important trends, streaks of correct answers	Mixed method	Evaluate gamification effects on users' classification accuracy and software usability	Gamified software, System log file	Positive
20	Motivate users to enter information in the website to support welfare recipients	Web	Social software	Forum	Lack of users' contribution in the website content	Structural Point, Badge	—	Fixed Action, Prize Pacing	Achievement game	Post a text, comment, rate the other comments	Quantitative	Categorize forum members by the type of their contributions	Gamified software, System log file, Observation	Positive
21	Transitioning to work Increase students' learning efficiency	Web	Educational software	Academic Education	Lack of students' motivation to practice with the use of system	Structural Point, Level, Badge, Challenge, Clear Goal, Immediate Feedback	Leaderboard	Fixed Action, Prize Pacing	Achievement game, in-game	Answer a question	Mixed method	Collect users' opinions about the gamified software and its effects on users' engagement and learning	Gamified software, Focus group, System log file	Positive
22	Increase students' learning motivation	Web	Educational software	Academic Education	Lack of users' motivation to practice with the system	Content Level, Clear Goal, Point, Challenge, Progression, Immediate Feedback, Achievement	Fantasy, Map, Leaderboard	Fixed Action	Achievement game	Perform a course-related task	Mixed method	Collect users' opinions about the gamified software and its effects on learning	Gamified software, Questionnaire	Neutral
23	Fill well-being survey form with a higher frequency	Web	Social software	Data collection	Lack of users' motivation to fill the survey	Structural Point, Badge, Achievement	—	Fixed Action	Achievement game, in-game	Answering questions, and inviting Facebook friends into the system	Quantitative	Collect users' opinions about the gamified software	Gamified software, Questionnaire	Positive
24	Increase participatory sensing in location services apps	Mobile	Social software	Data collection	Lack of users' motivation to send photo into the software	Structural Point, Badge, Level, Time Limit, Clear Goal, Challenge	Leaderboard	Fixed Action	Achievement game, In-game	Send a requested photo	Quantitative	Collect users' opinions about the gamified software and its effects on engagement	Software, log file, Gamified software, Questionnaire	Positive
25	Measure employees' feeling about gamified software at workplace	Web	Social software	Social bookmarking	—	Structural Point, Badges, Challenge, Immediate Feedback	Leaderboard, Immediate Feedback	Fixed Action	Achievement game	Login, adding a bookmark, accepting a recommendation	Quantitative	Evaluate gamification effects on users' engagement	Software, log file, Gamified software, Questionnaire	Partially positive

(Continued)

Appendix A. (Continued).

