

# **Gamification Elements and Students' Collaborative Problem-Solving Skills: A Literature Analysis**

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## **Abstract**

Collaborative problem-solving skills (CPS) are widely recognized as an important skill in the future workplace. However, the conventional teaching method is not effective in building students' CPS and need further intervention as nowadays youth are no longer prefer passive learning. Besides, they prefer to integrate multimedia and virtual elements into their study to make it interesting. Hence, gamification become one of the most popular topics for researchers to find out the strategies to improve CPS. Hence, this paper will discuss the literature analysis of gamification elements and their corresponding effects on students' CPS. Literature analysis is being conducted to explore the effects of different gamification elements on students' CPS. A total of 18 previous studies are being examined. Based on the literature analysis, it was found that achievement-related gamification elements, which include points, levels, leaderboards, and badges have significant effects on enhancing students' CPS. Avatar and feedback only show effectiveness in enhancing students' cognitive skills and the progression bar show no effect on cognitive skills and social skills. In addition, chat only shows effectiveness in enhancing students' social skills. It can be concluded that the use of gamification elements must be based on the different gamification goals.

## **Introduction**

Nowadays, generic skills, also known as transferable skills, such as problem-solving skills, collaborative skills, creativity, etc., which can be applied across all specific skills, are highly emphasized. Collaborative skills, which are teamwork skills are being chosen as one of the most important skills in the future workplace (Kagermann et al., 2013; Walker and Lloyd-Walker, 2019). Teamwork and problem solving even being included in the top 20 skills for future employability (Okolie et al., 2019). Therefore, collaborative problem-solving skills (CPS) which include both collaborative skills and problem-solving skills, are highly demanded in the 21st-century skillset (Fiore et al., 2018; Graesser et al., 2017; Rosen and Rimor, 2012). Despite the importance of CPS is highly emphasis for future employment, the conventional teaching method which is teacher-centered is not constructive for building today's young generation's

CPS as students nowadays are no longer prefer passive learning method (Genota, 2018; Seemiller and Grace, 2017; Shatto and Erwin, 2017; Swanzen, 2018). Instead, the research done by Global Research and Insights (2018), there are more than 50% of the Generation Z are likely to integrate multimedia elements or virtual application to improve their knowledge and skills. Hence, to improve the CPS of young generation, several strategies are being researched and one of the most popular strategies is gamification. This is due to the nature of gamification enables students to have positive enquiries and interaction, hence improving the two most important components in CPS, i.e., the cognitive skills and social skills.

Gamification means using gaming elements or games' mechanisms in a non-game context become a popular research topic following the current trend (Kurniawan, et al., 2019; Pavlidis & Markantonatou, 2018). In the traditional mindset, games may be improper to students and some educators even think that gaming is wasting of time and addictive to students which will subsequently lower students' performance. The gaming concept might be old, but gamification is a new concept. Gamification is not about playing real games, however, using the gamification elements such as the process, recognition (e.g., points, badges), and complement (rewards) to engage students and help them to develop their problem-solving skills and social skills. Combining these two skills develops students' collaborative problem-solving skills (CPS).

In recent years, people tend to play games, especially the younger generation who are still pursuing their education qualifications (McGonigal, 2011). According to Gee (2008), gamers tend to voluntarily spend countless hours developing their skills such as problem-solving skills to level up in the gaming world. Therefore, by successfully implementing gamification in education, the potential is very powerful to improve students' knowledge and skills. Therefore, in the current classroom or online learning, it is essential to create an atmosphere of fun by using the gamification concept which is very appealing to students of all ages.

Since CPS is so important in future career advancement, gamification is a critical intervention to today's traditional teaching method. Therefore, this paper aims to explore the importance of different gamification elements in enhancing students' CPS. Based on previous research, the literature analysis is carried out to identify the different effects and relationships between gamification elements on students' CPS. The important elements in CPS and gamification is being discussed in the following section. The objectives of this research are as follows:

- To explore the effects of gamification elements towards students' collaborative problem-solving skills.
- To generate gamification strategies which is corresponding from the important gamification elements to improve effectiveness of gamification in education.

### **Literature Review**

The following literature will discuss on the key elements of this research, which includes collaborative problem-solving skills and gamification elements.

