

Learning Analytics and Perceived Experience of Gamifying Homework Assignments

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Abstract: The purpose of this research is to assist the primary school students to complete their homework assignments, and understanding students' interpretation of gameplay experience and defining their satisfaction with gamification elements while playing online homework assignments. The implementation of the gamified homework followed the instructional design processes. The subsequent evaluation from a cohort of students comprised learning analytics besides surveying students' experience. The results indicated that they were satisfied with completing the homework with the employed game design elements where they were active and focused. In addition, they showed a tendency to challenges that involved in the treatment. One of the more significant findings to emerge from this study is that the micro gamification design approach has promoted the perception of motivation and enjoyment to take into consideration the design principles of the approach.

1 INTRODUCTION

Technology Enhanced Learning (TEL) constantly encourages new learning methodologies by using emerging applications and approaches as the foundation for this type of development. Gamification is one of these promising applications which motivates learners to achieve the learning objectives. More recent attention has focused on the provision of gamification applications in different fields (Çeker & Özdamlı, 2017). Thus, gamification is a multidisciplinary field which has the most portion of literature in Information and Computing Science and Technology, and Education (O'Donnell et al., 2017); (Kasurinen & Knutas, 2018). Gamification could help students for achieving complicated tasks with using proper strategy and software (Çeker & Özdamlı, 2017). There are many reasons to use gamification in learning that include making the hard work and tasks more enjoyable, increasing participation, satisfaction and motivation, and satisfying learners' needs and help them to be active learners (Çeker & Özdamlı, 2017).

Recent developments in gamification have heightened the importance of understanding the method of gamifying an educational activity in specific context besides the impact of gamification elements including game mechanics and dynamics (Dichev & Dicheva, 2017). The literature also recommends conducting more empirical research to prove the effect of gamification and learning performance by focusing on the effect of specific elements (Ortiz-Rojas, Chiluíza, & Valcke, 2017). Given these concerns, gamifying the homework assignments is one of the interesting topics which seeks to make the homework enjoyable for encouraging students to achieve it by applying gamification elements with different kinds of assignments. The research results revealed that students were enjoying the homework using gamification elements in the web-based homework (Goehle & Wagaman, 2015). Gamifying homework through using online platform had a positive impact on student motivation due to receiving feedback on their homework (Butler & Bodnar, 2017). Gamifying homework, in general, had positive findings for

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increasing the motivation and engagement of students to overcome the boring homework assignments through using this novel approach.

This research is a third iteration of detecting and tracking the results of gamifying homework where we figured out the positive impact of the last iterations (Metwally, Yousef, & Yining, 2019). We seek in this research to recognize students' perception and identify their satisfactions of game elements when gamifying homework assignments online in an attempt of deep understanding of gamifying homework investigation. We introduce the micro gamification design approach as a novel design approach for gamifying learning assignments. This research contributes to the current body of gamification literature in education by investigating and evaluating students' perceptions and experience of achieving gamified homework. This research also allowed us to analyse the homework completion, students' achievement analysis regarding the awarded points and badges. In addition, it gives an insight into the design considerations through approaching a micro gamification design.

Along these lines, the present research was examined the following research questions:

- What is the completion rate of gamified homework regarding the final score and number of students?
- What are students' achievements of gamified homework regarding the total score and badges?
- What are students' feedback on gamified homework on the platform?
- How do students perceive gameful experience in the gamified homework assignments?

These are the main research questions seeking answers through the implementation and evaluation of the intervention. Evaluation results give positive indicators to all four questions, denoting a strong potential for the effect of gamifying homework.

