Lappeenranta University of Technology
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DESIGNING GAMIFICATION FOR COLLABORATIVE LEARNING IN GROUP WORK

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ABSTRACT

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Designing Gamification for Collaborative Learning in Group Work

Master's Thesis

70 pages, 16 figures, 10 tables

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Keywords: Collaborative Learning, Group Work, Gamification, Progress indicator

Computer Supported Collaborative Learning (CSCL) is a teaching and learning approach which is widely adopted. However there are still some problems can be found when CSCL takes place. Studies show that using game-like mechanics can increase motivation, engagement, as well as modelling behaviors of players. Gamification is a rapid growing trend by applying the same mechanics. It refers to use game design elements in non-game contexts. This thesis is about combining gamification concept and computer supported collaborative learning together in software engineering education field. And finally a gamified prototype system is designed.

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With all of these, I could accomplish today's goal, thank you!

28th. Nov. 2015
Lappeenranta, Finland
Yongyi Wu

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LIST OF SYMBOLS AND ABBREVIATIONS

CS	Computer Science
CSCL	Computer Supported Collaborative Learning
IT	Information Technology
SMS	Systematic Mapping Study
XP	eXperience

1. INTRODUCTION

Software engineering courses play a critical role for IT students[1]. The positive factors are from fundamental knowledge spreading to practical projects providing. There are some problems that could happen when using the traditional way (lectures deliver, student listen) in education. For example: it's hard to keep students engage into classes, continuing to decline motivations, lacking of communications either between lecturer and students or students themselves[84].

Computer supported collaborative learning (CSCL) is a learning science that relates to students learning together with computer assistances. This term begins to appear in 1990s[2]. Literally it means people study in a small group using computer devices. CSCL consists with two parts: one is computer, the other is group learning. The study of group learning begun since 1960s. With computer and network technology developing, it makes possible to work together. In CSCL, it can be found that people get together to solve problems. And also it forces people to have more communication and interaction with each other.

CSCL in software engineering education has been proved with lots of advantages, such as collaboration, cooperation, teamwork skills can be practised by using CSCL[3]. However, there are still some difficulties when using collaborative learning to improve communication, motivation, engagement, interaction and cooperation among group of students. In other words, how to use CSCL more efficient in team work.

Gamification has become a popular topic in recent years, this concept can be used in many areas, e.g. productivity, health, sustainability, news and entertainment media. It uses "game-like" or "fun" element to encourage learning and increase engagement. It also can bring positive reaction and change behavior by setting up goals and rules[4]. In education field, adopting gamified methods for education is not a new idea. Some studies show that this mechanism can help students with better learning, effective performing, problem solving,

also bring social rules and more interaction and cooperation that might be problems in the old teaching way[4][5].

The research question which is going to be investigated in this thesis shows as follow:

- How to use gamification to get more efficient group work with visualized progress in Computer Supported Collaborative Learning?

This research question is supported by 4 sub-questions:

- What are the problems that can be found in collaborative learning research?
- What inter-member problems can be identified in group work project?
- What are gamified mechanics and elements and their features?
- How to use gamified mechanics and elements to visualize progress in group project?

In order to answer research question and sub-questions, a Systematic Mapping Studies is used to get the general background information of CSCL and gamification. After mapping studies, a questionnaire is conducted to find the data which indicate the problems could happen during collaborative learning in group work. Then gamification mechanics are analysed by case study to solve the problems that were found in the questionnaire. Additionally, gamification elements are discussed and used in new proposal system during designing phase.

The thesis' structure is as follows: In Chapter 2 CSCL introduces and the background information is extracted and generalized. Chapter 3 defines collaborative learning problems through a questionnaire. In Chapter 4, gamification mechanics are analysed for improving collaborative learning in group work. Chapter 5 introduces gamification elements in details and utilises gamification elements into the proposal system and validation. Finally, Chapter 6 is the conclusion and future research.

2. BACKGROUND AND PROBLEMS IN COLLABORATIVE LEARNING

In this chapter, a systematic mapping study is conducted to give a big picture of computer supported collaborative learning or group work research in software education field. The following research questions need to be answered:

- What is the background in computer supported collaborative learning research?
- What are the benefits by using computer supported collaborative learning?
- What kind of problems can be found during computer supported collaborative learning?

2.1. Introduction of Systematic Mapping Study in Collaborative Learning

In this thesis, systematic mapping study is conducted in computer supported collaborative learning research. Systematic Mapping Study (SMS) is to identify, assess and explain all the related research materials in relevant study fields. SMS is a secondary study, compared with original research as primary study. By performing SMS, the aims are to give a summary of all available studies or researches and to provide a big picture of the research field e.g. what is the history about this topic, what is the current situation of this research and what is the trend and popular topics. According to the results, SMS can discover new research direction which can be used in the future. The advantages that in SMS are: it gives less bias results from all the studies due to the well define methodology. It also provides phenomena between studies during the review, because its wide range. A visualized map is demonstrated as a result in the study, which shows the result more clearer and easier for readers[6].

A systematic mapping study includes three main stages: planning the review, conducting the review and reporting the review. Each stage contains several sub-steps. Sub-steps are executed by the introduction order below[5][7]: first identification of the need for a review, specifying the research questions and developing a review protocol are in the planning stage. Second identification of research, selection of primary studies, study quality assessment, data

extraction and monitoring and data synthesis are in the conducting stage. Third specifying dissemination mechanisms and formatting the main report are in the reporting stage. All the steps are necessary and some are involved iteration.

2.2. Systematic Mapping Study Plan

In order to describe a better background of computer supported collaborative learning in software engineering with students and the current research situation, also as a part of the thesis to answer the research questions that asked at the beginning of the chapter, this mapping study is performed. Based on previous studies, a guideline of Systematic Mapping Study in Software Engineering described by Peterson et al.[6] is used as a reference in this study. Because of the needs of some detailed results and the usages of other research methods, the guideline of conducting Systematic Literature Review in Software Engineering that described by Kitchenham et al.[8] is considered in this study as well.

The following steps are applied according to Systematic Mapping Study in Software Engineering:

1) Preparing the protocol:
    a) The process
    b) Research questions
    c) Search strategy
    d) Study selection criteria
2) Conducting attempt searching:
    a) Define keywords
    b) Choose the database for attempt searching
    c) Conduct the searching
    d) Review and analysis the results
    e) Refine the keywords
3) Performing the actual searching:
    a) Select the keywords and databases that confirm in the attempt search
    b) Search

c) Remove duplicates
d) Apply the criteria
e) Classify the inclusions
f) Summarize and analyze the inclusions

4) Data extraction：
    a) Data extraction and map processing
    b) Showing results

The strategy can be used from the attempt search to the actual search including search terms and resources. There is an attempt search at beginning by using test terms and resources, then the results are analyzed, the actual search terms and resources are confirmed and finally the actual search is conducted.

Search terms, search strings or keywords are not shown here, due to they are not confirmed yet and will be finalized after the attempt search, further used in the actual search. Resources can be found from digital libraries, specific journals, and conference or workshop proceedings.

Selection criteria defines the paper choosing standards from the databases, which includes inclusion criteria, exclusion criteria and quality assessment, all of them should based on research questions. Inclusion criteria defines what kind of papers should be included in the literature review of the first round search. The topics are included as follow:

- English language
- CSCL in Software Engineering (SE)
- Collaborative Learning in Software Engineering (SE)
- Education with CSCL in Software Engineering (SE)

The following topics are excluded as they are not related to the research:

- Non-English language
- The paper is not peer-reviewed
- The paper is not related with CS or engineering

Quality assessment describes as follow: in order to ensure the paper quality, the inclusions must be published in peer-reviewed journals, because peer-reviewed journals do not publish the paper that cannot meet the standards in the academic field.

2.3. Pilot search

There are several methods to specify the keywords that are used in the search[8]:

- Based on research questions
- From primary studies
- The professional people in the field

Also, a good way to define the search keywords is to consider the four different aspects that construct research questions: population, intervention, comparison, and outcomes[8]. The 4four aspects structure leads the research questions. And the search keywords should be extracted from each aspect of the structure.

The steps that are taken to define the keywords in this thesis combine the methods that mentioned above and the sequences following: consulting expert and asking for suggestions, asking for some recommended previously research papers. Specifying the topic and direction in the research, reading the already known primary studies to get the main idea. Based on the suggestions, advices and previous studies, attempt to define the keywords initially.

The databases can be chosen from all available digital libraries, specific journals, and conference proceedings[8]. But in this systematic mapping study, the database should meet the standards as: contain computer science or software engineering studies, support advance search and boolean operators, include full text. With the standards and the resources mentioned before the following databases are chosen in the search:

- ACM DL - http://dl.acm.org
- IEEE Xplore - http://ieeexplore.ieee.org
- Science Direct - http://www.sciencedirect.com
- Springer Link - http://link.springer.com

At the beginning, "Collaborative learning" AND "Software engineering education" were chose as the keywords for attempt search. However, the statistics show that over 1000 and 2000 available results from each searching separately. Because of the wide range results and considering other conditions and suggestions, the results should be narrowed to an acceptable number to screen. The combination keywords ("collaborative learning" OR "CSCL") AND ("software engineering" OR "programming" OR "coding") are considered. However the search results reduced to under 50 together in 4 databases, and one database shows 0 result.

The search results should be in a reasonable number, either too wide, or too narrow. After two times of pilot search with different keywords, the third time search keywords should be considered as same as the first one, Two sets of keywords. The first set is about computer supported collaborative learning, the second set is about software engineering. Also, by considering the research fields and four aspects to construct the well defined research keywords, software engineering, teaching and learning should be thought about as well. Finally, the search keywords are settled as:

- ("Computer Supported Collaborative Learning" OR "CSCL") AND ("Software Engineering")

These keywords are used in the actual search to find out the relevant papers from all databases.

2.4. Remove duplicates and apply criteria

After the actual searching with the keywords, there are 174 results from four databases. Among the results of the keywords, the inclusions should be peer-reviewed by published journals to meet the qualitative standards. English is the common language that is used in the paper for most of reader's understanding. Titles and abstracts from the search results need to be verified whether the content is related with computer supported collaborative learning and software engineering. Papers are written in non-English, not related with Computer Science or Software Engineering and duplicates have to be removed from the results. More details are shown in table 1:

Source Database	Searching Parameters & Filters	Total	Include
ACM Digital Library	Journals and conference publications between 2000 and 2014, search from metadata	52	16
IEEE Xplore	Journals and conference publications between 2000 and 2014, search from metadata with command search	27	9
Science Direct	Journals and conference publications between 2000 and 2014, search from metadata	54	5
Springer Link	Journals and conference publications between 2000 and 2014, search from metadata with English, CS, SWE	41	3
Total		174	33

Table 1. *Keywords: ("Computer Supported Collaborative Learning" OR "CSCL") AND "Software Engineering"*

2.5. Inclusions classification

In the process of how to classify the inclusive papers, the method keywording is used. Using keywording as a classification method because it has less time usage and works effectively. The method is divided into two steps. First, read and try to find the main point in title, abstract, keywords and concept. After this step, the set of keywords are considered and understood in the research and the big picture of the study can be drew out. Second, check the introduction and the conclusion section in the paper, if the abstract does not have a clear description of the concept or keywords, then try to catch the meaning of it. By doing this step, the keywords can be finally categorized for the mapping study[6].

When all the phases are done, papers are categorized into three facets. The research method is an important facet to discuss. It reflects what kind research approach is used in the paper. Also, the research issue is another part of the facets, which tells the general direction or the specific questions that the paper is going to study. Finally, the contribution of the research, including for example: metric, tool, model, method or process in the paper[6][8].

