

The Use of Gamified Differentiated Homework in Teaching General Chemistry

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Abstract – This study is a classroom-based action research utilizing the pretest-posttest single intact group approach to determine the effectiveness of Gamified Differentiated Homework on motivation and academic performance of Grade 11 students in General Chemistry. The intervention uses the differentiated homework to address the academic needs of students with varying levels of readiness, and gamification through the use of Classcraft™. Integrating gamification and differentiation to homework helped students improve their motivation and academic performance especially during the challenging times in pandemic where students are bombarded with so many homework tasks with little to no support in other subjects.

Keywords – gamification, differentiated learning, homework, general chemistry, motivation, academic performance.

1. Introduction

The community lockdowns brought about by the COVID-19 pandemic caused not only major changes in how we conduct our classes but also forced us to use a widely debated and ‘contradicted’ teaching tool - the use of homework [1].

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But this predicament also gives us the chance to highlight the need to address the shortcomings in implementing homework as well as fortify its strengths. One way to do this is by gamifying the differentiated approach to giving and doing homework.

In the Philippines, the Department of Education (DepEd) introduced four modalities that can be adopted by schools: Face-to-face, distance learning, blended learning, and homeschooling [2]. Distance learning is further classified into Modular Distance Learning, Online Distance Learning, and TV/Radio-based Instruction. As all students are given learning modules regardless of their modality, they are all required to answer learning activities, which are the basis for their grades. As a module is designed to be accomplished for one week and all subject areas provide the students with learning modules, we could only imagine how much stress and anxiety the students are experiencing with so many tasks and requirements they need to accomplish while locked down in their homes: so much stress and anxiety that some students suffered mental health problems and took their own lives [3]. The Department of Education reminded teachers of DepEd Memorandum No. 392, s.2010, which limits the amount of homework or assignments given to students, to help ease the burden of the students and their parents as reports say that some teachers give additional tasks during weekends, aside from the tasks included in the students’ learning modules [4].

In this context, we saw the need to rethink how learning modules and homework should be designed and implemented to students. Learning modules as homework should not only meet the requirements imposed by DepEd as stated in the Most Essential Learning Competencies (MELCs), but also address the different learning capabilities of the students, scaffolding their learning towards more challenging tasks and not a “one-size, fits all” learning material, while being sensitive with their socio-economic status. It should also be fun and motivating, not just to keep the students engaged in learning, but also for the sake of their mental health.

This research paper intends to address the following problems encountered by the researcher: (1) the poor performance of the students in General Chemistry 1, (2) the lack of motivation of students in doing more challenging tasks, (3) the poor perception of students towards doing homework, (4) the short amount of time students spends in doing their learning modules or homework, and (5) the low homework completion of students. We suppose that gamifying the differentiated approach to homework can attend to these problems. We also believe that addressing these problems will not only help student learn chemistry more, but also make the delivery of lessons and homework more cohesive and effective, given the pandemic situation.

On Homework

Homework is defined as school assignments given by teachers for students to accomplish before or after school hours [5]. In his definition, Cooper pointed out that (1) guided learning done inside the school, (2) extracurricular activities, and (3) home study courses cannot be classified as homework [6].

Teachers have different purposes in giving homework to students. Epstein & Voorhis [7] enumerated the purposes of assigning homework as 10Ps: Practice, Preparation, Participation, Personal development, Parent-child relations, Parent-teacher communications, Peer interactions, Policy, Public relations, and Punishment. Homework can be designed by the teacher to carry out multiple purposes, depending on the intentions of the teacher. Minke [8] listed four purposes of homework which, in the viewpoint of the researcher, can be used in designing a teacher's classroom instruction: (a) Pre-learning, (b) Checking of Understanding, (c) Practicing, and (d) Processing.

Homework has been known for decades to improve the academic performance of students [5], [6]. But in recent years, the positive effect of homework on a students' academic performance is seen to be directly affected by the length of homework time [10] and the grade level of the student [11], [12].

Despite its benefits, homework has quite a number of adversaries because of the disadvantages of its use. These are: inability of homework to address diverse students' needs [13], [14] lack of sensitivity to students' socio-economic status [15], [16], poor teacher monitoring and feedback, lack of motivators to increase students' engagement [14], poor regulation on the quantity of homework tasks [17], and poor design and content [18].