Paper number	Software information					Gamification solution				Results					
	Study purpose	Software platform	Software type	Usage context	Software engagement Problem	Gamification type	Game mechanics and its components	Game interface elements	Contextual reward type of	Reward usage	Reward trigger	Research design	Evaluation purpose	Evaluation instruments	Results
26	Engage and train new employees about the organization	Web	Social software	Social networking	Lack of personnel motivation to practice with the system	Structural	Badges, Challenge	Leaderboard, Map	Fixed Action	Achievement game	Answer a question	Mixed method	Collect users' opinions about the gamified software and its effects on engagement	Gamified software, Questionnaire	Positive
27	Motivate users to fill a survey form about their objectives in social networks	Web	Social software	Data collection	Lack of users' motivation to answer the questions	Structural	Point, Achievement, Challenge, Immediate Feedback	Leaderboard	Fixed Action	Achievement game, In-game	Answering a question	Mixed method	Evaluate gamification effects on users' engagement and performance	Gamified software, Software, log file	Positive
28	Increase students' learning efficiency and time they spend in e-learning platform.	Web	Educational software	Academic Education	Lack of students' motivation to practice with the system	Structural	Point, Badges, Challenge, Progression, Immediate Feedback	Leaderboard, Avatar	Fixed Action	Achievement game	Answer online exam questions, give point or badge by lecturer	Qualitative	Collect users' opinions about the gamified software and its effects on users' performance	Gamified software, Observation	Positive
29	Find the most relevant keywords to describe a location	Stand-alone	Social software	Data collection	Lack of users' motivation to enter information in the system	Structural	Point, Time Limit, Challenge, Clear Goal	Leaderboard	Fixed Action	Achievement game	Sort keywords based on their relevance to the current location	Mixed method	Collect users' opinions about the gamified software and its effects on users' engagement and performance	Gamified software, Interview, Survey, Observation, Think Aboud, System log file	Positive
30	Motivate users to fill survey forms	Web	Social software	Data collection	Lack of users' motivation to enter information in the system	Content	Point, Time Limit, Progression, Immediate Feedback	Fantasy	Fixed Action	Achievement game	Answer a question	Quantitative	Evaluate gamification effects on users' performance and engagement	Gamified software, System log file	Positive
31	Encourage users to mark inappropriate content and combat spam in cyberspace	Web	Utility software	Anti-Spam	Lack of users' motivation to report spams	Structural	Achievement, Challenge	Fantasy, Leaderboard	Fixed Action	Achievement game, In-game	Detect a spam, create, accept, and complete an assignment	Mixed method	Collect users' opinions about the gamified software and its effects on usability and users' engagement	Gamified software, Questionnaire	Positive
32	Enhance students' learning efficiency	Web	Educational software	Academic Education	Lack of students' motivation to practice with the use of system	Content	Clear Goal, Challenge, Point, Story, Virtual Currency, Badge, Level, Progression, Immediate Feedback	Leaderboard, Fantasy	Fixed Action	Achievement game, In-game, out-game	Answer quiz questions, solve a puzzle, class attendance, perform group projects	Quantitative	Collect users' opinions about the gamified software and its effects on users' engagement and learning	Gamified software, Questionnaire	Positive
33	Motivate people to report if shops' door is open or close	Mobile	Social software	Data collection	Lack of users' motivation to enter information in the software	Structural	Immediate Feedback, Badge, Point, Challenge	Leaderboard	Fixed Action	Achievement game	Report a shop's door condition	Mixed method	Collect users' opinions about the gamified software and its effects on usability, users' engagement and performance	Gamified software, Interview, Survey	Neutral
34	Increase students' learning efficiency and system long-term sustainability	Web	Educational software	Academic Education	Lack of students' motivation to practice with the use of system	Structural	Point, Clear Goal	—	Fixed Action	Achievement game	Answer a set of questions correctly	Mixed method	Collect users' opinions about the gamified software and its effects on learning and users' engagement	Gamified software, Interview, System log file	Positive
35	Increase users' motivation to post review or answer questions in product community website	Web	Social software	Forum, wiki, blog	Lack of users' engagement in website including entering or sharing content	Structural	Badge, Point, Level, Challenge	Leaderboard	Fixed Action	Achievement game	Ask or answer a question, social sharing, connect to other users	Quantitative	Evaluate gamification effects on users' engagement	Gamified software, System log file	Positive
36	Increase users' motivation to walk more	Mobile	Fitness software	Activity tracker	Lack of software motivator to promote walking	Structural	Point, Clear Goal, Challenge, Immediate Feedback, Progression	Leaderboard	Fixed Action	Achievement game	Walking	Mixed method	Collect users' opinions about the gamified software and its effects on users' walking	Gamified software, System log file, Interview	Neutral
37	Increase users' motivation to contribute in corporation wiki	Web	Social software	Wiki	Lack of users' motivation to enter content in the website	Structural	Point, Badge, Level, Challenge	Leaderboard	Fixed Action, Social Reward	Achievement game, In-game	Add or contribute to an article, rank the others' articles	Mixed method	Collect users' opinions about the gamified software and its effects on users' engagement and performance	Gamified software, Questionnaire, Interview, Observations	Positive

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Appendix A. (Continued).