2 BACKGROUND AND RELATED WORK

2.1 State of the Art

Over the past few years, there is a growing set of contributions in gamification research. "Gamification is not just a technology but also a methodology which some organizations adopt as a way to increase motivation" (Dichev & Dicheva, 2017). Gamification

has been implemented in business, health, crowdsourcing, and other fields including education. The vast majority of gamification research is located in education (Koivisto & Hamari, 2019). Gamification had positive effects on the engagement of elementary school students (da Rocha Seixas, Gomes, & de Melo Filho, 2016). It also has a positive effect on student motivation and attitude changes (Dreimane, 2019). However, it should be used with carefulness. Although using extrinsic rewards could help for promoting the motivation, it could harm and minimize intrinsic motivations and affect individual motivation (Busarello, Ulbricht, Fadel, & Andiará Valentina de Freitas e Lopes, 2016). Thus, "Extrinsic reward systems work for nonintrinsically engaging activities method". (Werbach & Hunter, 2012).

Regarding the game elements, the published literature reported the most used game elements which are: badges followed by leaderboard, point, level, besides rewards and achievement whereas other game elements rarely used like quest, progress bar, avatar, challenge, narrative (Sümer & Aydın, 2018); (Peixoto & Silva, 2017). Even so, there is no full agreement on the positive outcomes of points, badges, leaderboard which depend on the way of applying these elements (Tenório, Reinaldo, Góis, Lopes, & Guataçara dos Santos Junior, 2017). Furthermore, the effect of leaderboard found different views in virtual learning environments and has been stated negative consequences in a higher number of studies (Tenório et al., 2017). Regarding the objectives of using gamification in education, it is obvious that engagement, motivation and involvement were the most targeted objectives while the literature encompassed other objectives like support, promote the interaction, increase satisfaction, behavior changing (Peixoto & Silva, 2017).

The finding tried to recognize the effect of the gamified homework regarding the gamification elements; however, there is a need for more investigation of identifying the affordances which have a specific effect, and the reasons of particular game elements effects as extrinsic or intrinsic motivators in a specific context (Koivisto & Hamari, 2019); (Mekler, Brühlmann, Tuch, & Opwis, 2017). Consequently, Future studies could search the effect of mediated variables like learning styles and evaluating the perceived experience regarding these variables which would open a new direction to propose new design approaches. Studying goal types like specific, difficult weather will be the same in a gamified environment, single or multiple goals (Landers, Bauer, Callan, & Armstrong, 2015), especially with the homework activities.

2.2 Gamifying Homework

Homework is one of the crucial aspects of promoting the learning process. Assigning homework exercises for students intends boosting the learning experience and supporting the behavior changes. The education practices nowadays refer to the perceived negative attitude of the homework because it is not interesting for students and they feel bored when they have to complete it. Gamifying homework is one of the effective strategies of dealing with this problem. Achieving the homework assignments is interesting if the homework is formed as a game with using gamification elements and game design techniques. Gamifying homework is the process of implementing gamification elements and game design with homework exercises and learning assignments for helping learners to enjoy doing their homework. This way, there are promising endeavors concerned applying gamification and investigated the impact of using gamification and game design elements for completing homework assignments. Implementing gamification for homework of primary school students promoted satisfaction, behavioral intention and intrinsic motivation positively, and students felt enjoying when they completed their homework (Metwally et al., 2019). The gamified homework of university engineering students through an online gamification platform made them feel empowered, interested, and motivated besides they found it useful to their learning and for accomplishing the assigned tasks (Kulhanek, Butler, & Bodnar, 2019).

Regarding gamification elements in homework, levels and achievements in online mathematics homework supported students to focus on their goals of accomplishing assignments and tracking their level and achievements with the feeling of enjoyment (Goehle, 2013). Badges in the online homework system were useful for undergraduate students to submit their homework before the deadline (Uanhoro, Young, & Lin, 2016). In addition, achievement badges motivated computer science university students in some aspects of their behavior when they completed their homework exercises (Hakulinen, Auvinen, & Korhonen, 2015). Gamification elements like experience points (XP), leaderboards, badges, levels, achievements, progress bars, and awards have been used in a gamified homework portal for engineering students which was designed around quests, the results referred to the gamified environment had an impartial impact on students' academic motivation towards homework, and the platform enforced student motivation due to receiving continued feedback on their homework (Butler &

Bodnar, 2017). Using different gamification elements in the homework context contributed to improving homework completion rates and increased the motivation to achieve it. However, examining its impact by tracking and analysing the data sequentially and thinking of new design approaches to overcome the lack of common approaches are worthy matters. Thus, this research seeks to recognize students' perception and identify their satisfactions of game elements when gamifying homework assignments online and identify the most useful elements when applying with homework of primary school students.