At the end of all of these debates on homework, Gill and Schlossman [1] espouse in order to bring the most out of homework, one has to look at it without bias and try to reconcile its strengths and

weaknesses; making educational policies on homework based on empirical data but heeding the cries of students, parents, and teachers.

On Differentiation

Tomlinson [19] defined differentiation as "the efforts of teachers to respond to variance among learners in the classroom". When differentiating instruction for a diverse group of students, the teacher observe and apply appropriate teaching strategies to suit their different talents and learning styles [20]. The teacher also provides multiple options on how the students can access information, how they process the ideas they have acquired, and how they want to showcase what they learned [21].

As mentioned earlier that one of homework's shortcoming is inability to address students' diverse needs, incorporating differentiated instruction in the design of homework, is indubitably, the obvious solution. Teachers can differentiate homework based on the students' level of readiness, interests, and learning styles with diversified instruction elements like content, process, product, and learning environment [22], [23].

Studies have shown that differentiating homework or giving students options for the homework has positive effects students' engagement [24], [25] and academic performance [26]. But Heather [25] further added that when the difficulty of homework tasks is differentiated but no additional credits are given to those who engage on difficult tasks, students still tend to work only on easier tasks. To encourage students to take on more challenging tasks which can further improve their performance, gamification can be employed to motivate them.

On Gamification

Deterding [27] defined gamification as "the use of game design in nongame contexts". This definition was further clarified by Sailer et al. [28] by pointing out the four semantic components on which gamification is built: (1) game, (2) elements, (3) design, and (4) non-game contexts. These four components show gamification of education means: (a) non-game context like classroom activities become rule-based and goal-oriented just like games, (b) elements of games are embedded into classroom activities, such as rewards, tasks, ranking, etc., and (c) game elements are carefully weaved into the lesson to boost engagement of the students [29], [30], [31].

Several researches showed that using gamification in teaching students can improve their academic performance or achievement and attitude towards their lesson [30], [32], [33], [9].

To summarize, homework is a ‘problematic solution’ to students’ academic performance and motivation. By considering the strengths and weaknesses of homework and intentionally applying differentiation and gamification, homework can be transformed into a great instructional tool for teacher.

2. Methodology

The study is a classroom-based action research utilizing the quasi-experimental pretest-posttest single intact group approach consisting of 54 Grade 11 STEM students who consented to participate in the study. The explanatory sequential mixed method was used for data collection. Quantitative data consist of the students’ motivation and academic performance, and the qualitative data came from the focus group discussions.

Prior to the intervention, the Chemistry Motivation Questionnaire (CMQ II) was administered as pretest. The CMQ II was adopted from the study of Glynn et al. [34]. The Cronbach’s alpha of the questionnaire is 0.92. Students were further asked what problems they encountered in doing homework. Afterwards, an orientation on the use of Classcraft was conducted.

The online platform used to gamify homework, manage class activities and outputs was Classcraft™, which is shown in Figure 1.

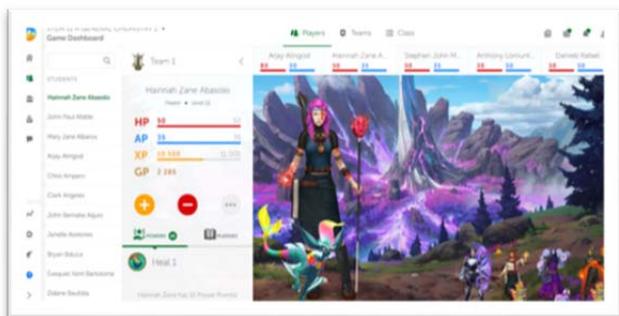


Figure 1. Classcraft Dashboard

▪ *Characters* - Students were allowed to choose among the three types of characters: Guardian, Healer, or Mage. Guardians have skills that can protect their teammates from damage and they have the highest HP among all other characters. This character is good for students who are struggling in class because if they fail to submit their homework on time, they exhibit negative behavior, or if they fail the formative test in the Boss Battle feature, their HP suffers greatly. Healers are for average students. They have moderate HP and they have skills that can heal themselves or their teammates when they lose HP. They can also revive fallen teammates. Lastly, Mages are great for students who do well in class. Mages have the least HP and this character could easily die if the student fails to submit homework on time or gives an incorrect answer in the Boss Battle,

but they have the highest Action Points (AP) which are needed to use skills. As the students accumulate Experience Points (XP) and Gold Points (GP), they can upgrade and personalize their character’s avatar to their liking.

