# Using Gamification can Increase Educational Development

A Thesis Submitted to the Department of Computer Science and Communications Engineering,
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Research guidance: Research on Distributed System

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# Chapter 1 Introduction

## 1.1. Research Purpose

This thesis research on using gamification can increase educational development. By searching previous papers and other information. I can find that gamification in education is a trend and has genuine potential. How to gamify education and what is its potential can be a topic. In this thesis, I focused on a protein-protein docking system which is developed by Mr. Iino from Shimizu Lab. And he has already graduated. Then I and my classmate Miss. Keren inherited his research. We developed this system into a Kinect version. And in my research I gamified this protein-protein docking system continuously for people to learn something about the simple knowledge of biology. Comparing with video game version and casual game version. Indicate that use of gamification can be an effective instrument to increase the activity of people in educational development.

## 1.2. Research Background

### 1.2.1. Education and Gamification

Traditional education is a kind of teaching form with books as the carrier, teachers as the center, the main activity mode is related on teachers' explanation and students' listening and practicing. With a textbook, a teaching reference book, a piece of chalk and a mouth, a

teacher can carry out education and teaching activities in a purposeful, planned and focused way in accordance with the principles of teaching theory and classroom teaching methods, so as to complete teaching tasks. Students' acquisition of knowledge depends on Teachers' behaviors and instruction.

It can be seen that traditional education is perceived by many students as ineffective and boring. The interaction between students and knowledge is very deficient, usually passive acceptance of a kind of knowledge, and lack of interest, it is easy to feel impatient, so as to reduce the motivation of learning. It is largely agreed that today's schools face major problems around student motivation and engagement. [1]

Modern education refers to the process of teaching activities carried out by using multimedia computers or devices and with the help of pre-made multimedia teaching software. Modern teaching, according to the characteristics of teaching objectives, through teaching design, reasonable selection and use of modern teaching media, with a variety of media information acting on students, trying to form a reasonable teaching process structure, to achieve the optimal teaching effect.

However, some educational software often suffers from the tedious experiment and data, leading to low levels of activity. [2] Students need to sit in front of the computer and constantly use software to learn. These educational software are usually purposeful, different from the traditional

teaching methods. Compared with just using blackboard and books to impart or obtain knowledge, these software using more abundant information for learners to use, but also lack of interest. After a period of time, students will also have negative emotions, which will reduce the efficiency of learning.

Therefore, on the basis of modern teaching, how to improve these problems is a subject worthy of exploration. We need to make education interesting, so that it can be accepted by learners of all kinds of personalities, and get the knowledge they want from it instead of passively accepting it. As the saying goes, interest is the best teacher. Once learners have a strong desire to acquire a certain kind of knowledge, they will no longer think that learning is just a task, learning can also be like playing games, let them immerse in it.

Everyone loves to play games. As an entertainment mode in modern life, the charm of games cannot be underestimated. Why can the game let everyone so immersed, what is the reason why a game is successful, and what factors in the game are most acceptable and loved by the public. By exploring these, whether we can use the inspiration from the game for education and make education more game like, so that learners can learn a kind of knowledge like playing games, and they want to learn this knowledge subjectively. I think this kind of learning method can strengthen their motivation for learning. On the other hand, they will be

more impressed by the knowledge they have learned subjectively. This knowledge will stay in memory for a long time, so that many people will not forget the knowledge they have learned after the goal is achieved.

Game is a kind of activity which is not constrained by external forces, and it is a kind of activity that players choose spontaneously. Educational test is a kind of activity which is purposefully and planned by educators to exert influence. Therefore, game is an equal independent activity between players under the control of internal motivation, while education is a bilateral interactive activity of teaching and learning under the control of external requirements; games focus on the needs, interests and abilities of players to carry out activities; while education is based on the goal, task and content of education as the core organization activities. [3] And also, good games are generally large-scale production, which requires a certain amount of time and money. But the original intention of education is to use less time and money to learn more valuable things, which seems to be contrary to the game. And, after all, education is a serious and earnest act, and its purpose cannot be exactly the same as that of games. Therefore, here we propose a way of Gamification, using game factors to improve the teaching system. It has the rigor of education and the interest of games, so that education is no longer a boring behavior for people, and education can also become fun.