### **Collaborative Problem-Solving Skills**

In 2017, OECD defined CPS as "the capacity of an individual to effectively engage in a process whereby two or more agents attempt to solve a problem by sharing the understanding and effort required to come to a solution and pooling their knowledge, skills, and efforts to reach that solution". Famous frameworks of CPS include Hesse et al (2015) CPS

Framework and PISA (2015) CPS Framework (PISA, 2015). This paper will be based on the Hesse et al (2015) CPS Framework which divided CPS into two main skills, namely cognitive skills, and social skills.

### **Cognitive Skills**

Cognitive skills are often known as task-work skills (Fiore et al., 2017). In terms of CPS, it represents problem-solving skills. Based on Hesse et al (2015) CPS framework, cognitive skills are further divided into two parts, namely task regulation and knowledge building. There are seven main points under task regulations, which are listed as follows:

*Problem analysis*- describe and analyze the problem in familiar language

*Goal setting*- set a clear goal

*Resource management*- manage resources or people to complete a task

*Flexibility and ambiguity*- accept ambiguous situation

*Elements of information collections*- explore and understand the element of the task  
*Systematicity*- implement a possible solution to a problem and monitor the progress

In short, task regulations are about the capabilities to understand and solve a problem. The other part of cognitive skills is knowledge building. a person to acquire knowledge-building skills, he or she must be able to represent and formulate the relationship and connection between issues, identifies the cause and effects, and adapts reasoning or course of action as information or circumstance change.

### **Social Skills**

On the other hand, social skills form the other part of CPS, which is the collaborative part. There are three elements under social skills, which are action, interaction, and task completion. Action refers to the level of participation in the learning environment; Interaction means the communication and response given to other team members while learning is conducted; lastly, task completion refers to the student's ability to participate motivationally in a task and consequent perseverance on a task (Hesse, et al., 2015).

### **Gamification Elements**

There are several gamification elements that have been studied in this research, namely points, levels, leaderboards, progress bars, feedback, badges, avatar, and chat. Each gamification elements have its own function in gamification as discussed in the following sections.

*Points*- Points are the numerical value that reflects the student's performance and earning of scores during the academic endeavors, either in-game or non-game context (Brewer, et al., 2013).

*Levels*- Levels are also known as skill levels, character levels, etc. Levels are very important in providing the hierarchical status of the students in gamification.

*Leaderboards*- Leaderboards refer to the use of an electronic board to display the ranking of leaders (users) in a competitive learning situation (Seaborn & Fels, 2015).

*Progress Bar*- Progress Bar also known as progression, steps, or maps in the gamification system. It is a status that provides extrinsic guidance to the students, showing the position or location of the students in the course.

*Feedback*- Feedback refers to the information given by the instructors to the learners about their performance in the gamification system.

*Badges*- According to Seaborn and Fels (2015), badges are a visual representation of achievement which can be collected by the learners through the learning process in gamification.

*Avatar*- Avatars are the characters used by the learners in the gamification system. Avatars may be integrated into the profile of the learners and represent the character of the learners.

*Chat*- Chat function is a platform in gamification in the state of either forum or live chat features in gamification.

This research will focus on using literature analysis to analyze the effect of the above gamification elements to collaborative problem-solving skills based on previous papers. The papers selected will be used to give the implication about each gamification element's effects on collaborative problem-solving skills and recommendation will be given to the stakeholder to improve the process of gamification in education.

### **Methodology**

In this paper, literature analysis will be used to identify different effects of gamification elements on the collaborative problem-solving skills of students. There are 8 main gamification elements being examined in this paper, which are points, levels, leaderboards, progress bar, feedback, badges, avatar, and chat. Besides, to have a clearer picture of CPS, the CPS is divided into cognitive skills and social skills as stated in the literature review. The words such as "Gamification elements and Collaborative Problem Solving" are being searched in the digital library and Google Scholar, ACM and Scopus and Web of Science to search for relevant journal articles. A total of 18 studies are being selected as the sample in this research from the total of 35 journal articles examined. The selection is based on the criteria on year of publication (latest) from 2016 to 2023 and all the articles are the research based on education sectors. The long period of publication year is used as the selection criteria due to there are still not much of integration of gamification elements with education sector. All the articles are being examined and summarized in the findings and discussions are made accordingly in the next section.