▪ *Point System and Levelling Up* - Whenever students submit their homework or output, either early or on-time, or exhibit good behavior inside the class, they can receive Experience Points (XP) and/or Gold Points (GP). When a student reaches a set amount of XP, the student’s character will automatically level up. Levelling up can open more options for avatar upgrades and gives the students Power Points that they can use to pick a new skill for their character. These skills can be used to protect or prevent negative consequences or give students privileges inside the classroom. GP, on the other hand, is the currency used to buy upgrades for their avatar. Unfortunately, the teacher can only give GP to their students if they pay for a premium account.

▪ *Class Tools* - The Class Tools are a set of elements that a teacher can use to gamify their class. It includes Random Picker, Random Events, Kudos, Stopwatch, Volume Meter, Grade Converter, and Boss Battles. Of these tools, the Boss Battle is the one frequently used since it acts as the formative test in the platform. The teacher may select a student or a team to fight a certain boss by answering questions. Correct answers can inflict damage to the boss while incorrect answers can cause the student to lose HP, but can be avoided by using skills. If the boss’s HP goes down to zero, the student wins the battle and gains XP and/or GP. But, if student loses the battle and the HP goes down to zero, other teammates will also lose HP.



Figure 2. Classcraft Quests

▪ *Quests*- The main feature that was used in Classcraft is the Quest. It transforms the lesson and the activities into an adventure that the students can engage into to progress in the lesson and submit their outputs (please see Figure 2).

In this Quest feature, the teacher designed the lesson into a series of tasks that the students can accomplish in order to progress with the lesson. When the students accomplish quest tasks, either early or on-time, they gain a certain amount XP and

GP, which the teacher can customize depending on the weight of each task. The student then submits output here and the teacher directly gives feedback on these outputs.

Gamification was done using the point system, avatar, and quests in Classcraft. Differentiation was incorporated in homework by providing students with video lessons, online lectures through Gmeet, and printed modules for differentiated content. Differentiating Process was done by providing students with varying levels of difficulty in the Process Homework. Product was also differentiated by giving students the opportunity to choose which performance task they would like to submit. As for the learning environment, it was also differentiated by allowing them to choose whether to attend the online class in Gmeet, to watch uploaded video lessons in YouTube, and/or ask questions about the lesson through Facebook Messenger.

The lesson follows a certain format to cater the different types of homework. The students were informed that the only required task to accomplish was the Easy Practice Homework, but they may also answer the Average and Difficult Practice Homework if they want to in order to gain more XP and GP.

After four weeks, XPs and homework completion were recorded. These were used to identify the effects of Gamified Differentiated Homework on the students' motivation and academic performance. The Chemistry Motivation Questionnaire (CMQ II) was again administered to see if there was a change in the students' motivation. After processing and analyzing the data, a focus group discussion was conducted to explain and to triangulate the quantitative analysis.

3. Results

Students' Existing Problems Concerning Homework

The following were the themes drawn from the analysis of students' responses regarding difficulties concerning homework.

Too much household chores and school activities/tasks. Students said they were overwhelmed with school activities and responsibilities at home. They felt overloaded with tasks from their teachers simultaneously giving them a lot of homework, individual and group activities, and research tasks, sometimes with very short deadlines. Because of this, they tend to forget to accomplish some of them. This further worsens when they get home where they have to perform household chores, leaving them with too little time to work on their homework and other school responsibilities. Excerpts from students are shown below:

"I'm overwhelmed with the (school) activities, the responsibilities also at home."

"I was overloaded with a ton of homework, individual activities, and group activities that we cannot manage our time well so instead of having free time for resting, we tend to use it to do our homework instead."