According to the criteria, Figure 1 illustrates total number of all the papers is 33 about CSCL in SE that published from year 2005 to 2014 with a time horizontal axis. It displays the number of papers published in each year. From the figure, it shows year 2009 and 2011 have the most numbers of publications, which are more active than other years for Computer Supported Collaborative Learning study.

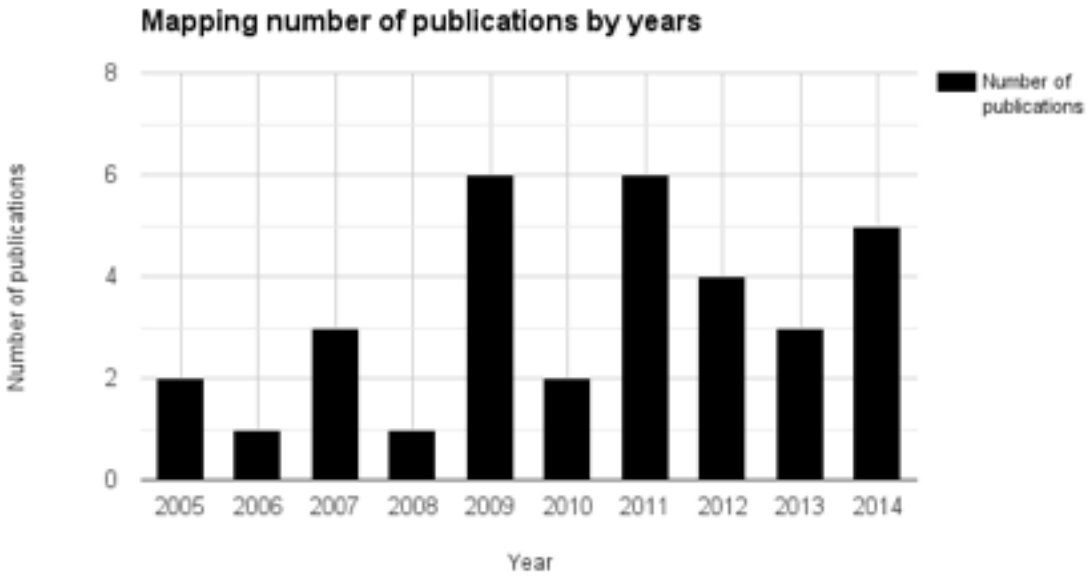

Figure 1. *The number of publications about CSCL in SE by years*

There are some research methods that are used in the articles in this mapping study. The most commonly adopted method is constructive research, which is in the paper introducing something then evaluating it. And the rest are case study papers, which about testing some courses.

In the Study, two main aspects are created according to [6]. One is the type of the contribution, which are process, model, metric, tool and method. These categories are derived from the keywords or abstract. The other is the research method, which can be used during the study. Table 2 manifests a systematic map of Computer Supported Collaborative Learning in Software Engineering. In this table, the horizontal axis shows the categories by contribution of the research. On the other side, the research methods are at the vertical axis.

The table lists a general view of Computer Supported Collaborative Learning in Software Engineering with results.

	Process	Model	Metric	Tool	Method
Constructive Study	Martinez-Mones et al. [12] Giraldo et al. [13] Papadopoulos et al.[16]	Liu et al.[9] Vatrapu et al. [17] Bijlani et al. [23] Rubens et al. [27] Collazos et al.[30] Garcia et la. [39]		Vujovic et al.[11] Harrer[29] Serrano-Cámara et al.[33] Chen et al. [35]	Knutas et al. [20] Chan et al. [21] Burkhardt et al.[22] Karakostas et al.[31] Caballé et al.[32] Serçe et al. [34] Chou et al. [36] Lonchamp [37]
Case Study	Vivian et al. [18] Alfonseca et al.[38]	Kilamo et al. [24] Maresca et al.[26] Kay et al. [28]	Martinez-Mones et al. [14]	Coccoli et al.[3] Elmahadi et al.[10]	Giraldo et al.[1] Ghislandi et al.[15] Law et al. [19] Knutas et al. [25]

***Table 2**. Mapping study of CSCL with research outcomes and methods*

Among these papers, some papers concern to implement a paradigm[5][9] or to create a framework[2]. Some papers focus on evaluating the results[15], effects[14] and performance[34] of CSCL which include using CSCL tools[10], motivation[33], communication[20], interaction[11][12], coordinating[32], cooperation[5], information sharing[36], group forming[27], individual work[18][28] and project management[22][26]. Also there are discussions using CSCL whether collocated or distributed[13]. All the research results approve that collaborative learning has positive aspects of cognitive strategies, critical thinking[21], deep learning, deep understanding, attitudes towards learning and

groupmates[33], and providing a more open and flexible working[37][38], studying environment with their peers.

A paper shows that using a framework in CSCL to improve group work for programming project[3]. The aim is to enhance the collaborative behavior as a outcome for students. Another paper from motivation aspect to improve students' performance in group work[33]. The result is positive by using a CSCL framework and a CSCL tool together. In software engineering education, CSCL concept and CSCL tool is used to stimulate and aid student in group work to increase their creativity and critical thinking[11]. These results show that CSCL can improve group work by making students more interactive.

However there are some problems, issues or difficulties that can be identified during collaborative learning or group work among students. Moreover, even graduates are still struggling with group work in work place. And group work is widely adopted in IT students and graduates for educating and working. So there is a significant need to find out these problems and to improve group work. A list below shows the main negative factors of using CSCL in programming project from the paper s that adopted in mapping study:

- Team size
- Different team member's level
- Personal problems
- Team member location
- Interaction, communication, collaboration problems
- Team project workload and contribution

Team size is one of the team or group work problems that mentioned in the papers[13]. Regarding the task or workload, team size should be controlled inside a reasonable number. Neither too less to cause heavy burden task for the member, nor too much to avoid free ridding or "inactive" mate. Both situations can bring conflicts in group work. Further, team formation is also an obstacle that may affect group project when the number of participants is large[26] and different style of learns[38].

Another problem before performing group work is the level of team members[13]. Students might come from different subject backgrounds, or even in same subject but with different level of knowledge. In addition, without the same level students, providing appropriate and enough material to support them is also considered as an issue[13].

From personal side, self-regulation or self-organized of students has been noticed. Although a large amount of methods and tools have been validated that are effectiveness in group working, there are still some problems which cannot be solved in the real classroom[12].

A lot of studies say that different cultural and social background plays an essential part in group work[19][21]. For example, different languages students from different locations formed in the same group can be a challenge to do the collaborative work. Also collaborative activities in the group relies on socio-aspect[24]. It says that most of learning can be seen as a social process. By doing group work is more depending on who you know than what you know. This also can be found in [20] that students prefer doing collaborations with pre-established social relationships.

Group project can be doing co-located or distributed. So schedule is another problem can affect groupmates during the project if they are in different locations[21]. Even in the same place, the conflicts with time still might happen with students, because other things occupy the time.

The motivation question[13][15][18][33] was mentioned. Group work do bring motivation, but the motivation might not be enough to keep the group going through the whole project. As some researchers noting, students give up collaborative learning with a huge amount percentage[30], this might because motivation cannot last longer.

Communication is not enough[21] to bring effective group work between groupmates and sometimes it just happens from one side[16]. Also communication does not happen smoothly, due to from social point of view for students is difficult to find the match peers[20]. Moreover different types of communication can be observed in group projects. Synchronized

and asynchronized communication are both used during collaborative activities. Adopting appropriate type of communication could affects for the group, thus affects the final project results[34].

According to a research[25], there are different types of interactions during collaborative learning. However interactions in collaborative learning do not happen spontaneously inside the team[16]. It also needs some support and guide[31][35], either from inside or outside of the team. Meanwhile interactions need to be enhanced to lead more effective learning processes and outcomes[17].

Workload and contribution are the components in group project. Workload allocation is an issue in collaborative learning and group work[18], because unfair participation. If workload is excess, then it needs to plan and with collaboration tools to facilitate[14]. From another side, contribution of students is hard to track and evaluate[28], because there is no feedback from them. This might be discourage students in the group work. Studies[18][28] show that there is a need of providing a visible indicator that can support students with their tasks in the group project.

2.6. Discussion

In this chapter, the results from systematic mapping study represent that collaborative learning can benefit the learning activities. Some findings explain the characteristics in collaborative learning. The common benefits that can be found by using collaborative learning in software engineering group projects are: improves group work performance, teaches teamwork skills and uses tools, in communication, interaction, collaboration and cooperation behaviors between group members. It is important that collaborative learning can be adopt in software engineering teaching whether students locate in the same place.

However there are still some problems that identified at the same time. From the team side, team or group size, locations, working or learning schedule are the aspects need to be considered. From the individual side, members' level, member self-regulation, culture and

social background can affect the group work. From group inter-factor side, motivation, communication, collaboration, interaction are the keys to the group activities and finally result. Also the task of the project is a basic element of collaborative learning, which needs to provide a visualized indicator about the workload and contribution during collaborative learning.

3. GROUP PROJECT PROBLEMS

Although collaborative learning has many benefits for students group work, like: increase motivation, critical thinking, learn teamwork skills, there are still some problems can be found when conducting it as mentioned before. Among all different kinds of problems, it is important to rank the most common problems and specify those problems that students always encountered with interactive behaviors during group project.

In order to find the answer, a questionnaire was conducted [85] by J. Ikonen, A. Knutas and Y.Y. Wu. The aim of the questionnaire is by analysing both the success group project and fail group project among students to find out the factors that discourage collaborative behaviors and to propose if it is possible to use tools or mechanics to support shortage aspects that have been identified. The questionnaire is specifically focusing on problems of collaborative behaviors among group members during group work. It is targeting only on individual's opinion without any group interviews.

There are 81 participants from 32 universities/affiliations in 22 different countries that has been recognized with most of them are students. The questionnaire was focusing on group work or project which related with programming, so the most of students have programming experience and IT or CS education background. In 81 available answers, there are more than half of respondents having positive feelings with group project.

3.1. Problems collection and rank

In the survey, the purpose is to find out the common problems and rank them that occur during the group project. There are 9 problems plus 1 no problem option listed as checkboxes. Also 1 open end text box for describing other problems that are not listed above. The 9 listed problems are based on previous research[63]. The problems are not focusing on the project itself but the activities of/among group members. Respondents are free to choose

problems as many as they encountered. This survey is only focusing on social activity related problems, other problems are not considered.

81 respondents reported 226 answers, which mostly are included in these nine problems. Only 6 students provided open end texts, which also can be generalized into the nine problems. Figure 2. illustrates the statistics data from the questionnaire. In the chart, horizontal axis represents vote number from participants, vertical axis represents different problems. Poor communication problem has 39 answers, which is the top 1 problem related to inter-member. Procrastination and schedule conflicts are the second and the third issues, which has 29 and 25 separately. Lack of cooperation has 23 votes as the fourth biggest difficulty as same as leadership problem, and the second issue related to inter-member's behaviors.

