A Systematic Literature Review on Adaptive Gamification: Components, Methods, and Frameworks

Fahrur Rozi, Yusep Rosmansyah, Budiman Dabarsyah
School of Electrical Engineering and Informatics
Institut Teknologi Bandung
Bandung, Indonesia
fahrurrozi@students.itb.ac.id,
yusep@stei.itb.ac.id, budiman@stei.itb.ac.id

***Abstract*—Nowadays, learning technologies have solved problems of distance, time, and cost in learning. However, another problem with e-learning, which is lack of student motivation, still remains. Some researchers must apply gamification in e-learning with the aim of giving participation and increasing student motivation. Characteristics of different users, the same learning content, and static gamification elements do not increase the expected motivation. To overcome this problem, gamification must be adapted to the characteristics of the learners. This study uses a Systematic Literature Review (SLR) to analyze research components, methods, and framework used in adaptive gamification. The first step is to determine the research question (RQ) and then to search on several kinds of literature published in popular journal databases, namely IEEE Xplore, Science Direct, Scopus, Springerlink and ACM from 2011 - 2019. As a result of a review of 25 selected articles, there are four components of adaptive gamification, namely, player/learner profiles, learning style, behavior, and skill/knowledge. Meanwhile, there are eleven types of methods used in adaptive gamification. The most popular method is scoring and Felder-Silverman Learning Style Model (FSLSM). Generally, the proposed framework consists of three elements namely adaptive gamification engine, adaptive component, and gamification display.**

Keywords—e-learning, adaptive, gamification, systematic literature review, SLR

I. INTRODUCTION

The development of information and communication technology has led to innovations in computer-based learning. Nowadays, the problems of distance, cost, and time in the learning process can be handled by implementing e-learning. In organizations, e-learning can be used to enhance employee training or to increase employee expertise onlines [1]. However, the learning performance of online trainees has a negative relationship to learning motivation, training content, face-to-face meetings, and ease of use. In fact, learning motivation and learning difficulties significantly affect learning achievement [2]. To increase motivation and curiosity, the learning process can be accomplished with gamification techniques. Gamification techniques can significantly increase motivation, attention and learning performance [3].

Another challenge, each employee has different abilities and characteristics. Although the application of gamification can help to increase learning motivation, it is important to know the characteristics of each individual. The application of gamification needs to be personalized, because different motivations can lead to different responses [4]. Therefore, it is necessary to personalize the learning method, so that every employee is able to learn according to his personal character.

In personalized learning, the display of content can be adjusted by adapting the style and learning needing for each individual. In adaptive models, one of the advantages obtained is that each student is presented with learning activities based on what they know and what they need to know. Benefits of learning with adapted game features can increase motivation and participation in the learning process [5]. In addition, personalized adaptive gamification has the potential to increase individual motivation and performance [6].

The development of adaptive gamification has generated tremendous interest among researchers. Two terms that often arise are adaptivity and adaptability. Adaptivity is a type of behavior where the user triggers several actions in the system that guide the learning process, namely modifying e-learning lessons using different parameters and a predetermined set of rules. Adaptability is a behavior where user makes changes and make decisions about the learning process, namely the possibility for students to personalize e-learning lessons by themselves.

To understand adaptive gamification, this study conducted a literature review using Systematic Literature Review (SLR). SLR can help to find solutions by reviewing previous relevant research. This study aims to understand components to determine adaptive aspect, methods to process component to be adaptive, and frameworks used in adaptive gamification. To get comprehensive results, research was conducted on several literatures published in popular journal databases such as IEEE Xplore, Science Direct, Scopus, SpringerLink and ACM from 2011 – 2019.

This paper consists of four parts. Section 2 provides an explanation of the systematic literature review as this research methodology. Section 3 describes the results of the review and answers to the research questions. Section 4 presents the research conclusions and suggestions for future work.

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II. Research Metodology

A. Systematic Literature Review (SLR)

Systematic Literature Review (SLR) is a secondary study to map, identify, critically evaluate, consolidate, and collect the results of major studies on specific research topics [7]. SLR is the standard method for getting answers by conducting a literature review based on previous related studies. The aim of conducting an SLR is to summarize previous research, to identify gaps that need to be met between previous and current research, to produce coherent reports/synthesis, and to create a research framework.

The purpose of the literature study is to understand research topics that are components, methods, and frameworks in adaptive gamification. To get comprehensive results, the research takes some literatures published from popular database journals, IEEE Xplore, Science Direct, SpringerLink, Scopus, and ACM from 2011 – 2019.

B. Research Question

The purpose of the Research Question is to maintain the focus of the literature review. This condition facilitates the process of finding data needed. Table I shows the research questions for this study.

TABLE I. Research Question

ID	Research Question	Motivation
RQ1	What are components used in adaptive gamification?	To identify common components to determine adaptive gamification aspects
RQ2	What are methods used in adaptive gamification?	To identify the methods to process component to be adaptive
RQ3	What are frameworks used in adaptive gamification?	To identify the frameworks used adaptive gamification

This research conducts searches on popular journal databases with specific keywords to answer Research Question described above. The keywords used are : **"adaptive" AND "gamification"**. Searching with keywords is done only in the abstract section. Search results found as many as 1.022 articles. Table II shows the results of the search process using these keywords.

TABLE II. The Result Finding of Related Study

No	Database Journal	Number of Articles
1	IEEE Xplore	29
2	Science Direct	10
3	Scopus	153
4	ACM Digital Library	49
5	Springerlink	781
Total		1 022

Inclusion and exclusion criteria were used to select the main study. The results of the article from these criteria will be reviewed by the researcher. The inclusion and exclusion criteria can be seen in Table III.