The literatures [17], [18] mentioned about teachers giving too much homework to students and parents complaining that their child is no longer able to have 'family time' because of too much homework. It was as if the students were choosing between school activities and family time: either they work on one and neglect the other. But the survey revealed that the students were actually trying to make ends meet.

Time Management. Some of the students admitted that they have poor time management. As one student puts it:

"The most common problem I experience in doing homework is my lack of time. I am not good in managing my time, there are a lot of things that needs to be accomplish and sometimes the activity is difficult so, I can't finish everything on time."

They also wouldn't answer their homework at home and just play games with their friends. One student says:

"Don't [sic] have enough time because I spend most of my time in doing household chores and playing basketball."

And when they come to school, they would do their homework tasks inside their classroom, sometimes even just before the subject's period while asking for help from their classmates. Some also blame their teachers for their poor time management for giving them too much homework simultaneously and with a very short deadline, and the household chores that they have to take care of when they come home from school.

Unmet Learning Competencies and Vague Instructions from the Teacher. Students had negative experience in doing homework because of their teachers. Some teachers did not teach the lesson but gave a homework anyway.

"The homework is different from what the teacher discussed during the lecture time."

They also complained about not understanding the lesson and vague instructions about the homework.

"Not specific instructions, I get anxious that my work will deviate from my classmate's [sic]."

Lack of Motivation. Some of the students admitted they lose interest in doing homework. Some of the reasons they mentioned were the distractions from

playing games, their homework was not interesting, and they have friends that they can rely on for their homework.

“The common problem ... is I lose interest to do the homework and my time goes to playing and roaming.”

“I keep on relying with my friends that I know they will help me in answering my homework.”

Lack of Materials/Money Needed to do Homework. The students find it difficult to accomplish their homework because of poor or no internet connectivity. Before the pandemic, they had rent computers in shops for them to be able to research for their homework. Printing or buying the materials they need for their homework are also some of the difficulties that they experienced when doing homework.

“There is lot of problem that I encountered in my junior high school while doing my homework like lack of equipment and things that I need to do to finish my task and assignment.”

“Lack of resources or money.”

“My problem is where I will get the load to use in searching and also the materials, I need in order to finish the task.”

Students’ Performance on the Different Types of Homework

The students’ performance on the different types of homework were measured using the students’ average XP per type of homework during the four-week intervention. The highest possible scores that a student can get from all types of homework are as follows: 800 XP for both Pre-learning Homework and Checking of Understanding Homework and 1000 XP for both Practice Homework and Process Homework.

Figure 3 shows the Pre-learning Homework (PLH) and Checking of Understanding Homework (CUH) had the highest average XP compared to other types of homework (PLH = 537.5, CUH = 552.5, PraH = 474.25, and ProH = 358.25). But as pointed out by the students in the focus group discussion, the PLH was the easiest because they require them to define the terminologies. The Checking of Understanding Homework also had a high average XP because it was given immediately after the discussion, which they find it easy to answer because it is still fresh in their minds. On the other hand, the Practice Homework (PraH), and Process Homework (ProH) require higher order thinking skills (HOTS), making it difficult to accomplish.

“Usually in Pre-learning Homework, it’s more on definition of terms that can be easily answered

using Google. We exert more effort on Practice Homework because we want to try the average and difficult (activities).”

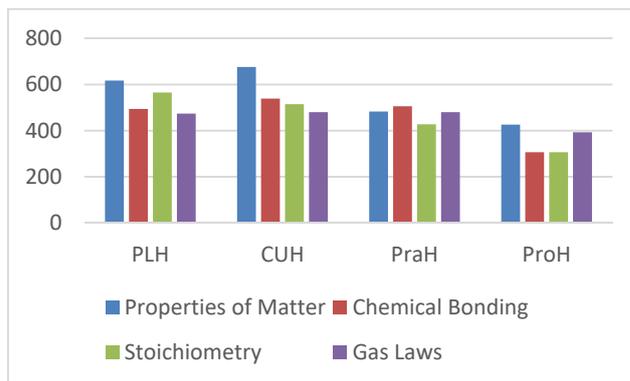


Figure 3. Average Experience Points per Type of Homework in Different Chemistry Topics

This implies that practice homework, and process homework should have bigger effect on the students’ grades.