3 METHODOLOGY

This research is derivative from broader research that aims at investigating the impact of gamifying learning activities and forming the best practices of instructional design processes in an educational context. Quantitative and qualitative methodologies were applied to understand the users' experience and perception of applied gamification in their assignments. Formative evaluation research was implemented which is a kind of developmental research for designing instructional practices or processes (Reigeluth & Frick, 1999) due to the iterative nature in this research for investigation and evaluation of game elements according to students' perceptions.


3.1 Setup

This part concludes the research setting of achieving gamified homework experience on the web. The process of gamified homework begins with selecting a unit of the English course of the sixth-grade primary school.

3.1.1 Instructional Design

We conducted preliminary procedures like analysing the content of the unit from the student's textbook, searching on the web for the educational resources which would be useful for setting different kinds of the questions and coming up with creating interesting types of the questions to fit the innovative design, and asking the English teacher for the homework assignments. There are a variety of questions types to reflect the required English skills that include listening, writing, reading skills. Thus, the homework has been formed into main exercises which are a reflection of the unit construction to include

Table 1: The instructional design scenario of gamifying homework.

Exercise Name	Question Type	No. of Questions	Level of Difficulty	Points (Total)	Level	Badge
Conversation time	Multiple Choice	4	Easy	20	One	

conversation time, listening time, word time, focus time, practice time, and reading time. We developed a new form of gamification scenario to be used for gamifying homework exercise which encompasses the instructional design of homework and the related game mechanics as shown in table 1. In other words, gamifying homework entails defining the exercise name which likely concerns on one skill, question type, number of questions, the level of difficulty to set the equivalent number of points, the total number of points, the level name, and the badge. We proposed and implemented a novel design approach which is “Micro Gamification Design Approach”. It is a proposed approach for designing gameful experience resulted from our efforts in previous iterations and the observation of students’ behavior and their feedback. We opt for the short player journey and the simple task with a specific objective and reward mechanism that encourages students to achieve many tasks with a passion for achievement and motivation (Metwally, Yousef, & Yining, 2020, in press).

3.1.2 Setting

For executing this experience, we adopted an online gamification platform “Seppo” which is an innovative tool for creating educational games and designed to help the instructors to create the game tasks and develop gamification experience for their students. The gamified homework on the platform consisted of nine micro gamified exercises distributed into four levels where students were advancing their level when they answered the exercises. Students were able to use the mouse and keyboard to navigate the gamified interface which inspired from a famous game (see figure 1).

They used mobile devices to log in and answer the homework. There are convenient sets of gamification element were implemented such as points, badges, leaderboard, time constraints, challenges, progression, chance, locked items, mission, and win state, as shown in table 2. The initial test has been conducted by inviting researchers and English teachers to log in and try using the system for collecting their feedback on the design and the ease of using the system. This test aimed at tracking any

Table 2: The game elements list.