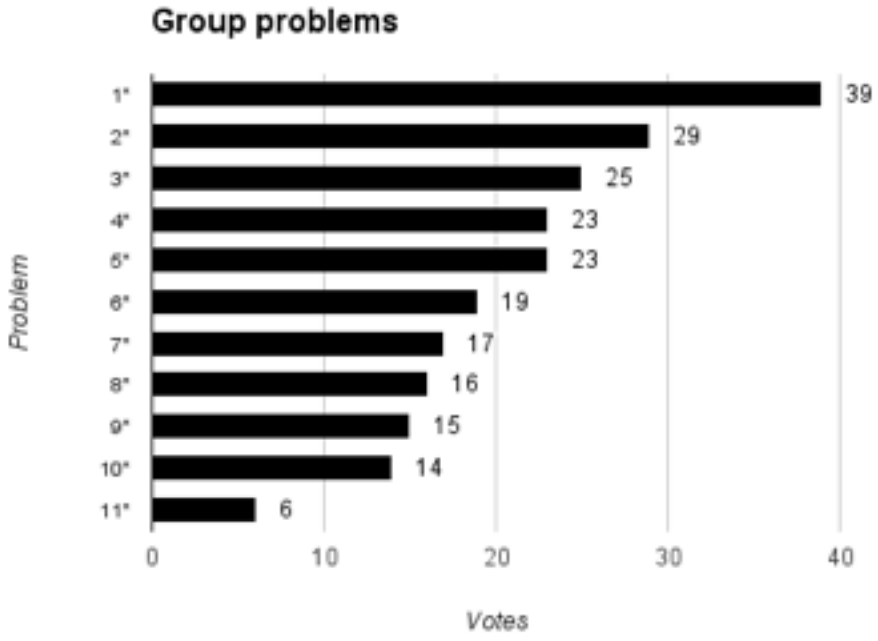

Figure 2. *Group problems*

1*: Poor communications among members 2*: Procrastination problem (Delaying or postponing problem) 3*: Conflicts in students' schedule 4*: Lack of cooperation 5*: Poor leadership 6*: Members' personal problems 7*: Integration Testing problem 8*: Lack of confidence (to begin the project) 9*: Haven't experienced problems 10*: Failure to compromise (Could not meet each other halfway) 11*: Other problem, please specify

The rest problems are not as important as those top 5. But there are 15 participants answered "Haven't experienced problems", the assumption of that is either they had a really successful project without any problem, or they had solid groupmates to take care of most tasks during the project.

3.2. Data analysis

The main questionnaire is divided into two parts. First part, the participants were asked questions about the "best" experience they have had in one of previous projects. The "best" experience in here is described as member feels satisfied during the group project and it has a successful project result. Second part, the participants were asked questions on the contrary situation, which is the "worst" experience they had before. Both parts have the same questions. With comparing the answers between each part, analyzing the data, the differences might be found in the results.

According to the answers, there are similar backgrounds in both "best" and "worst" experience projects. Most projects are university projects and groups sizes are maximum to 5 members. Most projects are described as important or very important, but slightly different in important level. Table 3. illustrates these background characteristics.

	is university project	**group size up to 5 members**	**important/very important**
"best"	78.95%	82.98%	86.67%
"worst"	74.32%	78.38%	68%

***Table 3**. Group project background*

Inside the "best" experience project part, the average number(4.17) indicates that respondents have a clear idea or goal of what they should do for themselves in the project. On the contrary, in the "worst" experience project, the average number(3.45) indicates that idea or goal is not clear enough. Even the average result is above 3, it still means that participants were wondering between different tasks instead of focusing on one single job. From the

comparison, it also tells that there might be connections between a particular idea for each group members and the project result tends to be successful. Table 4. illustrates the number of respondents in each level of the task between the “best” and the ”worst” experience project. The original survey uses likert scale 1 to 5 to describe the levels.

	1 (No idea of what I should do)	2	3	4	5 (Had a clear idea)
“best”	1	1	9	37	27
“worst”	4	18	14	16	22

Table 4. *Group task*

Divided workload and equal contribution were also asked in the survey. The workload measurements are described as from unfairly divided with value 1 to equally divided with value 5. Likely, contribution measurements are described as from much less to extremely lot more. The values are from 1 to 5 as well. Respondents feel workloads were basically equally divided in the “best” projects with contributions little higher than their equal defined tasks. Unlikely, workloads were extremely unfair in the “worst” projects, but the contributions were as equal as the “best” case.

Figure 3. illustrates basic data of divided workload and equal contribution trends in different cases. The horizontal axis illustrates the measurement level for contribution and workload. The vertical axis illustrates the participants numbers. The black bar represents the divided workload and the grey bar represents the equal contribution. The “best” experience project case workload and contribution trends are basically the same. While the “worst” case shows two different peaks between workload and contribution.

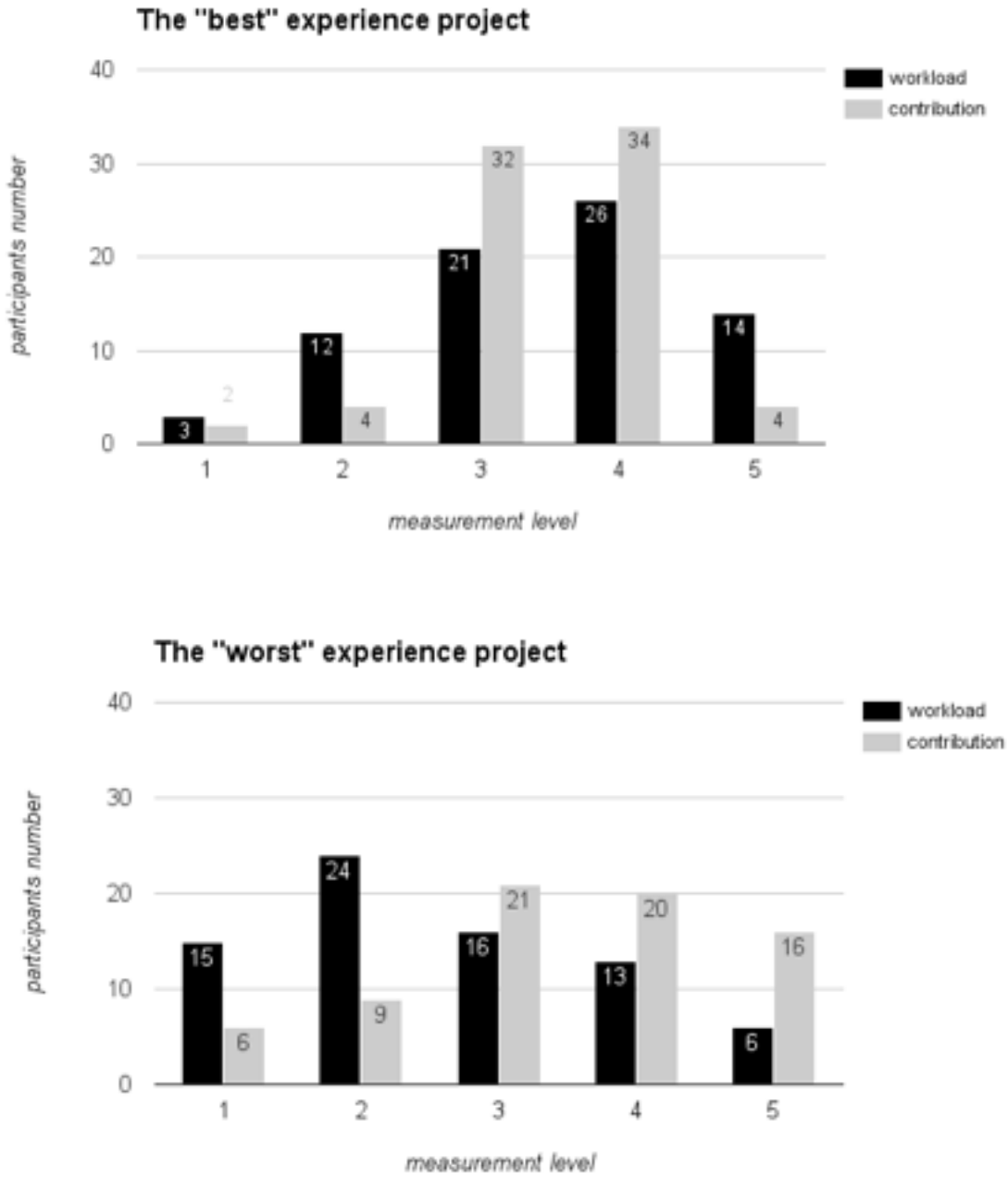

Figure 3. *Workload and contribution*

It has an assumption that while the workload is divided unfairly, the whole project cannot be parallel processed. With This unequal treatment, some members complete their tasks and wait there[64], while some are still struggling with their tasks with limited time. This can influence the whole project. So as study mentioned before that workload unfairly divided with some group members taking a lot more tasks during the project brings out an unpleasant experience then might lead to the project to unsuccess[65].

In collaboration section, work together, interaction and share information level were asked separately. Because they are not required questions, the number of answers are various from 73 to 76 for each question. Likert scales 1 to 5 are used to describe the level.

The collaborative levels are presented in Table 5. There are also two parts with same questions, one for the "best" experience project which the participant thought the project was successful or satisfied in green color, the other for the "worst" experience project which had the opposite feeling in red color. For each question there are 5 different levels, increasingly from 1 to 5. In each cell it shows the percentage of the respondents with color scale.

		1*	2	3	4	5*	Median
best project	**worked together**	1.32%	15.79%	30.26%	32.89%	19.74%	4
	interaction frequency	1.35%	12.16%	24.32%	32.43%	29.73%	4
	information sharing frequency	1.33%	8.00%	22.67%	45.33%	22.67%	4
worst project	**worked together**	21.92%	47.95%	19.18%	6.85%	4.11%	2
	interaction frequency	13.51%	36.49%	31.08%	12.16%	6.76%	2.5
	information sharing frequency	13.70%	35.62%	28.77%	16.44%	5.48%	3

***Table 5**. collaborations*

1*, 5*: For work together question, 1 means "independently", 5 means "Lot of cooperation". For interaction question, 1 means "Only a first/last meeting", 5 means "Very frequent". For share information question, 1 means "Did not share", 5 means "Very frequent".

Table 5. gives the data that in the “best” project with most participants select from level 3 to 5, which means participants have more collaborative behavior or do collaboration more frequently. On the contrary, In the “worst” project most participants select from level 1 to 3, which indicates there are not enough or not frequently collaborative behaviors happened during the project. Comparing with two parts above, more together works, interactions and share information can be found in the project which participants think successful.

Visible progress is a useful tool that can influence people’s perception[27]. Seeing the progress of each group member in the project was asked in the survey. 65/74 had a way to see the member’s progress in the “best” experience project which the participants thought the project was successful. Unlikely, more than half 40/74 participants had no way to see the progress in the “worst” experience project which the participants thought the project was unsuccessful.

By analysing data from “have a way to see the progress in the ‘best’ experience project” and “not have a way to see it in the ‘worst’ experience project”, there are differences in “work together”, “interaction” and “share information” between these two options. Figure 3. illustrates the differences. In chart horizontal axis demonstrates three collaborative behaviors. In vertical axis demonstrates the level of behaviors (according to Table 5). The black bar represents the collaborative behaviors in the “best” experience project with a way to see the progress. The grey bar represents the collaborative behaviors in the “best” experience project without a way to see the progress.

It can be seen in figure 4. that the average collaborative behaviors levels of the “best” project with a way to see the progress is higher than the average of the “best” project without a way to see the progress. It tells that in this survey having more collaborations in a project are always having a way to see the progress.