Effects of Gamified Differentiated Homework

Students’ Academic Performance in terms of Experience Points. The effects of gamified differentiated homework on the students’ academic performance in terms of Experience Points that they have accumulated were studied using Friedman’s Test in order to see if there was a significant change on the students’ homework scores during the four weeks of intervention, as it was assumed that the more motivated the students are, the better their performance.

Table 1. Descriptive Statistics of the Experience Points per Topic

	N	Minimum	Maximum	Mean	Std. Deviation
Week 1 Properties of Matter	54	200.00	3200.00	2201.85	916.41
Week 2 Chemical Bonding	54	0.00	3200.00	1846.30	1095.40
Week 3 Stoichiometry	54	0.00	3200.00	1814.81	1026.89
Week 4 Gas Laws	54	0.00	3200.00	1825.93	1208.49

Table 1 shows the descriptive statistics of students’ homework scores per topic discussed in the 4-week intervention. The mean of week 1 is significantly higher than the other weeks. The Friedman’s test ($\alpha = 0.05$) showed that there was a significant difference between the four topics, $\chi^2_3 = 18.86$, $p = 0.000$, on the academic performance of the students

during the four weeks of intervention. To see which week the students showed the significant difference, Wilcoxon post-hoc test with Bonferroni correction applied resulting in a significance level set at $p=0.0083$ was conducted. Table 2 summarizes the result of the post-hoc test.

Table 2. Summary of Wilcoxon Post-hoc Analysis for Students' Experience Points

	Week 1 Properties of Matter	Week 2 Chemical Bonding	Week 3 Stoichiometry
Week 2 Chemical Bonding	0.001		
Week 3 Stoichiometry	0.000	0.699	
Week 4 Gas Laws	0.001	0.856	0.986

Yildirim [33] suggested that gamification can positively affect the academic performance of the students, which means that we should expect a significant difference in the academic performance of the students between the initial week and the fourth week of intervention implementation. But the Wilcoxon post-hoc analysis revealed that the first week of implementation which covered the lesson on Properties of Matter consistently had the significant difference compared to the other weeks. This shows that the students were highly motivated during the first week of the quarter that they were very eager to gain experience points for their characters in Classcraft, but plateaued from the second to the fourth week of intervention.

Students' Motivation towards Learning Chemistry

To study the effects of gamified differentiated homework on the motivation of students toward chemistry, the pretest and posttest mean scores of the students per component of the CMQ II questionnaire were compared using paired t-test. The components of the questionnaire are Intrinsic Motivation (IM), Self-Efficacy (SE), Self-Determination (SD), Grade Motivation (GD), and Career Motivation (CM). Table 4 below shows the means per component of the Chemistry Motivation Questionnaire.

Table 3 shows that the means of the pretest and posttest of the components of motivation are relatively close to each other. The mean values in the table show students are already highly motivated to study Chemistry to begin with. This might have something to do with the fact that gamification is just targeting on the extrinsic motivation. The constructs measured by CMQII go beyond extrinsic motivation which may not readily be affected by gamification. In our succeeding discussion, this is further verified

from the student's verbatim response that Chemistry is already an interesting subject matter. If we are going to compare the five different components of motivation, it shows that the students have high scores in all components of motivation (very low – 1.0 to 1.8; low – 1.9 to 2.6; average – 2.7 to 3.4; high – 3.5 to 4.2; and very high – 4.3 to 5.0), with Intrinsic Motivation and Grade Motivation having the highest scores.

Table 3. Pretest-Posttest Results on the Five Components of CMQII

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	IM1	4.04	54	.55	.07489
	IM2	4.06	54	.77	.10423
Pair 2	SE1	3.62	54	.76	.10377
	SE2	3.69	54	.81	.10960
Pair 3	SD1	3.79	54	.63	.08581
	SD2	3.87	54	.78	.10565
Pair 4	GM1	4.06	54	.70	.09584
	GM2	4.16	54	.79	.10710
Pair 5	CM1	3.88	54	.86	.11720
	CM2	3.84	54	1.00	.13648

Table 4 shows that there are no significant differences on the five components of the CMQ II even after experiencing gamification and differentiation of homework. Just like in homework completion, it seems counterintuitive for students to not have an increased score on any component of the motivation questionnaire.