Paper number	Software information					Gamification solution				Results					
	Study purpose	Software platform	Software type	Usage context	Software engagement Problem	Gamification type	Game mechanics and its components	Game interface elements	Contextual reward type	Reward usage	Reward trigger	Research design	Evaluation purpose	Evaluation instruments	Results
38	Motivate developers to adopt good practices	Stand alone	Software engineering	Programming tool	Lack of programming environment motivators to encourage developers to adapt new practices and tools	Structural	Point, Level, Challenge	Leaderboard	Fixed Action	Achievement game	Use of structured navigation commands	Quantitative	Evaluate gamification effects on knowledge of navigation practices	Gamified software, Survey, System log file	Partially Positive
39	Increase working performance and collaboration	Web	Information worker software	Project Management	Lack of system motivator to encourage users to perform project tasks	Structural	Clear Goal, Level, Badge, Point, Challenge, Progression	Fantasy, Leaderboard	Fixed Action, Prize	Achievement game	Perform the project tasks	Mixed method	Interfaces color and usability analysis	Gamified software, Questionnaire	Positive
40	Involve stakeholders during requirements elicitation	Web	Social software	Data collection in requirement engineering	Lack of system motivator to encourage stakeholders in requirements elicitation	Structural	Point, Progression	—	Fixed Action	Achievement game	Enter a new requirement, comment or vote	Quantitative	Collect users' opinions about the gamified software and its effects on users' engagement	Gamified software, Questionnaire	Positive
41	Involve stakeholders during requirements elicitation	Web	Social software	Data collection in requirement engineering	Lack of system motivator to encourage stakeholders in requirements elicitation	Structural	Status, Challenge	Leaderboard	Fixed Action	Achievement game	Enter a new requirement, comment or vote	Quantitative	Collect users' opinions about the gamified software and its effects on users' engagement	Gamified software, Questionnaire	Positive
42	Increase the engagement and motivation of people in evaluation activities	Mobile	Social software	Data collection	Lack of users' motivation to enter content into the software	Structural	Point, Achievement, Challenge, Clear Goal	Leaderboard	Fixed Action	Achievement game, out-game	Write a review, applying a tag, start a friendship	Quantitative	Collect users' opinions about the gamified software, its usability, and its effects on users' engagement and performance	Gamified Software, Questionnaire, System log file	Positive
43	Engage residential energy consumers in demand dispatch programs	Mobile	Social software	Data collection	Lack of users' motivation to enter information into the software	Structural	Point, Level, Challenge, Status	Leaderboard	Fixed Action	Achievement game, In-game	Submit consumption flexibilities	Quantitative	Usability test	Gamified software, Questionnaire	Positive
44	Engage users in a specific trading website	Web	Social software	Trading service	Lack of users' motivation to enter content into the website	Structural	Badge	—	Fixed Action	Achievement game	Post trade proposals, comment on friends' proposal, complete transactions	Quantitative	Evaluate gamification effects on users' engagement and performance	Gamified software, System log file	Positive
45	Engage users in a crowdsourcing app	Mobile	Social software	Data collection	Lack of users' motivation to enter requests in the app	Structural	Point, Badge, Status, Challenge	Leaderboard	Fixed Action, Prize	Achievement game, In-game	First replier of a request	Quantitative	Evaluate gamification effects on users' engagement and performance	Gamified software, System log file	Positive
46	Teach technical skills quickly and smoothly	Web	Educational software	Industrial Education	Lack of users' engagement in the content of the training system	Structural	Clear Goal, Achievement	Map	Fixed Action	Achievement game	Learn an instruction or tip	Qualitative	Collect users' opinions about the gamified software	Gamified software, Interview	Positive
47	Motivate students to perform course practices	Web	Educational software, Social software	Academic education	Lack of students' motivation to practice course with the use of the system	Structural	Level, Badge, Time Limit	—	Fixed Action	Achievement game	Answer a number of questions in 10 minute	Mixed method	Collect users' opinions about the gamified software	Gamified Software, Observing users, Survey	Positive
48	Centralized system to idea management	Web	Social software	Data collection	Lack of employees' motivation to enter idea in the system	Structural	Point, Challenge	Leaderboard	Fixed Action, Social Reward	Achievement game	Create a new idea, select user's idea to discuss, put comments on others' ideas	Quantitative	Measuring users' engagement and performance with the system	Gamified software, System log file	Positive
49	Encourage driver learners to undertake a wider range of practices	Mobile	Tool software	Activity recorder	Lack of software interestingness to motivate users to practice driving	Content	Story, Virtual Money	Fantasy	Fixed Action	In-game	Frequency of practice, the total practices time, and the skills and contexts completed during the practice	Mixed method	Collect users' opinions about the gamified software and its usability	Gamified software, Interview, Questionnaire	Positive
50	Enhance students' online collaborations	Web	Social software	Forum	Lack of users' motivation to enter content in the forum	Structural	Point, Badge, Challenge	Leaderboard	Fixed Action	Achievement game	Ask or answer a question, put a comment	Mixed method	Collect users' opinions about the gamified software, its effects on users' engagement and learning	Gamified software, Interview, Survey, System log file	Positive

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Appendix A. (Continued).