Elements	Description
Points	Refer to the score which used to measure student’s performance after answering the exercise. Obtained as a reward for achieving goals.
Badge	Kind of visual feedback to praise the student’s specific actions if they gained points or completed their homework under different conditions to reward them.
Level	Gradual systems for the player to obtain new advantages as they advance. Mastering new advanced level represents the progress toward achieving the goal.
Progression	The visual map to recognize to what extent the student completes the homework.
Challenge	Advanced exercises that require more concern and skills to be answered correctly.
Chance	The function enables students to try again to answer questions in case they answered wrong.
Time Constraints	The limited time to answer some exercises like a countdown timer.
Locked Items	Items need action for unlocking such as the exercises that require typing the code to open.
Scoreboard	Shows the performance of every student available to others and is useful to maintain competition among students.
Feedback	The message that shows the result of the student’s response when answering the exercises to indicate whether it was right or wrong.
Gameboard and Game World	The element which has the context or story encompassing all the assignments and enables to move and explore the experience like the interface that appears after logging in and includes the homework exercises.
Win State	The state upon completing all the exercises and the feeling of accomplishing the homework with receiving a prize.
Mission/Goal	It means having a clear goal to complete the assignment, for example, answering all exercises, collecting points and badges to achieve the mission.
Increasing Difficulty	The gradient in the level of questions difficulty. The easy questions in the beginning then increasing the level of difficulty.
Notifications	That appears after answering the questions and getting points or badges to notify the student.
On-boarding/ Tutorials	Gentle introduction and instructions of playing for completing the assignments and using the other game elements.

possible errors during the use. We created accounts for the participants and invited them to log in to the platform where they can complete their homework with using the gamification elements.

3.2 Participants

Before running the research implementation, we obtained consent from the students' parents and their teachers and informed them that the collected data would be anonymous and secure, and they are free to withdraw from the experiment at any time. After obtaining informed consent, the treatment has been conducted with 14 valid responses of sixth-grade primary school students making the study's sample size $N = 14$.

3.3 Instrumentation and Data Collection Tools

Based on the research objectives, the data collection tools investigated the quantitative and qualitative data the data were gathered via the archived records of student's activities on the platform with a detailed analysis of the completion rates of homework exercises. Furthermore, a quick survey on the platform used for realizing students' feedback on gamified homework on the platform. To evaluate students' perception and experience of gamified homework, and identify their preferences of gamification elements, they were asked to answer an online self-reported questionnaire divided into two sections where the first section focused on gamification elements and included questions related to their perceptions of using the gamification elements with a 3-point visual scale ranging from happy to sad to describe their satisfaction and feeling of doing homework. The second section focused on the reflected experience of using the platform included open-ended questions for clarifying the positive aspects of the gamified homework, and whether they had problems or recommendations for the future enhancement, adopted from (Yanfi, Udjaja, & Sari, 2017). All participants data were kept maintaining anonymous and confidential.

3.4 Procedure

After obtaining approval from the participants and their parents, the researchers hold an introductory session for the students to introduce the platform and give the instructions of logging and using the elements besides the possibility of previewing the full instructions after the logging. We asked the students

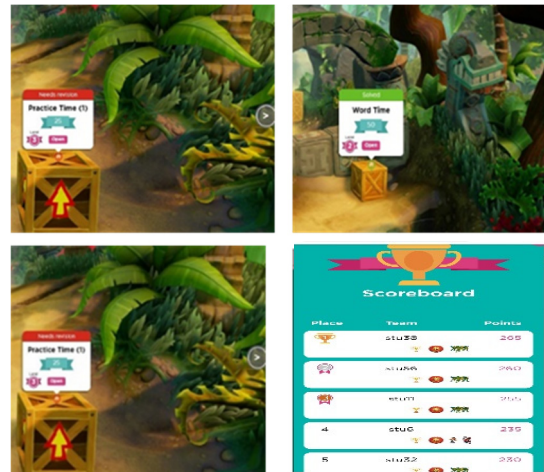


Figure 1: The interfaces of gamifying homework.

to log in on the platform to answer the homework exercises by using their account from their personal computer or the mobile device. They can collect points and badges, preview and observing their rank on the leaderboard besides the other game elements. Students were encouraged to contact the teacher and researchers at any time through using the online chat on the platform if they faced a problem and need support. To identify their feedback for using the platform, they answered a quick survey appeared during they answer the exercises. After achieving the homework, we measured the students' perception of gamified homework through online questionnaire consisted of two parts. The first part tackled questions related to their perceptions of using the gamification elements with a 3-point visual scale ranging from happy to sad to describe how they felt about doing homework. The second part included open-ended questions for clarifying the positive aspects of the gamified homework and whether they had problems or recommendations for future enhancement.