Table 4. Paired Samples Statistics of the Five Components of CMQII

		95% Confidence Interval of the Difference		t	Sig. (2-tailed)
		Lower	Upper		
Pair 1	IM1	-.266	.237	-.118	.907
	IM2				
Pair 2	SE1	-.341	.193	-.557	.580
	SE2				
Pair 3	SD1	-.371	.200	-.598	.552
	SD2				
Pair 4	GM1	-.414	.214	-.640	.525
	GM2				
Pair 5	CM1	-.339	.413	.198	.844
	CM2				

The focus group discussion shed some light on why this occurred. A student mentioned that chemistry is a really difficult subject that the effect of gamification and differentiation was dampened. The student's answer to the question, "Why do you think there was no improvement in your motivation even though you experienced using Classcraft for a whole quarter?" was:

“I think it has nothing to do with Classcraft. Because chemistry is already a difficult subject. Although it is interesting, it still is a difficult subject.”

It should also be noted that the participants of this study are STEM students. They had grades in math and science that are above 85 and a general average of at least 83. This means that they are already interested in science in the first place.

A student answered:

“I think, we were already motivated in the first place. Even though we knew that this subject is really difficult. And at the end of the quarter, we were still motivated because we enjoyed the class discussions and the things that we were doing.”

On the other hand, two students responded that they were disappointed with the Boss Battle in Classcraft. The Boss Battle feature of Classcraft is a game-like way of administering formative test to an individual or a group of students and it can only be opened and shared by the teacher. If the students get to answer a question correctly, they can cause damage to the Boss while an incorrect answer can reduce their character's HP. The students cannot access it on their own. A student pointed out that he was already interested in chemistry in the first place. Then, when he heard about Classcraft, he got even more interested to the point that he set a very high expectation on the gaming experience in Classcraft, like that of a role-playing game (RPG). But after two weeks, he learned about the limitations on the gameplay of Classcraft, like the static characters that do not roam around the maps and the limited function of the Boss Battle, which gave him disappointments.

The students also blamed the current learning situation and the online modality. The students were yearning for face-to-face interaction, which they thought could have made learning more interesting.

“And in the current way of learning, it is difficult to discuss the lesson properly without much interaction. It's better to learn chemistry if there is an interaction between the teacher and the students because it is easier to point out (by the teacher) if (the students) understood the lesson or not.”

“In this modality, it is difficult to learn something by heart because it feels like to learn, you just have to submit and submit paper works or outputs. That's how it felt.”

Students' Homework Completion

The gamification and differentiation of homework tasks are expected to increase the students' engagement. The pie graphs below show the number

of students (in percentage) who submitted their homework tasks ahead of the deadline, on-time, late, and no submission.

Data from the pie graphs showed the increasing number of late and no submissions as the weeks went by (please see Figure 4). This is counterintuitive since there are rewards given to students who submit their outputs early. With the help of the focus group discussion, it was revealed that the reason was that during the start of the quarter, there were few learning activities given to them by their other teachers, giving them more time to work on

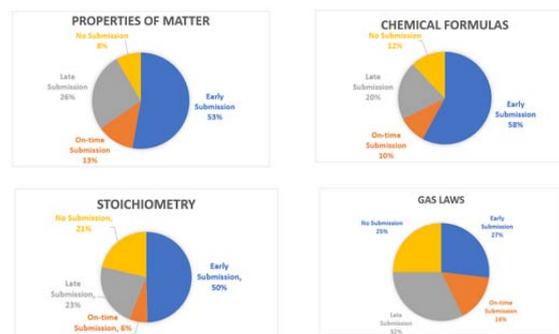


Figure 4. Students' Homework Completion for Weeks 1 to 4

the homework tasks in chemistry. But as the weeks progressed, the lessons became more difficult and they received more learning activities from their other subjects, causing them to commit late or no submissions. As one student stated in the focus group discussion, “As the lessons progressed, the activities got more difficult. Other subjects also contributed. There were many learning tasks.”