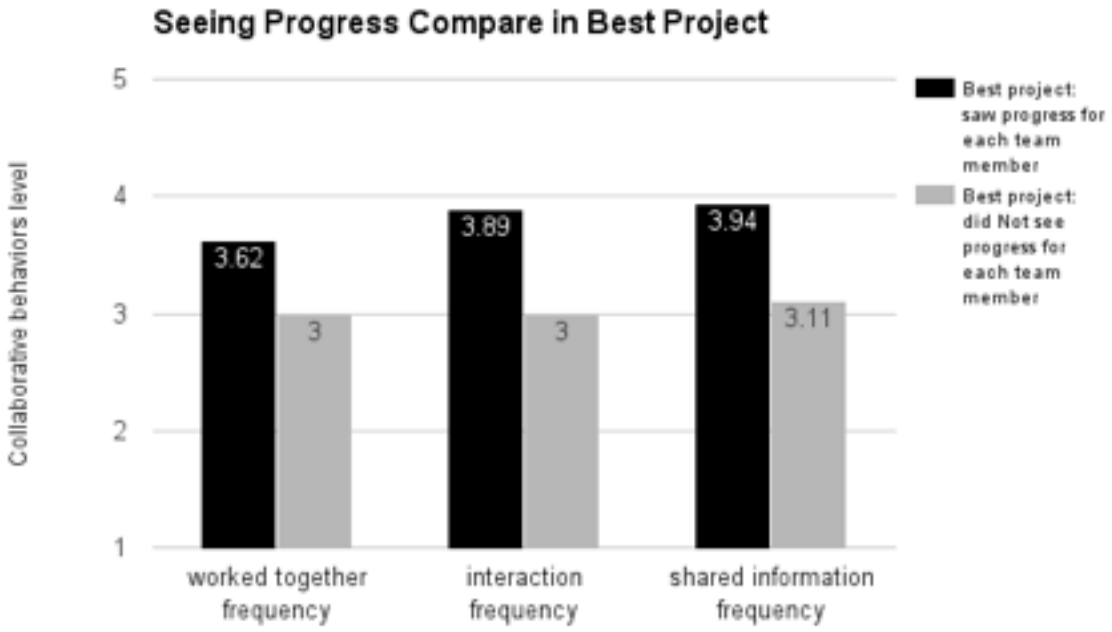

Figure 4. *seeing progress compare in "best" project*

The similar result can also be found in the same circumstance in Figure 5. In the "worst" project chart, the black bar represents with seeing progress and the grey bar represents without seeing progress. Even in the same "worst" experience project, doing collaborations with seeing progress are still slightly higher than without seeing progress in behaviors level.

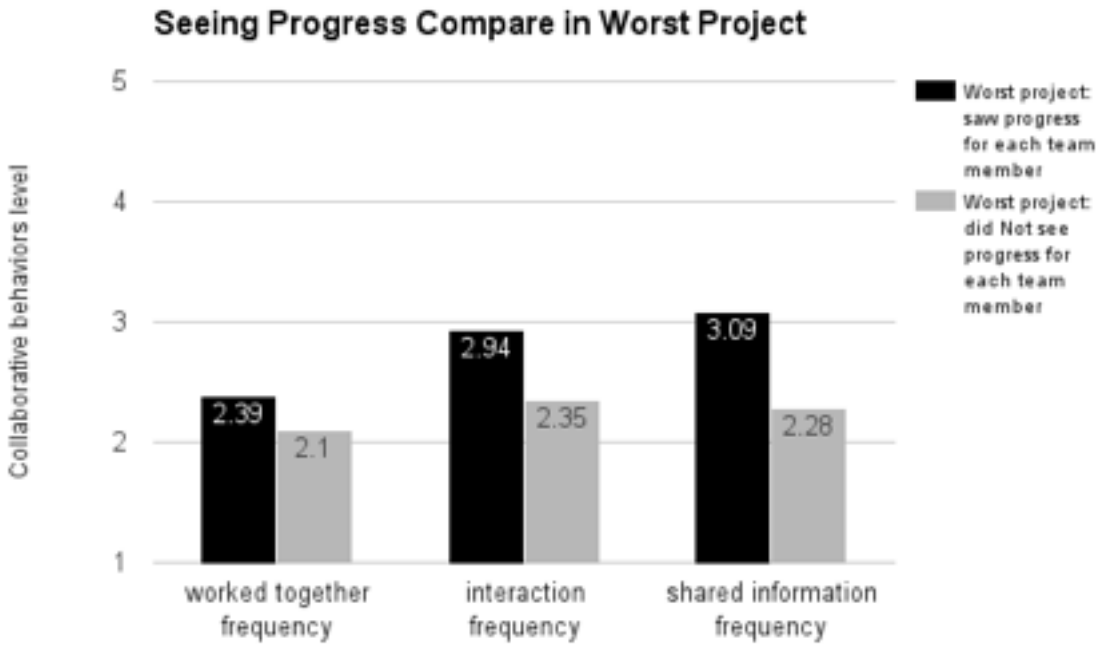

Figure 5. *seeing progress compare in "worst" project*

While the survey gives the basic data of work together, interaction and share information with visible progress and from the data it can be seen that collaborations are different with visible progress and without visible progress. But there is no clear evidence to prove if there are correlations between visible progress and collaborative behavior in group project. It needs more research on this topic. For example, more detail in questionnaire with visible progress bar and individual's behaviors, as well as behaviors among individuals.

71 out of 81 participants chose they would like to see member's progress in group project. And they also want this visualizing progress can be monitored in short period, from real time to weekly monitoring. But some participants suggest that the progress depends on the length of the project time. It tells that people prefer to have a visible progress with indicating the actual situation in a short time.

As the positive effect of using visible progress indicator, what kind of visible progress indicator (text or graphic or both) and how does the visible progress indicator work inside group instead of for individuals still need more research.

3.3. Tools in team project

In open ended question for how to track the group progress, it shows that meetings are the most common way to track progress in groups. 11 out of 81 respondents mentioned keyword “meetings” in their answers. The other widely used tool is github. 10 out of 81 respondents chose github to monitor their group progress. Besides those two, like regular report, Email, Google collaborative tools, social network, even text message can be seen in the answers as well.

By studying respondents text, it can be generalized into 3 ways that people always use to track the group process. First, traditional methods, meetings, report, email and message. Although they are old style, people still prefer using them a lot (mentioned 36). Second, social network or online collaborative platform. There are some people choosing the tools that they often use for other things into group project (mentioned 25), for instance, Google tools and Facebook. Third, distributed repository system (mentioned 15), like Github, is a well known tool for programmers. It can be found that, although there are many collaborative tools and distributed repository platforms, a lot of people are still using the traditional way to check other group member’s working status.

In software version control system part, almost half (43.2%) respondents have never used software version control system in their projects, or never heard it. This also proves collaborative tools are not well known and adopted.

Among the people who had experience of using software version control, Git is the first option in distributed version control system. More than half people used it before in their projects. Subversion, CVS and Mercurial are also used by some people.

If respondents know visualize progress tools and named it is also asked in the survey. But only 30 respondents answered that question. JIRA (7), Github (5), Trello (5), Google (3) are

in front of the tool list. It can be seen that using visible tool to track members' work is still rare. Most people still work without knowing other's status.

3.4. Correlations between questions

There are strong positive connections between workload divide and work together. It tells that the more fairly workload is divided, the more group members work together. It shows in both "best" and "worst" projects, the correlations have the similar relationship values, correlation in the "best" project is 0.41 and correlation in the "worst" project is 0.53. Also there are moderate positive connections between workload divide and share information. It means that the more fairly workload is divided, the more information sharing behaviors happen. In "best" and "worst" project, the relationship values among workload divide and share information are 0.36 and 0.29 separately.

According to the data, it demonstrates moderate negative relationships among seeing progress and share information, in "best" project correlation is -0.31, in "worst" project correlation is -0.38. it means that if respondents can see other member's progress, then more frequent share information behaviors happen. Literally, it can be understood that without seeing each other's progress, sharing information is limited.

The correlation shows very strong positive relationship among how often shared information, how frequent was the interaction these two questions in "worst" project. The value between shared information and interaction is 0.75, which indicates when one factor value increasing, the other value increases as well. In other words, two things happened at the same time, which respondents were interacting while sharing information. Literally, this could be understood as respondents only share information when they have chance to interact. So automatic sharing tools are really rare used.

When combining all the correlations mentioned above, it is can be found that equal divided task and providing a visible way to know each one's progress have correlations with working together, interaction and sharing information these collaborative activities. And some

supporting tools are not well used for group project, although they can help students with their jobs.

3.5. Discussion

By comparing “best” and “worst” project in this questionnaire, it is can be found that there are still some problems during group project or collaborative learning. The results show that poor communication and lack of cooperation are the top two common problems that among group project students. It is also found that unfair divided workload and unequal contribution are commonly happening in the “worst” projects, which might influence the progress of project. Comparing with collaborative activities, in “worst” project there are less collaborations than in “best” project. Furthermore, according to the question of seeing progress in the project, if students have a visible progress indicator, the projects are always with high level collaborations. So it is can be assumed that having a visible progress indicator is a good tool to support students. By analysing the results, the data indicate that aided tools (like, distributed version control) are not broadly used as well. With these problems, it is proposed that in software engineering group works, to use some motive mechanics (gamification) and visible progress indicator with supported tools to encourage students to get their work done more effectively in group project.

4. INTRODUCTION OF GAMIFICATION CONCEPT AND MECHANICS

Gamification is defined as using game elements in non-game contexts[4]. It can bring more motivation and engagement, increase collaboration and interaction[28]. It also can give user a visual feedback with enjoyment[40] which can be used in solving group project problems. In this chapter, first gamification background is generally introduced. According to the same procedure, it is necessary to do the similar background study of gamification as collaborative learning. Then for solving the problems which have been found in the questionnaire, four gamification mechanics are discussed. The following questions can be answered:

- What is the current situation of gamification study in teaching and learning?
- What is the benefit of gamification?
- What are gamification mechanics?
- How to use gamification mechanics?

4.1. Gamification systematic mapping study

By following the same rule of collaborative learning mapping study, the keywords of gamification are ("Gamification" AND ("Learning" OR "Teaching")). After searching, there are 351 results from year 2011 to 2014 in 4 databases. The inclusion and exclusion criteria also follow the previous standards mostly. The differences are the content about gamification and education are included. More details are shown in table 6:

Source Database	Searching Parameters & Filters	Total	Include
ACM Digital Library	Journals and conference publications between 2011 and 2014, search from metadata	91	7
IEEE Xplore	Journals and conference publications between 2011 and 2014, search from metadata with command search	10	9

Science Direct	Journals and conference publications between 2011 and 2014, search from metadata	129	2
Springer Link	Journals and conference publications between 2011 and 2014, search from metadata with English, CS, SWE	83	2
Total		351	22

***Table 6**. Keywords: ("Gamification" AND ("Learning" OR "Teaching"))*

Figure 6 illustrates all the papers that related to gamification which are published from year 2011 to 2014. It shows paper publishing trend during these years. From the figure, it can be noticed that year 2011 is the beginning year of the gamification research with the minimum amount of papers at 1. But In 2013 the number is drastically increased to 12. Although 2014 has less published papers than 2013, there are still several months left, so the number might go up by the time passes.