Gamification—the use of game design elements in non-game

contexts—has already seen a successful adoption in many areas. [2] It can also be defined as a set of activities and processes to solve problems by using or applying the characteristics of game elements. [4] Gamification commonly employs game design elements to improve user engagement and positive emotion. A collection of research on gamification shows that a majority of studies on gamification find it has positive effects on individuals. However, individual and contextual differences exist. [5] In general, gamification can help making tasks more attractive. The use of educational games as learning tools is a promising approach. Games have remarkable motivational power. They utilize a number of mechanisms to encourage people to engage with them, often without any reward, just for the joy of playing and the possibility to win. Yet, the effective classroom adoption of games requires an appropriate pedagogical integration and sometimes a certain technical infrastructure. Can we then, instead of using full-scale games, incorporate game thinking and game design elements in the learning environment as an alternative, less costly and more flexible approach to improving learners' engagement and motivation?

### 1.2.2. Video Game and Casual Game

In this paper, I try to compare with two kind of gamification – video game version and casual game version. In short, a video game is an

electronic game that involves interaction with a user interface to generate visual feedback on video display device. [6] While a casual game is a video game targeted at a wide, mass market audience, as opposed to a hard core game, which is a game targeted at a more niche audience of hobbyist gamers. [7]

Ever since their inception, video games have captured the imagination of millions. As gamers, we have always been captivated by the vast open worlds, immersive stories, and a video game's ability to help us escape from our reality. It's the reason we constantly find ourselves endlessly exploring the wonders of The Elder Scrolls, or happily getting lost in the forests of unexplored realms. For some, the world, environment and the story are everything.

In modern society, material culture is developing rapidly, and people begin to enjoy life. The process of enjoying life, or a certain way of enjoying life, can be called "casual ". Compared with the purpose of video games, casual games are more people choose a way to relax, casual games do not need a player is a game talent, also not so competitive. Players may play games just because they find it interesting. But at the same time, casual games also have the nature of electronic games, giving players satisfaction and entertainment. It may not need so many skills, and players will not spend too much time indulging in the game. They just do it subjectively at the time they just want to play, and they don't need a lot

of game training to win a game like E-sports.

In the fact, it's hard to define the difference between video games and casual games. Because they are actually mutually inclusive. Casual games also belong to a kind of video games. The definitions are blurred. The most common understanding is that a casual gamer can refer to someone who only plays games that do not have a built-in competitive mode, or those that are less serious about the games they play, instead preferring the stress-free and immersive environments of non-competitive games. That’s not to say that non-competitive environments are not stressful. Depending on the genre or strategy involved, they can still create tension and pressure, but this is not the same pressure one feels in a competitive space. It can also be someone who takes part in competitive play but does so for fun without the drive or desire to sink countless hours into the game. In this case, it would be a person who would play ranked matches yet not care too much about their rank or stats. They play for the enjoyment of the game, and often for the thoughtless monotony of running around with a gun or the enjoyment of interacting with friends. So if we have to say that video games and casual games are different, it may be that the audience is different.

To sum up, casual games seem to meet the needs of some other fields, such as education. Because, the original side of the game for educational purposes is not to let learners have a strong sense of

competition to win a game result, but through the use of game techniques to let players learn certain knowledge, so as to produce a game result, such as to get a high score. Therefore, in this paper, I try to discuss which version of this protein-protein docking game is better for education. And I also find there are few existing studies comparing video game and casual game. Which one can engage people's learning activity more has a value to discuss, I think.

### 1.2.3. Protein-protein docking

Protein-protein interaction is essential in biological process. The interactions occur when two or more proteins bind together. The interaction is called protein-protein docking (PPD). As claimed in [8], the research field in PPD might benefit from intuitive and interactive tools that would lead to a rapid gain in general knowledge on the problem, or get new ideas by trial and error exploration. For example, as shown in [9], a tangible device is adopted to manipulate PPD for docking proteins more naturally. The detail of this part showed on our pervious paper.