Students' Perception on the Use of Gamified Differentiated Homework

To determine the students' perception about the use of gamified differentiated homework, students were asked three questions: (1) What did they like about gamified differentiated homework? (2) What did they not like about gamified differentiated homework? and (3) How did gamified differentiated homework helped them in studying General Chemistry?

What did they like about gamified differentiated homework?

The students mentioned in the focus group discussion several areas in gamified differentiated homework that they like, but mostly, on the use of Classcraft since it was the platform used to gamify the lesson. These are the following:

1. Avatar customization;
2. Rewards for early submission;

3. Levelling up of character;
4. Feedback system;
5. Boss Battle;
6. Organized Learning Quests;
7. Differentiated activities.

The students liked the avatar customization because it gave them a sense of ownership. It gave them a venue to express themselves and be motivated to work hard on their homework so that they could get extra GPs to purchase equipment and pets to improve the appearance of their avatar. The reward system in the Learning Quests encouraged them to submit their outputs earlier. Levelling up their characters also gave them a sense of accomplishment. Some students said:

“Because of that element, I became more eager to submit my outputs and submit it earlier to get more points so that I could improve my equipment and my pets.”

“It encourages students to immediately answer their homework and submit it early to get (extra) points. And when they get the extra points, they get to level up.”

They also liked the feedback system because it gave them a feeling that the teacher is really looking into their work and they really appreciated it.

“In that way, you are able to point out our mistakes and what we should correct. And then I also really appreciate your effort to give us feedbacks because I noticed, of all of our teachers, you are so diligent in giving feedbacks to our outputs, and I really appreciate it.”

The Boss Battle also encouraged them to cooperate with their teammates to earn more XPs and GPs.

“There was more thrill when we did our quiz that way (Boss Battle). Aside from that, we can also get extra points if all of our group members got the answers correctly.”

The organized Learning Quests allowed them to track their progress on the lesson and their outputs.

“All of the activities are organized. For example, in every weekly lesson, and all of those activities are found in one location, they are organized. The next lessons are also organized in the same manner. For me, it’s easier to get back to those activities, and it is effective that way.”

“The progression is laid out: every time I submit my output, whenever I finish a quest, I get to unlock a new one. For me, it’s satisfying to look at it and it’s more motivating to work on our module because we can see that we are progressing, unlike when we just submit our work.”

And lastly, the students liked the differentiated activities available for them to choose from, particularly, the Practice Homework. This gave them the freedom to choose which activity they think they could accomplish based on their own assessment of their own skills. And since they were only required to answer the Easy Practice Homework and there are no negative consequences if they get incorrect answers in the Average and Difficult Practice Homework (just extra XP and GP if they got it correctly), they were encouraged to challenge themselves and try to solve more difficult tasks.

“You are giving options on what to take: Easy, Average, or Difficult, which something that our other teachers haven’t done yet. What’s good about it is that we can assess how far our skills can go.”

What did they not like about gamified differentiated homework?

There were some issues that the students experienced while using Classcraft. It was difficult to create and access their account even though their access codes were correct. The students also noticed that it was more difficult to open Classcraft using the mobile app compared to opening it using the browser. The students also gave some suggestions on how the platform could be upgraded to improve their gaming and learning experience. The Boss Battle should be accessible to the students outside the class period. In the current setup, only the teacher could access the Boss Battle feature at pick the student or group of students who could fight the Boss. If this feature could be accessible to the students, they could have an equal chance with other students to gain extra XP and GP. This would also give Classcraft an RPG feeling that a lot of students love. Another thing is that the mobile app should have a notification feature that informs the students about the new quests and deadlines they have to meet. But to compensate for this, we informed the students about the available tasks in Classcraft through our group chat. Classcraft should also have some recommendation on the amount of GP the teacher should give the students for every XP that the students can earn. In this way, the students will have a limited GP that the students should plan on how to use to customize their avatar.