Paper number	Software information					Gamification solution				Results						
	Software platform	Software type	Usage context	Software engagement	Gamification type	Game mechanics and its components	Game interface elements	Contextual type of reward	Reward usage	Reward trigger	Research design	Evaluation purpose	Evaluation instruments	Results		
51	Learn the parameters that affect climate changes	Web	Social software	Social network	Problem	Lack of users' motivation to engage in the website (read or write)	Structural	Point, Challenge, Clear Goal, Immediate Feedback, Progression	Avatar, Leaderboard	Fixed Action, Social Reward	Achievement game	Create or complete missions, add an article, get rate on completed missions	Mixed method	Collect users' opinions about the gamified software and its effects on learning	Gamified software, Interview, Survey, System log file	Positive
52	Increase users' physical activities	Mobile	Fitness software	Activity tracker	Problem	Lack of software motivator to promote walking	Structural	Clear Goal, Challenge, Point, Badge, Progression	—	Fixed Action, Prize	Achievement game	Number of steps or floors	Mixed method	Collect users' opinions about the gamified software and its effects on users' activities	Gamified software, Interview, System log file	Positive
53	Improve students' motivation to engage in learning activities	Mobile	Educational software	School Education	Problem	Lack of software motivator to engage students to perform outdoor learning activities	Content	Clear Goal, Challenge, Badge	Leaderboard	Fixed Action	Achievement game, out-game	Perform an outdoor learning mission	Mixed method	Collect users' opinions about the gamified software and its effects on users' learning	Gamified software, Interview, Questionnaire	Positive
54	Help users manage their tasks	Mobile	Tool software	Task management	Problem	Lack of software motivator to encourage users to enter tasks	Content	Story, Point, Clear Goal, Virtual Money, Level	Fantasy, Avatar	Fixed Action	Achievement game, In-game	Complete the tasks on time	Mixed method	Collect users' opinions about the gamified software	Gamified software, Interview, Questionnaire	Neutral
55	Enhance users' engagement in data collection for plant research projects	Mobile	Social software	Data collection	Problem	Lack of users' motivation to enter information into the app	Structural	Badge, Challenge	Leaderboard	Fixed Action	Achievement game	Check-in, answer a question, put a comment, take a photo	Mixed method	Collect users' opinions about the gamified software and its effects on users' engagement and performance	Questionnaire	Positive
56	Motivate users to have an eco-friendly transportation	Mobile	Social software	Transportation	Problem	Lack of software motivator to change users' transportation style	Structural	Clear Goal, Badge, Point	—	Fixed Action	Achievement game	Change trip style based on system challenges, perform activity	Mixed method	Collect users' opinions about the gamified software and its effects on users' engagement	Gamified software, Interview, Questionnaire	Positive
57	Increase the quality of data classification through crowdsourcing	Web	Social software	Data collection	Problem	Lack of users' motivation to classify data in the system	Content	Points, Challenge, Level, Time Limit, Achievement, Progression	Fantasy, Leaderboard	Fixed Action, Prize	Achievement game, out-game	Select an answer that has the most similarity with others' answers	Quantitative	Evaluate gamification effects on collected data and users' engagement	Gamified software, Survey, System log file	Positive
58	Enhance students' activities on shared contents of school	Web	Social software	School Education	Problem	Lack of users' motivation to use the contents	Structural	Level, Point, Badge, Virtual Good, Immediate Feedback	—	Pacing, Fixed Action	Achievement game, out-game	Watch a movie, read a text, put comment, reward by peers	Mixed method	Collect users' opinions about the gamified software, and its usability	Gamified software	Positive
59	Encourage self-monitoring of blood glucose	Mobile	Health-care software	Self-monitoring	Problem	Lack of software interestingness to motivate users to measure blood glucose	Structural	Point, Level	—	Fixed Action	Achievement game, Out-game	Perform a blood test	Mixed method	Collect users' opinions about the gamified software, and its effect on users' health	Gamified software, System log file, Interview, Questionnaire	Positive
60	Improve communication skills	Mobile	Health-care software	Communication disorders	Problem	Lack of software interestingness to motivate users to smile	Structural	Point, Immediate Feedback, Level	Avatar	Fixed Action	Achievement game	Frequency of smile	Mixed method	Collect users' opinions about the gamified software, its usability, and effects on users' performance	Questionnaire	Positive
61	Help diabetics patients manage their habits	Mobile	Health-care software	Self-monitoring	Problem	Lack of users' motivation to enter content into the system	Structural	Point, Clear Goal	Avatar	Fixed Action	Achievement game	Enter a log	Quantitative	Evaluate users' engagement, system usability, and its effect on users' health	Gamified software, System log file	Positive
62	Improve patients' participation to find the medication that works best	Mobile	Health-care software	Self-monitoring	Problem	Lack of users' motivation to enter content into the system	Content	Status, Achievement, Badge, Progression	Fantasy	Fixed Action	Achievement game	Fill the pain report	Qualitative	Collect users' opinions about the gamified software, and its usability	Gamified software, Interview, Questionnaire	Positive
63	Encourage users to report accidents and traffic	Mobile	Social software	Transportation	Problem	Lack of user motivation to share accident data	Structural	Points, Badge, Status, Challenge	Leaderboard	Fixed Action, Prize	Achievement game	Postaccident photo, direct the traffic, voting the best traffic officer	—	—	—	—

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Appendix A. (Continued).