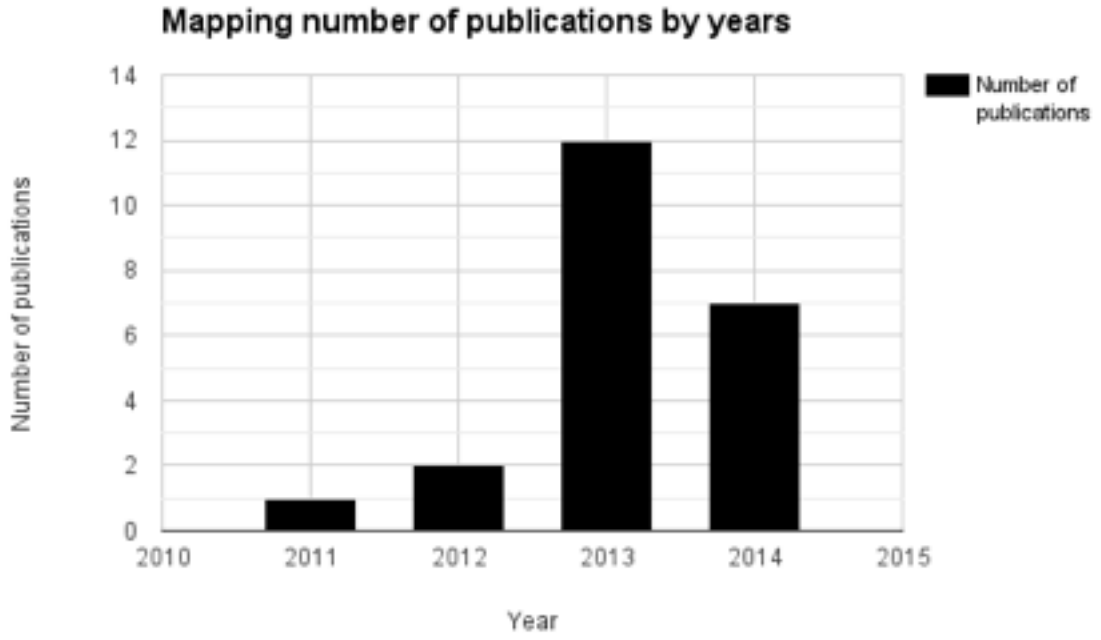

***Figure 6**. The number of publications about gamification by years*

In research methods part according to [6][58], most of papers use constructive research method, other papers adopt case study, mapping study, literature study or survey. In study type, evaluation of gamification is the most applied study type in gamification research, it has 18 papers in the whole. The second type is implementation of gamification, there are 3 papers using this type. The rest is improvement of gamification, which is only one paper in this type. They are categorised by different processing results of gamification. A systematic map below demonstrates the study results. The horizontal axis describes the study contribution and the vertical axis describes the research method, which is the approach that adopted in the study, more details are in table 7.

	Evaluation of Gamification	**Implementation of Gamification**	**Improvement of Gamification**
Case Study	O'Donovan et al.[40] Ibanez et al.[51]		
Mapping Study	de Sousa Borges et al.[41] Pedreira et al.[58]		
Constructive Study	Iosup et al.[42] Barata et al.[44] Denny [45] Dubois et al.[46] Hakulinen et al.[47] Barata et al.[48] Jayasinghe et al.[50] Moccozet et al.[53] de Almeida Haaranen et al.[56] Dorling et al.[62]	Bartel et al.[49] Thomas et al.[55] Ferro et al.[61]	
Literature Study	Souza-Concilio et al. [54] Erenli [57]		Rughinis [52]
Survey	Ziesemer et al.[43] Seaborn et al.[59]		

Table 7*. Mapping study of Gamification with research type and contribution*

With two basic introduction papers[52][57] and two mapping studies[41][58], there are papers which state features of gamification in details, like, improving students participation[42][53], engaging[44][49][50][62] and affecting motivation[43][54][59]. There are also some papers which discuss the elements using in gamification, such as points, badges[45][47][56], leaderboard, levels[40]. Gamification mechanics are mentioned in[40] [41], for example, visual feedback, rewards, challenge, competition[40] and cooperation[51] and gamification designing[46][55] is discussed as well.

From mapping study results, there are some positive factors about gamification in the fields below:

- Engagement and motivation
- Performance
- Learning
- Guide-lining
- Behaviour changing
- Social activities

It can be found that gamification can improve people's engagement and motivation as well as performance. By changing behaviour, guide-lining and socialising, it makes the learning more efficient. Although the research is still in an early stage from Figure 6, there are still lots of empirical works with positive results that indicate gamification has potential influence.

Based on the background knowledge of collaborative learning and what problems have been found in group works, it is assumed that using gamification concept into group project is a way to get more efficient results and to solve those problems. In the following, these gamification topics are going to be discussed in details:

- motivation
- mechanic of feedback
- mechanic of reward
- mechanic of challenge
- mechanic of competition

- mechanic of cooperation

During the discussion, several cases are proposed. The gamification mechanics behind these cases are introduced.

4.2. Motivation in gamification

But before introducing the mechanics of gamification, there is one important concept in gamification that has to be discussed, motivation. Motivation is the core of gamification and the upper level above gamification mechanics[83]. It is the purpose to do gamification [40] [48][61]. Motivation is a psychology concept. It literally means the desire to do things. It is not just awake and relaxing by doing nothing. It is doing something instead of doing something else. The formal definition is that "*Motivation is a theoretical construct used to explain the initiation, direction, intensity, persistence, and quality of behaviour, especially goal-directed behaviour*"[66]. It concerns people's passion, endurance and direction[67]. In learning environment, motivation is highly valued because of its consequence, which can influence people's orientation towards to the final goals. With motivation, people can also develop new skills, increase the willing to do the tasks, spend more time on the tasks, raise persistence facing problems and improve the engagement[68].

Practically, motivation is the reason people doing things for something[69]. For example, reward, people work not only for salary but also for bonus, the bonus is a reward; to beat others, in football match players play the game to beat the opponent team; to explore something new, travel to other countries is also an exploring some different culture, food and landscape.

Nowadays, there are different ways to motivate people, either intrinsic or extrinsic. The following methods can be adopted in motivating: feedback, rewards[69], challenges[70], competition, cooperation[71]. These methods can bring positive effects for different tasks. According to the research, feedback can bring future improvements and achieve higher level cooperations[69]. Reward is the most well-known method and the most used method to motivate people. Rewards can encourage people to contribute and participate effectively[69]. Challenge helps people to develop positive expectations so that they can reach the successful

goal[72]. Competition and cooperation are two different methods from opposite sides. But both competition and cooperation can bring positive effects[71].

All the methods mentioned above in games are the same mechanics adopted from psychology. Designers use these mechanics and combine with other game stuff to design games. The concept is widely used to motivate players by playing games. It is assumed that this idea can be used in gamification to improve students performance in group project as well.

4.3. Gamification mechanic of feedback

Feedback is the information that reflects to people and informs their current status in constant forward progress[73]. It is the most important and most straightforward mechanic that influences people. Feedback tells people by doing activity what is “right” and what is “wrong”. There are always some other game elements that interact with feedback, like points, levels and visualization.

A good feedback mechanic should have these characteristics to be effective, to make people feel excited and engaged[5]. First, feedback can be felt naturally, not forced. Second, as a mechanic, people want to accomplish the goal through positive feedback. Third, feedback has to be constantly shown if people meet the condition. Forth, feedback happens with the context and continuously influences people. Fifth, it is good to give people surprising feedback, but should be balanced not overwhelmed.

LinkedIn[74] is a professional social website. It uses gamification to encourage users to complete their profile information. As a professional social website, people come to find valuable human resources. So it is good to have completed profiles for LinkedIn. LinkedIn created a way to solve this. The solution was using a visualized progress bar (Figure 7.)[74]. In the progress bar, there was a visible indicator to give user a feedback with how much profile information that user has been completed with a number percentage on the side. Things were not only this, to encourage user more, LinkedIn put another indicator below, if user added another profile information, the complete percentage would be increased. The

visualized completeness meter is powerful, that gives people a feedback how they perform with filling profile activities, and encourage people to complete profile perfectly which is 100 percent.

***Figure** 7. LinkedIn progress bar* [74]

4.4. Gamification mechanic of reward

Reward is the mostly used mechanic not only in games but also in other things. It is one of the main factors to motivate people in gamification. In some circumstances, rewards are not the essential part that related the final goal. But in other circumstances, rewards give you extra abilities, which is directly related to the final goal[5]. There are two different opinions about how to reward. One is rewarding as often and easy as possible, so people could be attracted at the beginning. The other is getting rid of the unnecessary rewarding, because it is not the main purpose of motivation[5]. By these reasons, the reward structure should be designed carefully and meaningfully.

Foursquare[76] is a famous location service that provides rewards when they check-in. It is one of the best website that uses gamification techniques. When people using Foursquare check-in at a location, they can earn a virtual badge as a reward (Figure 8.). By using badges and other elements, like points and levels, Foursquare motivates people revisit a location and let them become more loyal[76]. It is proved that by using reward and other gamification mechanics, people can be motivated and their behaviors can be changed.

Figure 8. *FourSquare badges* [76]

4.5. Gamification mechanic of challenge

Challenge is the mechanic that people have the clear goal but with unknowing the outcome[73][5]. In the circumstance that people certainly knows if the goal can be reached or the goal cannot be reached is not a challenge. This uncertain statement can motivate people to try the challenge. And challenge can give people an obvious direction, show them the path to go, which indirectly emphasize the goal. With handed resources, people can try to win the challenge in different combinations to know how to use them better.

There are many ways to make the challenge in gamification. In general challenges can be set by clear obstacles. It consists of various difficulty levels, multiple missions, limited time, limited resources, hide and seek information and random challenges.

Nike plus is an application running on iOS and Android platform. It is using a sensor in Nike shoe to measure runner's performance and store the athletic data in handheld devices. Nike plus is designed to encourage people running by many built-in features like, graphical display, progress feedback and different levels with longer distance etc. Among these features, there is a feature that gives runner an opportunity to challenge runner's friends who are also using Nike plus by complete one defined distance goal, see Figure 9. The farther distance the runner runs, the better position he or she is on the leaderboard. It is a very good gamification example that uses challenge mechanic to motivate people.

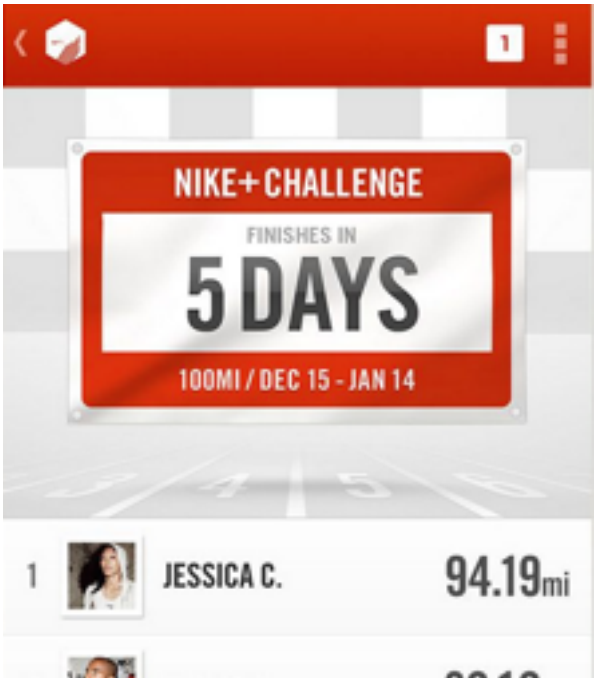

***Figure 9**. Nike+ challenge from http://www.nike.com/fi/en_gb/c/running/nikeplus/gps-app*

4.6. Gamification mechanic of competition

Competition is all the participants that "constrained from impeding each other and instead devote the entirety of their attentions to optimising their own performance"[78]. It can be found in many sports games, like football or basketball. One of the useful effects is to bring hard fun through competition[73]. Competition happens not only in single person versus single person, but also between teams. It increases the difficulty level of winning, and at the meantime encourages cooperation inside the team.