4 RESULTS

The Evaluation methodology falls under three headings: learning analytics, students' feedback of gamified homework on the platform, and students' perception of gameful experience on the platform. The following sections will describe in more details the study findings.

4.1 Learning Analytics

Regarding the participants' activities of completion the gamified homework, of the 14 students, 9 (64.3%)

who achieved the gamified homework and rewarded (60% or above) of the final score at least (180 points of the total 300 points) where ($M = 178.21$, $SD = 82.48$). This observed finding refers to that gamification mechanics could be motivational affordance to push the students to complete their homework but does not guarantee academic performance.

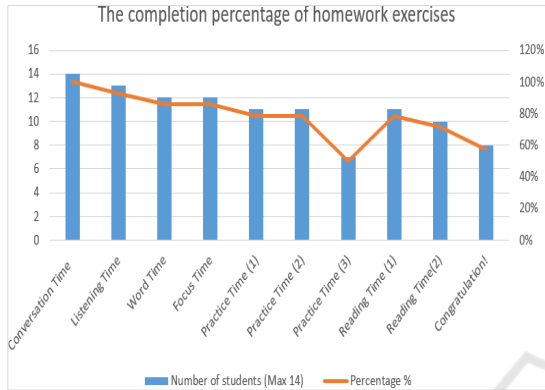


Figure 2: The completion percentage of homework exercises (N = 14).

Regarding the completion percentage as shown in figure 2, there is a slight drop in completing or submitting an exercise which is restrained with the time to submit the answer, for example, there are (7) students who completed the exercise which is constrained by the time count successfully while there are (4) students could not submit the answer before the ending time so the system did not reward them. The highest completion percentages manifested in the first exercise which could be interpreted as this exercise is the first one on the board game.

Regarding the average points for every exercise, there is a significant difference between the average points and the maximum number of points of two exercises. The first one is the “word time” exercise which its questions were focused on new vocabularies that require more concentration to avoid confusion when answering. The second one is the time-restricted exercise “Practice Time (3)” that could reduce the points if the answers have not been submitted before the time ends as shown in figure 3.

Regarding the achievement of each student according to their rank on the leaderboard, there is a correlation between the total number of answered exercises and the total score which reached (0.93). Moreover, the correlation between the total number of answered exercises and the total number of badges (0.99), that indicates the consistency of operating the awarding system with the effort of accomplishing homework (see figure 4).

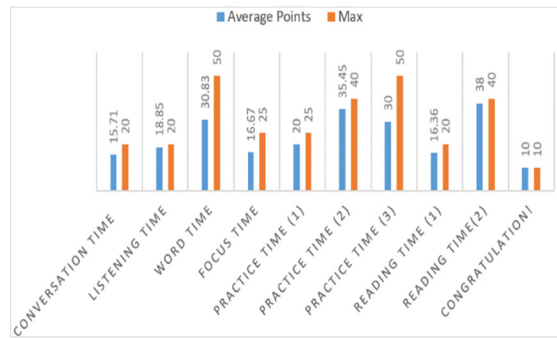


Figure 3: The average points of homework exercises comparing to maximum points (N = 14).