Paper number	Software information					Gamification solution				Results				
	Software platform	Software type	Usage context	Software engagement	Gamification	Game mechanics and its components	Game interface elements	Contextual type of reward	Reward usage	Reward trigger	Research design	Evaluation purpose	Evaluation instruments	Results
64	Documenting developed software	Web	Social software	Forum	Lack of users' motivation to enter information in the system	Structural	Points, Challenge	—	Fixed Action	Achievement game	Being the first to answer a question, add an answer, get vote on the answer	—	—	—
65	Increase preparation against natural disasters	Web	Social software	Data collection	Lack of users' motivation to enter information in the system	Structural	Points, Badge, Clear Goal, Challenge,	Leaderboard	Fixed Action, Prize	Achievement game	Tag geographic features	—	—	—
66	Enhance media tagging by users	Web	Search engine software	Data collection	Lack of users' tendency to tag contents	Structural	Point, Level, Achievement	Avatar	Pacing Fixed Action	Achievement game, In-game	Tag a media file	—	—	—
67	Gather noise pollution data	Mobile	Social software	Data collection	Lack of users' motivation to send information into system	Content	Story, Clear Goal, Point, Level, Challenge, Achievement	Avatar	Fixed Action, Prize	Achievement game, In-game	Send noise information into the system	—	—	—
68	Train health concepts	Mobile	Educational software	General education	Lack of users' motivation to practice with the use of system	Content	Story, Point	—	Fixed Action	Achievement game	Answer a question	—	—	—
69	Enhance the performance of customer service agents	Stand-alone	Information worker software	Customer relationship management	Lack of software motivators to engage users at work	Structural	Badges, Challenge, Level, Clear Goal, Progression	Leaderboard	Fixed Action	Achievement game	Perform requested activities, answer questions, help others	—	—	—
70	Motivate users to optimize their mobility planning	Web	Social software	Transportation	Lack of software motivators to encourage users to change their mobility planning	Structural	Clear Goal, Challenges, Point, Level, Badge, Immediate Feedback, Progression	Leaderboard	Fixed Action	Achievement game, In-game	Win the predefined challenges	—	—	—
71	Motivate users to convert book images into text	Mobile	Social software	Data collection	Lack of users' motivation to type the texts into the system	Structural	Point, Level, Time Limit, Achievement, Challenge	Leaderboard	Fixed Action	Achievement game	Type the wanted word	—	—	—
72	Motivate users to have a healthier lifestyle based on their current condition	Web /Mobile	Health-care software	General Health	Lack of software motivator to encourage users to enter content and complete health missions	Structural	Clear goal, Challenges, Point	Leaderboard	Fixed Action	Achievement game	Complete a health mission, answer a question, report a compliance	—	—	—
73	Stimulate people to have outdoor activities	Mobile	Entertainment software	Entertainment	Lack of software motivator to engage users in outdoor activities	Content	Clear Goal, Challenges, Point, Level, Progression	Leaderboard	Fixed Action	Achievement game	Find a hidden object	—	—	—
74	Engage children in a search training system	Web	Educational software	General education	Lack of children's motivation to practice with use of the system	Structural	Point, Badge, Challenge	Leaderboard, Avatar	Fixed Action	Achievement game	Find a requested webpage with the shortest possible query	—	—	—
75	Increase users' motivation to use learning content	Web	Educational software	General Education	Lack of users' engagement with software content	Structural	Clear Goal, Point, Badge, Progression	Map	Fixed Action	Achievement game	Complete a learning goal	—	—	—
76	Increase users' physical activities	Mobile	Fitness software	Activity tracker	Lack of software motivator to promote walking	Content	Clear Goal, Story, Level, Point, Badge	Fantasy	Fixed Action, Prize	Achievement game	Complete a walking mission	—	—	—
77	Motivate users to learn vocabulary words	Mobile	Educational software	General Education	Lack of users' engagement in software content	Structural	Point	Avatar	Pacing Fixed Action	Achievement game, In-game	Study vocabulary words	—	—	—
78	Encourage students to test their developed software	Web	Software engineering	Programming tool	Lack of programming environment motivators to encourage students to test their developed software	Structural	Point, Story, Clear Goal, Status, Achievement, Challenge, Progression, Immediate Feedback	Leaderboard	Fixed Action	Achievement game, out-game, out-game	Perform a requested test	—	—	—