When Microsoft testing its Windows 7 in different languages, the gamified project is one of the most successful process in gamification. Translate into different languages is difficult and expensive. To solve this problem, Microsoft established a competition with which language version would be the most qualified in Windows 7. More details are in table 8.

Game Duration	One Month
Total Players	>4,600

Total Screens Reviewed (Points Earned)	>530,000
Average Screens per Player	119
Top Player Screen Reviews	> 9,300
Total Defect Reports	> 6,700

***Table 8**. Gamified language testing statistics* [79]

Because it is a challenge, huge numbers of employees from different geographical offices in Microsoft want their language version to be the best even without any financial support.

4.7. Gamification mechanic of cooperation

Cooperation is the mechanic that lets people work together to help each other with the mutual goal[5]. Under cooperating, the more people working together, the more efficiency to the final goal. Cooperation mechanic mostly happens inside groups or teams, which called coalition. Hence it is more about social aspect to bring fun factor in gamification. In lots of sports and games, cooperation is very common, like soccer, pictionary etc. Cooperation also have correlations with communication, coordination and interaction.

Stack Overflow[80] is a question and answer website for software developers, which uses gamification elements and mechanics. After becoming a registered user, Stack Overflow shows the basic rules, which contains the basic activities and evaluation standard in this online forum (Figure 10.).

Figure 10. *Rules* [80]

In this online community, to get a good answer, users need to do lots of cooperative activities. They contribute different answers, vote for different answers, edit different answers and leave comments. By doing all of these, user can get higher reputation (shows by points). Further user can have more privileges (Figure 11.).

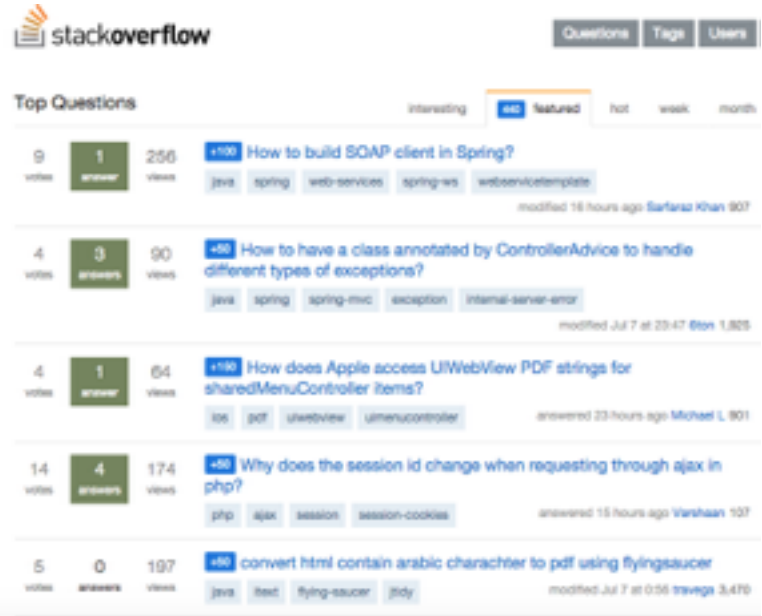

Figure 11. *Stack Overflow* [80]

With cooperation mechanic as well as other gamification mechanics and techniques, Stack Overflow is more popular than other simple question and answer websites. People work together with their questions and answers are more efficient[46].

4.8. Discussion

Gamification can bring lots of benefits in teaching and learning and motivation is the key to successfully gamify. Challenge, feedback, reward, competition and cooperation are basic gamification mechanics in group project. The differences among these approaches, challenge sets clear goal with unknown result, feedback reflects member's status,reward gives bonus and award, competition lets member do better than others and cooperation lets member help others. The similarities in these approaches are that they have the original power to motivate people. These mechanics engage, encourage and inspire people to do things. But if the project wants to fully gamified, some other important elements need to be used. Those elements consist of the foundation of gamification. Next chapter will introduce using game elements in the gamification and how to design them into the system.

5. GAMIFIED PLATFORM DESIGNING WITH GAMIFICATION ELEMENTS

The fundamental of gamification is components[83]. Designers use those elements to implement games. In this thesis, the elements are used in a similar circumstance, a gamified system. First this chapter talks about basic elements: point, level, experience bar, leaderboard, badge and social elements. Then introduces a logical designing with gamification elements and mechanics. Last it describes what is Github and how to use Github which is a test environment with gamification mechanics and elements in practical. The research questions in this chapter are:

- What are gamification elements?
- How to use gamification elements?
- What is Github?
- How to combine the design into Github test environment?

5.1. Introduction of gamification elements

Points, Level, XP bar, Leaderboard, Badges and Social elements are the usually used components in gamification design. In this part, these gamified tools are used in the design to make students more motivations, more communications, more collaboration and bringing more efficient group work[42][40].

Points system is a measurement standard to manage the value of the units, the actions or the performances[42]. In this system, the points can be earned by, for example: filling out profile information, creating a new project, asking a new question, answering questions, sharing good advices or suggestions and connecting social elements.

Levels are the reflection of points, experiences and goals accumulation. The obviously uses for levels is to break whole mission or task into small, executable segments. In addition, levels incentivize users to use the system and to get higher level. Moreover, levels can give

the access or block some information or materials, when user can or cannot reach a certain level. This is also another reason to let the user stay and use the system[42].

XP bar or eXperience Points bar, is to show the progress during the mission or task. The benefit to use XP bar is that to display the gain or earn, no matter how small it is, to tell the improvement, accomplishment the user did and to motivate the user visually. For example, the bar indicates the status that where the user is. Besides that, it shows the small piece XP that the user gain to incentivize the user as a reward system[40].

Points, levels and XP bars always appear together. Figure 12. illustrates the design sketch of how points, levels and XP bars combine and work with each other in the prototype system.

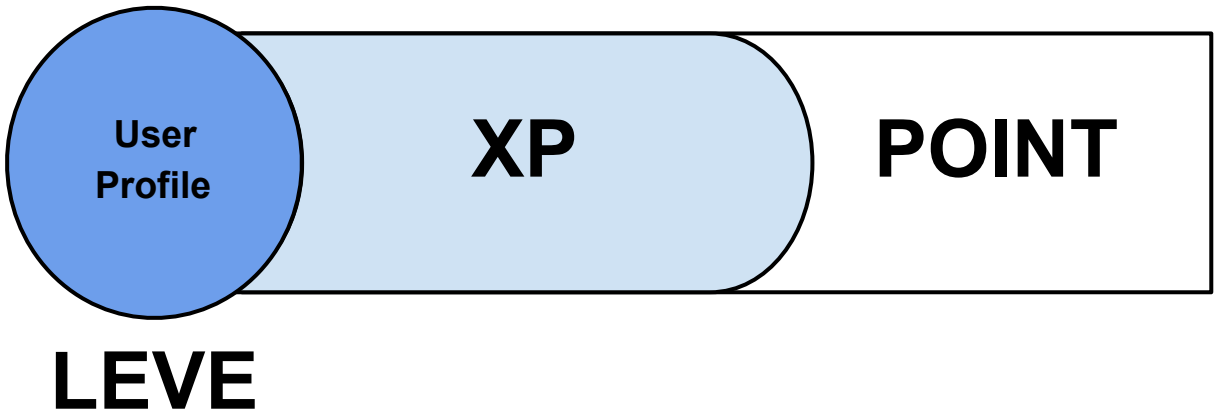

***Figure 12**. Points, Level and XP bar prototype*

Leaderboard displays the useful data statistics, also uses to show the achievements[42][40]. In another way, leaderboard can use to rank users and compare with each other with points or scores. It provides a convenient way to lead users to success[62]. Leaderboards are always related to the users who use the system or social connections. In this prototype, leaderboard shows users rank according to their points. Moreover, the trend is shown based on their performance. Figure 13. demonstrates the sketch of the leaderboard looks like.

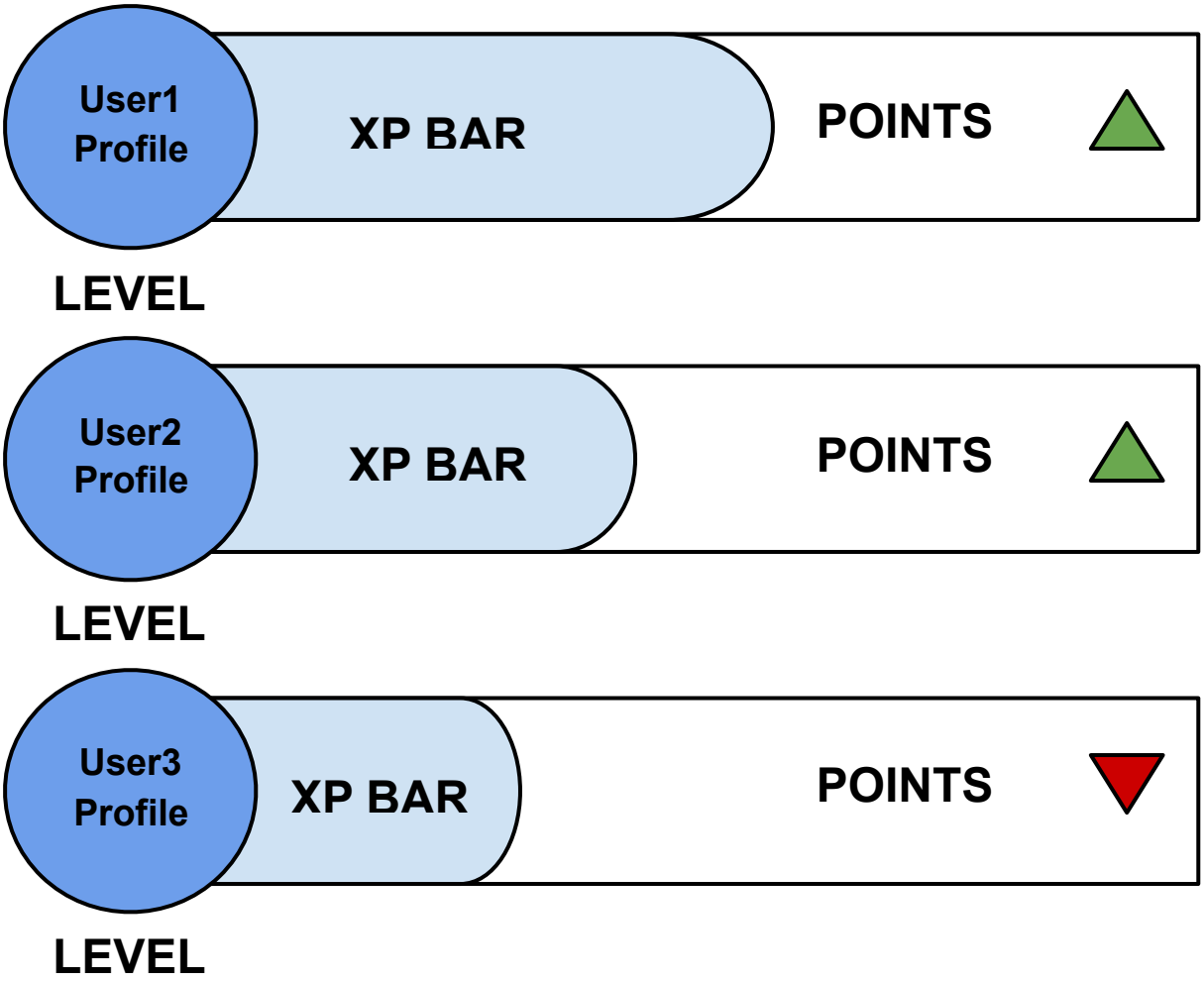

***Figure 13**. Leaderboard prototype*

Badges mean the achievements that the user earns in certain skill area[40]. However it also has another meaning is that to surprise the user who has completed some achievements which with special meaning. Like, The most contributor, The most answer questions, The most activity user. Or 1 question answer, 10 question answers, 100 question answers. With badges, they can let the users feel their values and show them to other users. It is a way to motivate users to keep using the system, as well as to get more badges. Figure 14. shows some badges prototype: 1 Answer, 10 Answers, 100 Answers, 1 Question, Team Star, Project creator.