TABLE III. Inclusion and Exclusion Criteria

Criteria	ID	Criteria
Inclusion	I1	Articles related to components, methods, and frameworks in adaptive e-learning
	I2	Articles are written in English
Exclusion	E1	Articles are same but a different database journal
	E2	Articles in a book, publication, conference review and white paper

C. Searching Result

After filtering with inclusion and exclusion criteria in search results using keywords, several journal and conference articles found were shown in Table IV. The number of articles was 25 articles, including journals and conferences. This article will be reviewed in this study.

TABLE IV. Filtering Process Results

No	Publications	Number of Articles
1	Journal Q1	3
2	Journal Q2	6
3	Journal Q3	1
4	Journal Q4	0
5	Conference Proceeding	15
Total		25

III. Results and Discussions

A. Components of Adaptive Gamification

Based on results of literature review, there are four components to determine adaptive gamification aspects. This component is used as an input to adapt gamification. Components of adaptive gamification includes player/learner profiles, learning style, behaviour, and skill/knowledge. Table V shows component of adaptive gamification and its references.

TABLE V. Components of Adaptve Gamification

No	Component	References
1	Player/Learner Profiles	[8][9][10][11][12][13][14][15] [16][17] [18][19][20][21][22]
2	Learning Style	[23][24][12][25][26]
3	Behavior	[27][28][12][29]
4	Skill/Knowledge	[30][31][32]

The first component is player/learner profiles which is the most widely used component in gamification adaptive research. They are characteristics of the learner such as gender, age, and motivation. They also can be input in adaptive gamification because each learner profiles have different preferences in determining game elements.

The second component is learning style obtained from interaction learners with system. They show way learners absorb, understand and store information [26]. Dimension of learning style includes active/reflective, sensing/intuitive,

sequential/global, and visual/verbal [23]. The different dimension of learning style can personalized teaching style [25].

Other components are behavior and skill/knowledge. Learner behavior is almost similar to learning styles. Learner behavior can also be established from interactions with the system. While skill/knowledge can be determined from questions using a questionnaire. Skill learners can be divided into three types, namely beginner, intermediate and advanced level [32]. This difference in skill can determine learning materials according to their respective levels.

B. Methods of Adaptive Gamification

The results of the review found that there are eleven types of methods used in adaptive gamification. The method used is an algorithm or model. Differences in methods are influenced by component of adaptive. Table VI shows a list of methods used adaptive gamification.

TABLE VI. METHODS OF ADAPTIVE GAMIFICATION

No	Method	References
1	Scoring	[8][11][30][13] [31][32] [29][18]
2	Felder-Silverman Learning Style Model (FSLSM)	[23][25][26]
3	Linear Model	[9]
4	CN2 Rule Induction Algorithm	[27]
5	K-means Clustering	[10]
6	Interpretive Structure Model (ISM)	[24]
7	Two-Step Cluster Analysis	[28]
8	Intelligent Tutorial System	[12]
9	Smart Sparrow (Adaptive e Learning Platform - AeLP)	[15]
10	BrainHex Test	[14]
11	AdaptWeb® (Adaptive Web-based learning environment)	[17]

The most populer method is scoring and Felder-Silverman Learning Style Model (FSLSM). The scoring method is found in eight papers [8], [11], [30], [13], [31], [32], [29], and [18]. This scoring means adaptive determination based on value using a particular formula or results of filling out the questionnaire. While, FSLSM method is widely used in learning style component [23], [25], and [26]. FSLSM uses a learning style index (ILS) to identify learning styles of items in question questionnaire. Others method is found in 1 paper such as Linear Model, CN2 Rule Induction Algorithm, K-means Clustering, etc.

C. Frameworks of Adaptive Gamification

Gamification with a clear design framework has a tendency to be more successful. Therefore, some researchers proposed adaptive gamification framework design. The results of the review found that there are five types of adaptive gamification frameworks. Table VII shows a list of adaptive gamification frameworks.

Generally, the proposed framework consists of three elements including adaptive gamification engine, adaptive component, and gamification display. Some researchers added other elements. Framework of Hassan et al proposed a framework with adaptive gamification experience (activities and elements) based on the dimensions of learning [23]. Cadish and Ravid Framework add gamification analytic for monitoring engagement or playfullness [29].

TABLE VII. FRAMEWORKS OF ADAPTIVE GAMIFICATION

No	Frameworks	References
1	Framework of Hassan et al.	[23]
2	Cadish and Ravid Framework	[16]
3	ALEF (Adaptive Learning Framework)	[29]
4	Design Framework of the Proposed Social Learning Platform	[20]
5	Framework of Bockle et al.	[21]

IV. CONCLUSSION

This study has succeeded in identifying and analyzing components, methods and framework used in adaptive gamification based on research questions submitted with SLRs between 2011 - 2019 in several popular journal databases. Based on the keyword formula found 1.022 papers then by applying the inclusion and exclusion criteria, 25 papers will be reviewed. The results of the review are as follows; components used in adaptive gamification are player/learner profiles, learning style, behavior, and skill/knowledge. The method populer in adaptive gamification varies according to the conditions. The most populer method is scoring and Felder-Silverman Learning Style Model (FSLSM). The results of this study also identified types of framework proposed, namely Framework of Hassan et al., Cadish and Ravid Framework, ALEF, Design Framework of the Proposed Social Learning Platform and Framework of Bockle et al. Generally, the proposed framework consists of three elements including adaptive gamification engine, adaptive component, and gamification display.

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