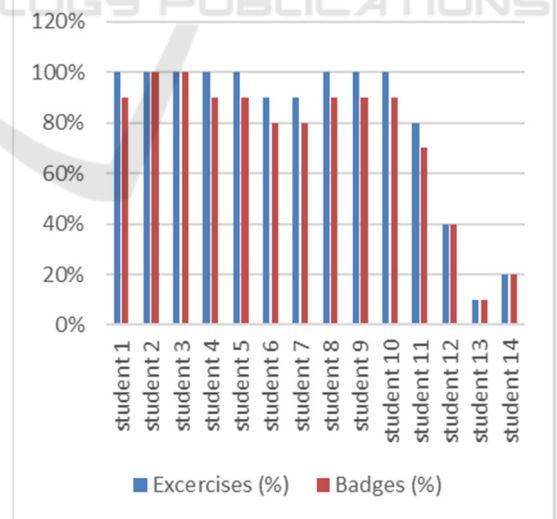
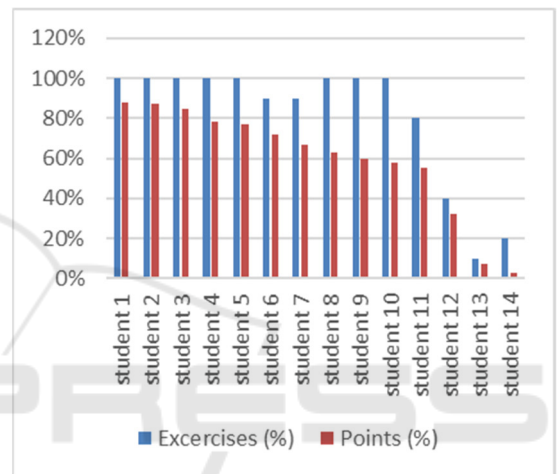


Figure 4: The achieved exercises regarding the total number of points and badges (N = 14).

4.2 Students' Feedback of Gamified Homework on the Platform

In terms of students' experience of achieving the homework assignments on the platform, the finding shows that the students were excited to use the platform for learning and accomplishing the homework exercises. They felt active and focused as shown in figure 5. The positive feedback from the students showed that the gamified homework on the platform was useful and they appreciated using the platform to complete the homework and learning where they felt active and focused as most aspects they appreciated. They enjoyed the challenges as the most feature they liked. We noticed that some students showed an overwhelming for competing others with the highest score on the leaderboard by trying to edit answers to improve their score. Overall, they liked learning and doing their homework on the platform with the challenging spirit and answering different kinds of questions. These features are not available when they used to complete the assignments in the traditional setting without using the platform. It has evidently appeared that the effect of gamification elements on enjoyment and motivation perception of doing homework.

4.3 Perceived Gameful Experience

To identify and confirm the research finding, and for a deep understanding of the individual gameful experience of students, we analysed the data of the self-reported questionnaire. Their response to the questionnaire gave us an insight of the gamified homework on the platform. Data has been gathered from students in five different schools in Egypt. The majority of students expressed their satisfaction of using the following gamification elements: points, badges, levels, progression, challenges, chance, unlocked items, leaderboard, feedback, board game, win state, mission/goal, increasing difficulty, notifications, and rule as shown in figure 6. They found these elements useful and enjoyable (Goehle, 2013), except one student who commented that badges and levels were not useful and enjoyable; however, student's response was happy. Progression was a motivated affordance to complete the homework, and the chance was beneficial due to the possibility of trying to answer again, as one student stated. There is no full agreement of time constraints element as it has been mentioned in a comment that the time was enough for answering the exercise unlikely it has been in the last iteration.