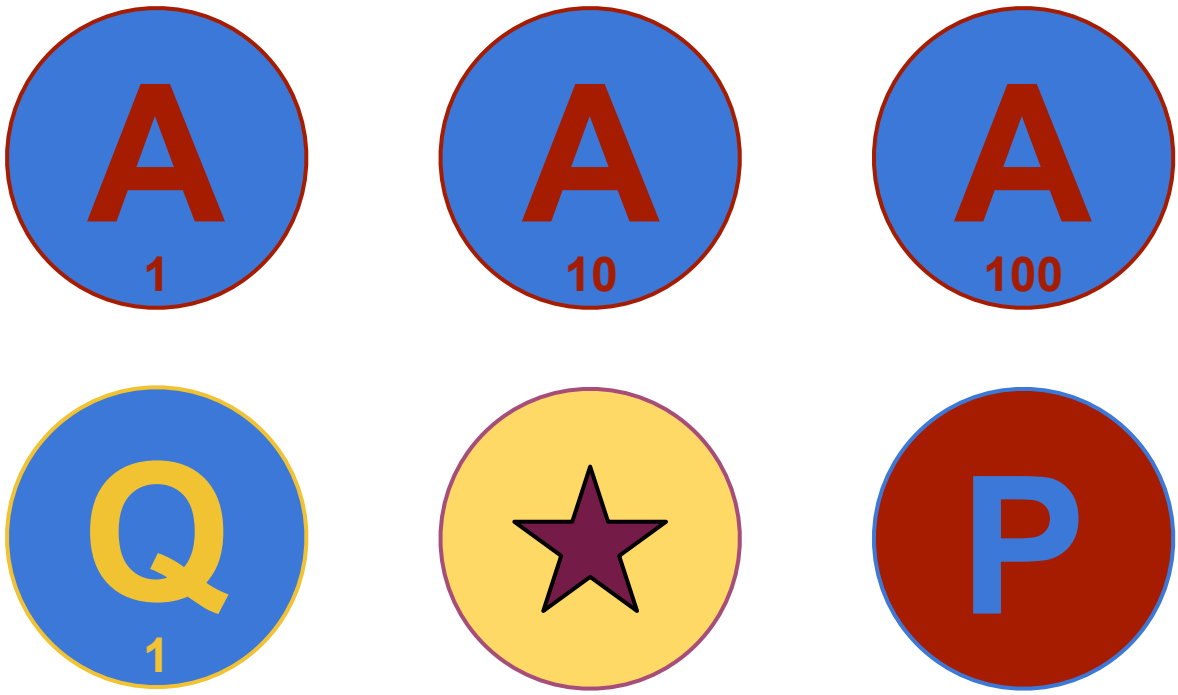

***Figure 14**. Badges prototype*

Social elements, in this case, especially means social influence in the system. There are lots of network services and games which have social elements to encourage and persuade users[81]. In the prototype, it is assumed that social influence could affect other users, although it is based on how important the target is for other users. In general, the social influence can bring positive effects toward the system. Others include already known relationship in a team or group, that can strengthen the connections between each other[42]. By applying social element, all other elements can be combined together, thus increase their reward effects, as well as improve the perception of competition. For example, the group or team concept can be used to form a logical unit to compete in the system.

5.2. Gamification Logical Design

According to the gamified elements that mentioned above, this part describes how to put them together to design a gamified system that attracts students to try, motivate students to use and keeps students staying with it. The designing highlights the visible progress and motive characters. The purpose is to share the status with more students, increase communications and interaction both inside and outside the group, as well as training

collaborative learning instead of traditional learning among students. There are 5 parts in the design: points system, levels system, experience bar (XP bar) system, badges system and leaderboard system.

Point system. Points are the basic elements for gamified design. Points system is the mechanism that turns student behaviors into points. It shows students the value of doing tasks during the project. Everything depends on points. So the first step for users and as well as designers is to fully explain and define, how to get points from the activities of the system, what behaviors to take in the system to get points. Moreover, activities should be easy to take that motivate and encourage users' behavior and keep what they do. Some activities that users can only do at once, but some activities that users can do many times during the whole project.

In gamified group project, there are 3 ways to get points. First is from Communication. Second is from Documentation. Third is from Programming. In communication, it is split into two branches. One is synchronized communication, such as verbal chat or text chat. The other is asynchronized communication, such as comment system or online forum. Synchronized communication brings more broad topics, but asynchronized communication focuses on one specific topic [35]. Students can get points from either ways of communication. During synchronized communication, because it happens naturally, so the points are counted by time. Asynchronized communication points are counted by sentence or text line.

In Documentation, it consists of any paper work, like brainstorm skeleton, presentation or report during the project. Documentation is the description of different ideas and project summaries. It is an important part in the project and explains and helps others to understand the project. For documentation, students can also get points by pages.

In Programming, as it is the most important part and the essence of the project, it is counted in gamified system as well. By following a good programming habit, no matter what kind of programming language students use, the rule is to give points for each line. By reflecting the

gamification principle, students can get points as rewards to encourage and stimulate them to do more activities which related with the project.

eXPerience bar system. In XP bar or visible progress indicator system, they're basically as same as the points system. However, XP bar could change the meaningless points collection into visual graphs and then illustrate the status to the students. With the visualized graph, students can understand the points better.

Visible progress indicator in the system, it turns points into measuring progress. If the users just get the points as a measuring standard and a terminal checkpoint as one level destination, they might not sense the grading system and the big picture behind it. Instead of giving them some untouchable conceptual numbers little by little, visible progress indicator could manifest the overall outline and constantly upgrading and showing the progress for the user. Experience bar is continually growing, the user can feel increments piece by piece. In addition, the student can feel his or her own action value by progress indicator.

Because of unknowing points of the whole project, it is hard to give the percentage in visible progress indicator. Instead, the gamified system gives unlimited progress status according to the points that students earned.

Level system. Level converts the long-term aim into short-term, easily achieve and multiple small segment aims. and it is also working with points system simultaneously. For example, the user needs to achieve 10000 point as a whole. It is difficult to achieve if it is just like a whole mission. But it can be split into small piece and completable goals. Like 500 points as the first, second 1000, third 1500, etc, each level is a little harder than the previous one. This makes the meaningless 10000 points into several meaningful operational steps. It gives users feedbacks and rewards and engages them to do this.

In our system, the levels are split into small segments based on points system. When the project starts, all student are at the same level 0. Along with the points cumulation, students reach the checkpoint of next level, then to get an upgrade.

Badges system. Badges are other kind of elements in gamified design. They are for rewarding and encouraging users. For each badge usually students can only get once during the whole project. It's a meaningful honor and also it's a milestone. Badges are permanently owned by the student.

Badges system is working related with behavior changing. The badges system has strong connections with the points system, although badges system has its own running rules. Badges system consists of different kinds of badges, which contain different functions and different purposes. Badges mean the achievements that the user earns in certain skill area. However it also has another meaning is that to surprise the user who has completed some achievements which with special meaning. It is a way to motivate users to keep using the system, as well as to get more badges.

Badges have three main purpose in teaching and learning: design learning path, change behavior and motivate. Proper designed badges can lead students into the right direction of learning without missing focus. Students always know what is the next goal or several goals simultaneously. By collecting badges, student's behavior can be changed, due to repeating. Earning badges is not simple, students have to follow pre-designed pattern to shape their behavior. Earning badges through the whole learning phase and with the comparison of other badges owner can bring motivation related with the badges system[13].

As same as the point system, badges system contains three different kinds of badges: communication badges, documentation badges and programming badges. Due to it is a prototype system, there are only 3 different badges in each aspect which described as different levels. To motivate students, when they earned a badge, there are correspondent points to get as rewards.

Leaderboard system. Leaderboard system is a sorting mechanism by how much resource does the user get based on social relations in the system. By using this students can monitor their individual information and meanwhile can also check other user's progress and status[16].

Leaderboard allows students directly to interact with others. The leaderboard system shows students' names, points and progress information in general. To bring more competitive factor, leaderboard lists the ranking tendency of each student.

To use more cooperative factor in the design, as well as to avoid "one man's hero". Leaderboard also ranks the points that each group from all of those three aspects. At same time, to balance the competitive factor and the cooperative factor.

Gasification elements and mechanics connection. In our system, feedback mechanic can be found in many aspects. People can feel feedback through different tasks. The most used element is point, people can earn points by finishing tasks.Visualized progress bar is also a mode of feedback. Using level as another kind of feedback can give people continuously engagement. For example, people are able to do tasks, ask questions and write comments, all of these activities would get feedback naturally and motivate people to repeat doing it.

In our system, badges are mainly used as rewards. People can get badges when doing tasks, repeating tasks by several times. People can also get extra points as rewards when they get the designed badges. Extra points can help people ranking higher on the leaderboard, as well as motivate people to get them.

In our system, people can earn points by finishing different predefined tasks. The gamified system can automatically set up a daily challenge with points. People need to get certain points to win the daily challenge by doing tasks and the results can be shown on a challenge leaderboard. This daily challenge can improve people's engagement and give a better experience, as well as encouraging people spend more time doing activities.

In our system, the form of competition exists mainly using leaderboard. There are two kinds of leaderboards, one is for each person, the other is for each team. According to the activities that each person did, those activities turn into points and show on the leaderboard as rank mode in order to motivate people. As encouraging more positive behaviors, other different

kinds of leaderboards can be added. There is team leaderboard to strengthen the cooperation among team members as well.

In our system, the similar cooperative mechanic is adopted. There is an ask, answer and comment section in the system to encourage people doing more cooperative activities. People can earn points from doing these tasks. The cooperation is not limited among the team members, all the people that related to the project can also participate. The people who know the knowledge can help the people who do not know to complete the common goal, the project. Hence, it is a cooperation mechanic creating a win-win situation.

Game properties and win rules. Like people should obey laws all the time in society, so every game also has its own rules, gamified system is not an exception. Rules allow the mechanism to conduct by the ideas of basic design. They also define who can be rewarded and who can be punished in gamified system. By understanding rules, “players” should know what behaviors are encouraging in the gamified system and what behaviors are forbidden in it as well. In other meaning of the rules is to guide the “player” to complete the playing in the gamified system. Good rules can let the “player” always stay in the “flow”. This could make “players” always feel the fun, it’s also one of the standards to tell if it’s a good design.

There are some basic rules description that are used in the system and the rules contains 6 parts and very simple:

1. how to win: most points
2. who can take part in: students
3. how to collect resource: get points
4. achievements: badges, levels
5. goals of gamification: knowing individual progress
6. time: project period

5.3. Introduction and gamification of Github

Github[82] is a web-based graphical interface, desktop and mobile distributed version control and source code management service based on Git. Git is an open source version control system, which was created by Linus Torvalds, who also is the founder of Linux. Github allows developers to control different versions and keep them easy to manage. The basic idea is when developers are creating a project, the changes keep coming out, github manages those differences and keeps those modifications to make the versions straightforward. It is also allowed developers to collaborate, like download an old version, upload a new version, make changes and share with others to make it easy to use.