### **Findings and Discussions**

Based on the previous research done by researchers, a summary of the effects of gamification elements on CPS is listed in the table below

Table 1

*Effects of Gamification Elements on Collaborative Problem-Solving Skills*

<b>Gamification elements</b>	<b>Effects on cognitive skills</b>	<b>Effects on social skills</b>	<b>Effect on other aspects</b>	<b>Researchers</b>
Points	Students' problem-solving improved	-	Engagement, enjoyment improved	Thongmak (2018)
	Improve learning outcomes and knowledge of students	-	Engagement improved	Denny, et al. (2018)
	Result and achievement of students is improved.	-	Engagement improved	Hew, et al. (2016)
	Student academic successes enhanced	Students' participation improved	-	Özdener (2018)
	-	Students' participation improved	Students' satisfaction enhanced	Barna and Fodor (2017)
Levels	-	Students' participation in learning activities is improved	Engagement improved	Khalil, Ebner, and Admiraal (2017)
	-	Improved online discussions among students	Engagement and motivation improved	Ding, Kim, and Orey (2017)
	Students' performance improved	-	Level of innovation and motivation improved	Rincon- Flores et al. (2018)
Leaderboards	Students' academic successes improved	Students' participation improved		Özdener (2018)
	Students' competences in learning improved	-		Mekler et al., 2017; Sailer et al., 2017
Progress Bar	-	-	Students' motivation improved	Roosta et al. (2016)
	-	-	Students' engagement improved	Ding, et al. (2018)

Feedback	Students' understanding on learning improved	-	Students' satisfaction improved	Fleischmann & Ariel (2016);
	Students become more understand in the problem	-	-	Thongmak (2018)
	Students' performance in learning improved	-	-	Kim et al. (2016)
Badges	Students' result and achievement improved	-	-	Pechenkina et al. (2017); White & Shellenbarger (2018)
	Students' result and achievement improved	-	Students' engagement improved	Tsay et al. (2018)
	-	Students' participation improved	-	Barna & Fodor, (2017)
Avatar	Students' performance improved	-	-	Rincon- Flores et al., 2018
	Students' competencies in learning improved	-	-	Sailer et al., 2017)
Chat	-	Improved communication	-	Kotsis (2021)

Based on Table 1, the achievement-related gamification elements such as points, levels, leaderboards, and badges are effective in both cognitive and social skills (Özdener, 2018). These gamification elements can enhance students' cognitive skills such as improving their achievement and result in learning, improving problem-solving and academic successes of learners. Researchers also found that level setting in gamification can improve students' willingness to learn complex topics, as a result, improving students' knowledge of the topic (Butler & Bodnar, 2017; Diniz et al., 2017). On the other hand, social skills such as participation are being enhanced through these elements. This is because the students can view others' achievements through these gamification elements, hence, will create a sense of competition among themselves. Some researchers suggested that achievement-related gamification such as points and leaderboards elements enhance students' knowledge as the system creates a positive competitive environment for the students to improve themselves so that they can outperform each other (Kuo and Chuang, 2016; Alomari et al., 2019). To outperform each other, they tend to become participative in learning so that they can earn more points, advance in levels, have high rankings in leaderboards, and earn different types of badges.

On the other hand, feedback from the instructors only helps in enhancing students' cognitive skills (Fleischmann & Ariel, 2016; Thongmak, 2018; Kim et al., 2016). Unlike chat, feedback is one-way communication in which the students are less exposed to interaction and therefore the collaborative skills are minimized. A similar result shows in the avatar,

where the students will only improve in cognitive skills without having improvement in social skills (Rincon- Flores et al., 2018; Sailer et al., 2017). In addition, through the literature analysis, it can be found that progress bar there are no studies focusing on the progress bar and CPS. The study is more emphasis on the engagement and motivation of students when come to the progress bar as a gamification element (Roosta et al. ,2016; Ding, et al., 2018). Lastly, there is the least research emphasis on chat elements in gamification. However, undeniably, the chat feature can help to improve students' communication through interaction through discussion on the assignment's topics.