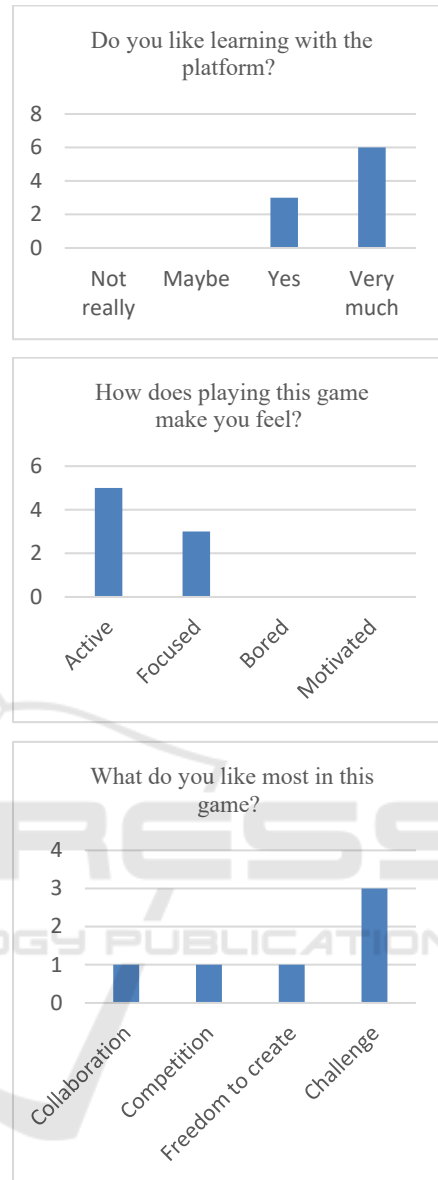


Figure 5: Students' feedback of achieving the gamified homework assignments on the platform (N = 14).

The qualitative result of students' comments according to the most things they liked in this experience, the problems they faced, their evaluation of the application and their recommendations for development were as a following:

They admired the gamified homework including the mentioned elements above especially the badges (Hakulinen et al., 2015), and the possibility of revising questions. The vast majority evaluated the gamified homework with the full mark, they defined the reasons for the given the score because it keeps away from feeling the boredom, they enjoyed

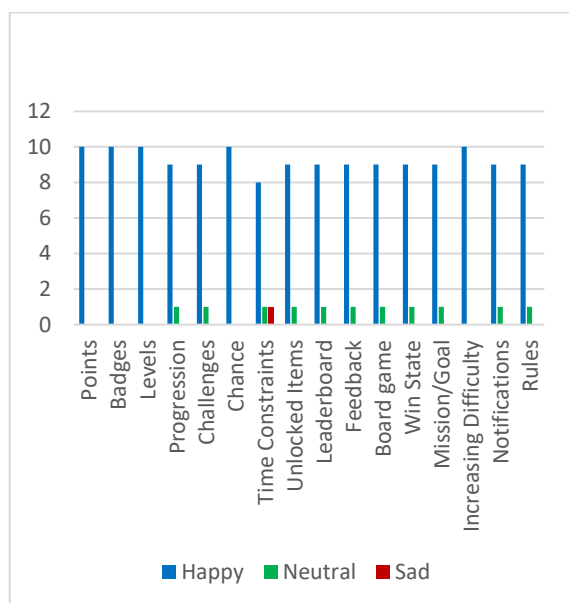


Figure 6: Students' satisfaction of gamification elements (N = 14).

learning English, and the homework covers different types of questions. Some students had an expectation of the gamified homework as a game but the concept of gamification still not clear in their minds. Therefore, the confusion could happen easily with predicting the same technics of the famous games as a game they can play.

According to the problems of using the application, they experienced the technical problems of the loading time. They recommended including different types of exercise with different board games, increasing the number of attempts for answering, and supporting the animation features. Below are examples of their comments.

"This apps is good"

"Yes, I like it. The learning is very well and I love it"

"The game is very good and the questions are easy"

"Yes, I liked very much. Badges were nice. I enjoyed doing the homework"

Furthermore, we were interested to hear the reflection of an English teacher about this experience through observing students' responses. The feedback was optimistic in general with praising the listening exercises and the time-constrained questions.

Competition questions played a role for motivating students, the interface design was attractive, and the leaderboard could support students' motivation but some students were eager to dominate the leaderboard that could distract their attention from the main objectives. The teacher appreciated the new design of the homework for this unit which is short and simple, that matches with the micro gamification design, and recommended involving the questions which require spelling new vocabularies. In addition, students prefer to use mobile devices to complete their homework due to the possibility of using it to open and answer the assignment on the way.