Github consists of three main parts or functions: Repository, Issues and Wiki. A repository is the place where all the files of a project located. Repository stores all related files of the project and developers can have more than one repository under one user account. In repository, developers can create new repository, change files and commit changes.

Issues is a good way to track the code and talk about the bugs and problems. It has so many features that can collaborate, assign and label anyone who works for the project. It also makes group members focusing on the topic that they are discussing. The benefit of issues is that allows developers share and discuss with others inside or outside the group, cooperate and interact with them.

Wiki plays the documentation part in Github. It is the key section for the people who want to learn, know, maintain or update the project. It also record the project information for the developers that for later using. In wiki page, users can easily add, edit, modify the content and even trace the history. With these features, managing documentation is not a heavy task.

Based on the survey result, in distributed repository tools, Github is the most well known platform. It has so many features that mentioned above, however only few students use this repository tool. Github is a good tool for software developing but students do not have the enthusiasm to try it. It is assumed that with gamification mechanics, Github might increasing the number of users in group projects.

As a practical element and as well as the platform is going to be gamified, the Github gamifying process in real world need to be described and simulated. Also in order to demonstrate the progress of each student's contribution, the functions in Github need to be converted into visible format for the students. According to the introduction of Github, storing and modifying code are main parts as repository and commit. Issues and wiki are for discussing problems or questions and documenting files separately. Each function in Github can find corresponding gamification mechanic and component. Figure 15. shows how the functions in Github convert into points under the rules.

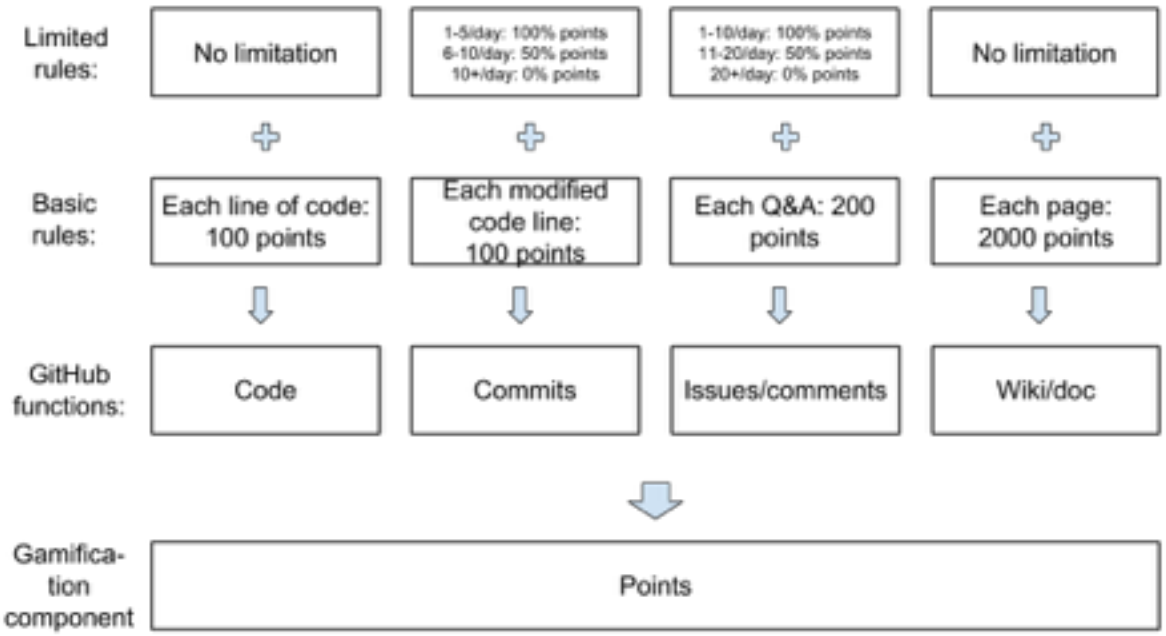

Figure 15. *Points description*

Table 9. demonstrates different levels in gamified Github system from Level 1 to Level 7 with needed points to get the current level and cumulative points in total. Student can get higher level with the same rule, which is the next level is 500 points more than the current level.

Level	**need points**	**cumulative points**

Level 1	3000 points	3000 points
Level 2	3500 points	6500 points
Level 3	4000 points	10500 points
Level 4	4500 points	15000 points
Level 5	5000 points	20000 points
Level 6	5500 points	25500 points
Level 7	6000 points	31500 points

Table 9. *Levels and points needed (from level 1 to level 7)*

Badges can be gained through repeating tasks. Table 10. shows the badges names and meanings in gamified Github system. The three ways to get badges are from code, comment and document, which related with programming, communication and documentation in group project. In addition, there is an extra way to earn another kind of badge, helping or answering other students which inside or outside the group.

Badge	**Meaning**	**Bonus**
2C	2 lines of code	500 points
100C	100 lines of code	5000 points
10kC	10000 lines of code	10000 points
1Q	1 comment	500 points
10Q	10 comments	1000 points
100Q	100 comments	5000 points
1P	1 page of document	1000 points
5P	5 pages of document	5000 points
50P	50 pages of document	10000 points
1H	1 help	500 points
10H	10 helps	1000 points
100H	100 helps	5000 points

Table 10. *Badges in gamified Github*

The gamified system can be used for students group project by the following example. As the Figure 15 illustrates, each function in Github can be used and the results can be converted into points by basic rules and limited rules. Like, one student writes 30 lines of code and 5 comments by the end of the day. So according to the rules, he can get 5000 points with 2 badges bonus points and upgrade to level 1. On the next day, the student just writes 10 lines of code but answers 3 questions from other students, so he gets 1600 points. The total points he has now is 6600 and he can upgrade to level 2 according to the level rules. Other students in this group project can do the same or similar tasks everyday to get points, upgraded and badges. Their individual progresses results are shown by the visible progress indicator or experience bar and ranked by leaderboard. It is assumed that by using the visible progress bar and other gamified methods, the students status can be checked by each other and the students themselves can be motivated by gamification mechanics. Figure 16. shows the simulated results which from 12 users using the gamified Github system. From the figure, it can be seen that every user has their own data from the project and every user can check other's status from the visible progress indicator.

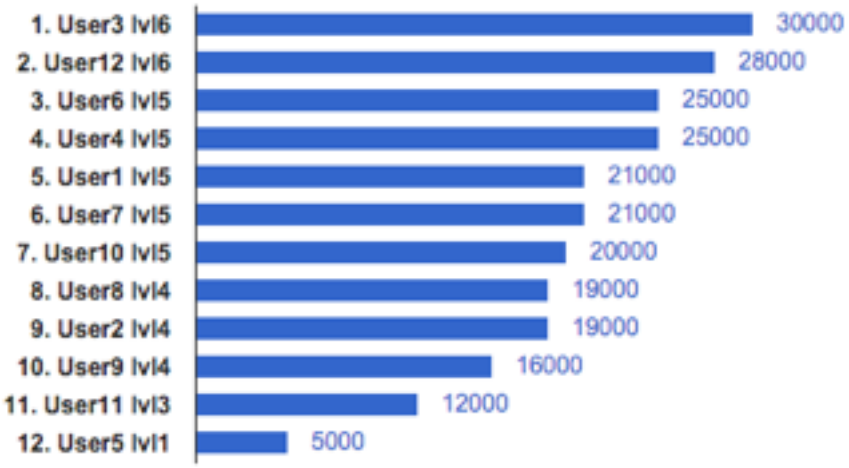

Figure 16. *Simulated results*

5.4. Theoretical evaluation

Due to the limited time and resources, the prototype system need to be implemented by practical work in the future by the same mechanism. In this thesis we propose a simple way

to examine the gamified system, board game type can be used in the test. It is a manual way to do the experiment instead of the digital way. In the manual experiment group task, a paper sheet is used as a game board. The visible progress indicator can be printed. Points and badges can be marked. Individual leaderboard and player's name can be shown as well.

The group task can be defined as multiple people coding task. To observe people's group task behavior as well as individual behavior, students can be divided into groups, each group contains 3 to 4 people to accomplish this task. During the task, group members can pick single role to finish the task or pick multiple roles as well. Game rules are simple as described in the gamified Github section. Points and badges can be earned by doing programming tasks.

It is assumed that the main found is the connection between visible progress indicator and motivate participants. Participants should notice the progress either from themselves or from their groupmates or other groupmates. The interactions should be increased. Points should be noticed as well by participants and will be able to influence participants as an aided factor with visible progress. Badges and levels should also stimulate participants in some points based on visible progress bar.

It is assumed that visible progress indicator can encourage and motivate participants during the group tasks. Participants can notice the progress either from themselves or from their groupmates or other groupmates. There will be interaction and communication happening during the group task. And visible progress bar can increase interaction (face to face) and communication (verbal) during the group task. Checking visible progress frequency can be described as a indicator of how active is the group project.

Points can be noticed as one of the gamification elements. It is assumed that points are able to influence participants during the group project, especially motivate students. Due to the manually reason, the points will be running as an aided factor with visible progress. When participants check the progress, they also check the points to get more details. Badges and levels work in a different way that related with visible progress bar, which also motivate

participants during the group project. Participants will have more energy to do task when they will get a new badge or upgrade to a new level, which means badges and levels are able to stimulate participants in some points based on visible progress bar.

Leaderboard can be noticed during the task process with participants. It is a ranking indicator to give students a individual comparison that brings more competition between them as well as motivate them. Group factor can show cooperation between participants during the task. Also group factor can create connections with visible progress thus gives more communications. This may need more time to observe.

5.5. Discussion

Gamification elements are including points, levels, XP bar, leaderboard and badges. Points are the basic value standard in gamification system. XP bar shows the user's process status. Normally XP bar and points are combined together in gamification systems. Levels break long-term goal into short-term goals. Badges are rewards of honor and milestones for users. Leaderboard is a sorting system that related to social elements that arranges user from high to low. In logical design, each gamification element correspond to each mechanic that mentioned in chapter 4. A distributed version control tool -- Github as a test environment is gamified combining with gamification elements and gamification mechanics. In order to avoid pitfall in the system, the limited and logical rules have been created. At last a theoretical evaluation result is described for future practical experiment.

6. CONCLUSION AND FUTURE WORK

In this thesis, it is found that collaborative learning in group project could benefit students in learning activities. There are some main characteristics that have been found in collaborative learning field as follow: collaborative learning are able to improve studying performance, teamwork skills and tools using skills, also communication, interaction and collaboration behaviors that can be discovered among group members with different levels. In addition, collaborative learning in group task can be used in the same location or different locations.

It is identified that there are still some problems within group project or collaborative learning. Poor communication and lack of cooperation are the most two common problems with group project students. Unfair divided workload and unequal contribution happens in the unsuccess projects as well. There are less collaborative activities in the unsatisfied project. There is a need of group project students to have a visible progress indicator, so the projects could have high level collaborations.

Gamification mechanics that include: challenge, feedback, reward, competition and cooperation can motivate people in group project. These mechanics engage, encourage and inspire people to do things. Gamification elements consist of the foundation of gamification, which contain points, experience bar, leaderboard, levels and badges. These mechanics and elements with corresponding rules build an entire gamification system that gives another way to solve the problems that mentioned before.

From the hypothesis of manual experiment using gamification within a group task, it is assumed that visible progress indicator is able to motivate, encourage students in group tasks in certain circumstances (under gamification rules). Points, badges and levels can be added into the experiment as aided factors. For the future study, this manual experiment should be conducted in a practical way on Github platform to test if it can improve efficiency and solve the problems in group project.

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