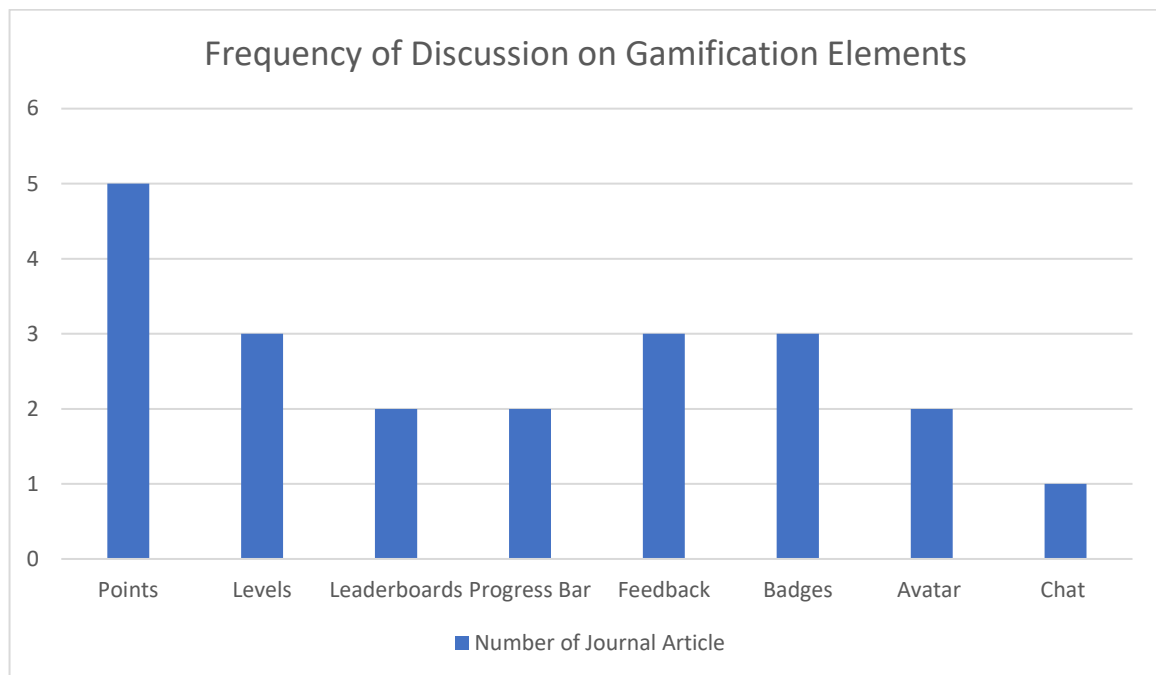


Figure 1: The Frequency of Discussion on Gamification Elements

Figure 1 shows the frequency of discussion on gamification elements from the total of 18 journal articles selected. Points have the highest discussion and implementation among all the gamification elements, with frequency of 5 out of 18 articles. The second highest gamification elements being discussed are feedback and badges, with frequency of 3 out of 18 articles. Chat has the lowest discussion based on the selected journal articles, with only 1 out of 18 articles mentioned and discussed on the element. This shows that points is the most popular gamification elements being discussed and researched. This might be due to points can directly reflect the performance of students and it is easier to illustrate the ranking of the students. On the hand, chat with the least discussion and research might be due to chat is a very common method in delivering knowledge and comment among students and lecturers. Hence, many of the researcher may not emphasis on this element as it has been implemented since long time ago.

## Conclusion

Based on the result in the previous section, it can be said that the CPS of students can only be improved through achievement-related gamification elements where they can improve both the cognitive and social skills of students. This is these elements show the ranking or status of the students, which will stimulate other students' willingness to study and participation in class. However, different goals of gamification should use different

gamification elements as strategies for improving learning outcomes. For example, if the goal of gamification is to enhance students' problem-solving or knowledge, the instructor should provide more feedback to the students so that their cognitive skills can be enhanced.

This paper serves as a fundamental for future researchers to investigate the gamification elements in different areas. This paper only focuses on the education context; hence, future researchers may compare the result in other sectors to get more comprehensive information regarding the effects of gamification elements.

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