4.4 Discussion

Analysis of students' completion results and students' feedback on the gamified homework on the platform with the findings of the self-reported questionnaire discloses that the intervention has had a detectable positive influence on the perceived gameful experience, including their interest of the assignments (Pastushenko, Hruška, & Zendulka, 2018). The successful completion of homework assignments by the majority of students indicates that the use of gamification elements are feasible and influential for primary school students (Metwally et al., 2019). The user-friendly interface was well suited for the sixth-grade primary school. Usability of the application promoted students to use the app through the personal computer or mobile devices. A tacit advantage is that students have invested using mobile devices to complete their homework. Students achieved homework assignments with using the motivational affordances so it contributed to motivating but we cannot confirm the academic achievement as it seems does not have an effect on student performance (Goehle & Wagaman, 2015); which it depends on their efforts of studying. The time count element had a controversy effect with mixed results that clearly appeared in the exercises completion analysis, some students need more time to think of the answers and fail to submit, and other students have experienced this kind of questions so they submitted the answers before the time ends. It can be noticed in a student's comment when indicated that s/he submitted the answer, unlike the last iteration.

The optimistic results of students' feedback on the platform concurred with the responses of the questionnaire, they were active and focused on doing their homework. They addressed the challenges as the most feature they liked. It has been noticed with some students wanted to dominate the leaderboard for satisfying basic psychological needs. It refers to the

gamified homework promoted intrinsic motivation that touched the basic psychological needs: competence, autonomy, and relatedness (Ryan & Deci, 2000). Nevertheless, leaderboard as an element could carry possible unintended consequences (Osatuyi, Osatuyi, & De La Rosa, 2018); or negative implications (Tenório et al., 2017). Some students tried to edit the answers to improve the score not to learn from mistakes. Thus, this element found their well for editing the answers with limited attempts before showing the correct answer.

There are variances between students in completing the exercises due to their personality traits or the allowed time they were available to login however, their attitude was positive towards using game design elements in homework context. Using different types of elements instead of implementing one element in isolation may produce effective behavior and it could be explained according to conditioning theories that some elements motivate some learners but other learners may be better conditioned by other elements (Landers et al., 2015).

Interestingly, the propitious reflection of the design from teachers in accordance with the micro gamification design approach, the short exercises with immediate rewards meet the needs for the feeling of achievement.

5 CONCLUSIONS

This study aimed at understanding students' interpretation of gameplay experience and defining their satisfaction with gamification elements while playing online homework assignments. It seeks to introduce the micro gamification design approach as a novel design approach for gamifying educational assignments. The research developed the gamified homework experience in light of the instructional design processes to design and develop the homework assignments with associating the gamification elements. One of the more significant findings to emerge from this study is that the micro gamification design approach has promoted the perception of motivation and enjoyment to take into consideration the design principles of the approach. Research questions investigated through analytics and evaluation data refer to the completion of homework assignments, feedback, and perceptions of the gamification elements and gamified homework on the platform.

On the basis of the evaluation finding, it may be concluded that students were satisfied with completing the gamified homework where they were

active and focused. In addition, they showed a tendency to challenges that involved in the treatment. Most of the gamification elements found their interest like points, badges, progression, chance, levels but other element had a controversial effect like leaderboard, time constraints. Students preferred to use mobile devices for completing the homework rather than using a personal computer. They recommended including different types of exercise with different board games, increasing the number of attempts for answering, and supporting the animation features. The main limitations of the research are that the small number of participants which entails more investigation to increase the sample size and including other school grades which could open a new future trend to search the optimum gamification design for different grades. As a result, it cannot be generalized, so an additional investigation is required. It would be noteworthy for future research endeavors to examine the particular effects of the game elements in different settings to approve their feasibility.

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APPENDIX

Table 1: Exercises analysis.

Exercise	Students Status	Points			
	Answered	Total	Average	Min	Max
Conversation Time	14 / 14	20	15.71	5	20
Listening Time	13 / 14	20	18.85	5	20
Word Time	12 / 14	50	30.83	0	50
Focus Time	12 / 14	25	16.67	10	25
Practice Time (1)	11 / 14	25	20.0	15	25
Practice Time (2)	11 / 14	40	35.45	20	40
Practice Time (3)	7 / 14	50	30.0	10	50
Reading Time (1)	11 / 14	20	16.36	10	20
Reading Time (2)	10 / 14	40	38.0	30	40
Congratulation!	8 / 14	10	10.0	10	10

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