In the previous sections of this study, it was revealed that, based on the result of the questionnaire, gamified differentiated homework had no significant effect on students’ performance and motivation due to some factors. But the question on how gamified differentiated homework helped them in studying General Chemistry revealed that there are some experiences not covered and measured by the

questionnaire. The students mentioned that the extra points for early submission motivated them to work harder on their outputs so that they could customize their avatar. The organized Learning Quests made them felt “satisfied and motivated” as they could see how they were progressing in their work. The types of homework (i.e., Pre-learning Homework, Checking of Understanding Homework, Practice Homework, and Process Homework) also helped them better understand the lesson because of the scaffolding effect of the sequence of applications. And lastly, the different levels of Practice Homework (i.e., easy, average, and difficult) gave them a chance to test how far they have learned the lesson.

4. Conclusion

The analysis of the data gathered revealed the following:

The students’ existing problems concerning homework are: (1) too much household chores and school activities/tasks; (2) time management; (3) unmet learning competencies and vague instructions from the teacher; (4) lack of motivation; and (5) lack of materials/money needed to do homework. Numbers 1 and 3 are quite unique and were not mentioned in the literature and worth noting for future studies. As mentioned by Bennett and Kalish [17], the amount of homework given to the students should be minimized, but the amount of household chores should also be monitored so that the students could still have enough time for the school and personal activities. School heads may look for ways to regulate the amount of homework tasks given to students. And when teachers observe that the students are having difficulty managing their time, they should consider having a dialogue with their parents in order to tailor the steps both teachers and parents can undertake. The lack of motivation in doing homework as a pre-existing problem among students implies the usual way teachers administer their homework is no longer effective [14].

When compared using Friedman’s test and Wilcoxon post-hoc, it was revealed that the Pre-learning Homework had significant difference compared with Checking of Understanding Homework, Practice Homework and Process Homework in terms of XP scores which means that the students are having a hard time working on Checking of Understanding Homework, Practice Homework, and Process Homework since these involved more work than Pre-learning Homework. This implies that the Checking of Understanding Homework, Practice Homework, and Process Homework should have higher bearing compared on the students’ grades.

In terms of the effects of gamified differentiated homework on the academic performance of the students with regards to Experience Points, the students did not show improved academic performance as the weeks progressed. Their performance was more dependent on the difficulty of the lesson. It was revealed that the students had significant performance in the first week lesson compared to other lessons. When it comes to the effects of gamified differentiated homework on the homework completion in terms of the percent of early, on-time, late, and no submissions, the students had increasing percentage of late and no submission as the weeks progressed. The focus group discussion revealed that the amount of work that the students are working on and the increasing difficulty of the lessons caused the students to have an increase in late and no submission of homework. The paired t-test analysis of the Chemistry Motivation Questionnaire showed that there was no significant difference before and after the implementation of the intervention. The results of the quantitative data seemed to contradict the studies done by Yıldırım & Şen [33] and Lister [30] which stated that gamification can improve student performance/achievement and motivation. The focus group discussion revealed several reasons for such result, which included the difficult nature of chemistry, the inherent motivation of STEM students in science despite the difficulty of studying chemistry, some problems and issues the students experienced when using Classcraft, and the modality which the class was using.

And lastly, the students’ perception on the use of gamified differentiated homework, the students expressed that they liked the avatar customization, rewards for early submission, levelling up of character, feedback system, Boss Battle, and organized Learning Quests that they observed in Classcraft, the gamification platform used in the study. They also liked it when they were given options on the difficulty of tasks that they want to engage on, particularly on the Practice Homework. On the other hand, they voiced out some problems and issues that they experienced in the platform that should be dealt with by the developers in the future. These include the difficulty in creating and accessing their account even though their access codes were correct, the poor performance of the mobile app compared when Classcraft is opened using a browser, the accessibility of the Boss Battle to all students even without the aid of the teacher, the GP recommendations for certain XP gained by the students, and the notification feature that alerts the students on the latest quests and deadline of submission in Classcraft. Students improved in terms of their interest in doing homework, experience of

rewards and recognitions to those who do well in homework, and being given options on how much and how difficult our homework tasks would be which are attributed to gamified differentiated homework.

Even though the motivation of the students did not significantly improve based on the result of the CMQ II because of some factors, the perception of the students on the use of gamified differentiated homework showed that it made the learning of General Chemistry 1 fun and interesting. It is also worth noting that differentiation of homework tasks or giving the students options was specifically mentioned by the students in the focus group discussion, and this should be considered whenever we are developing learning materials for our students.

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