The purpose of this paper is to gamify the previous system of protein docking and explore whether people can learn protein related knowledge by using this game. Learning protein docking will be a boring process. The difficulty lies in the fact that the naked eye cannot observe the structure of protein, and students may be bored with infinite experiments.

Therefore, if we use the previous education methods to teach the content of protein docking, it will not necessarily produce ideal results. The interest generated after gamification may be the driving force for students to learn.

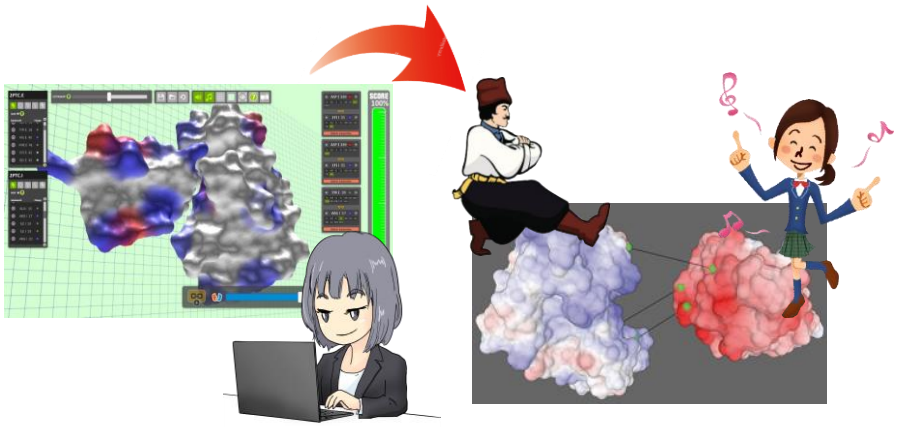

Figure 1: gamification of protein-protein docking system

## 1.3. The Structure of Paper

The first chapter describes the purpose and background of the research, and the second chapter describes the related prior research. The third chapter describes the basic design, while the fourth chapter is about the user study, evaluates and discusses the results. The last chapter summarizes the whole paper and talk about the future work.

# Chapter 2 Related Work

While there has been a surge in the acceptance and prevalence of game-based learning in schools over the past decade, playing games in the classroom is nothing new. Educational games have been a commonplace part since the beginning of the 1980s. [10] Things have changed a lot since then, but one thing has remained the same: the best educational games aren't just tools for teaching. They show people that education can be fun and instill a love of learning that will carry on throughout their lives.

For a long time, the world of games and the world of education are intertwined. In fact, Canadian scholar Bagley once analyzed the ***Horizon Report*** released by the new media alliance of the United States from 2004 to 2012. He pointed out that 37 new technologies were proposed in these reports, but only 7 were confirmed by the following 4 ***Horizon Reports***. Among them, game based learning and mobile learning ranked the top two. In 2014, Shanghai issued the ***Blue Book on the Trend of Informatization of Basic Education in Shanghai*** and other related reports, which predicted that game based learning (educational games) would be widely used in the next few years. The United States, the European Union, China and some developed countries have invested heavily in brain science research, and published many articles in famous journals such as nature and science to explore the relationship between

game learning and brain cognitive ability. It has been proved that game chemistry learning will become a new means of education, combining with mobile learning, VRAR, stem learning, programming learning, brain science, etc., will become the inevitable development trend of future education mode, and jointly promote the development of education.

Back in history, there have been many successful examples of gamifiying education in people's lives. Here, I introduce some educational games with the significance of the times to help for understanding the point of this paper.

## 2.1 LOGO Programming

***Logo*** is perhaps a strange inclusion on a list full of games, as it is actually a programming language [10], but its early application in education and use as a fun way to teach programming and mathematical concepts earn it a solid place on any list of foundational computer programs in education. Students will primarily remember ***Logo*** through its use of a turtle-shaped icon, which could be moved and altered. Through inputting commands, essentially very basic programming codes, students could use the turtle to draw geometric shapes, from circles to stars to spirals. While ***Logo***'s use peaked during the mid-1980s, it was nonetheless pivotal in the development of educational programs, teaching a generation of learners that programming wasn't only accessible, it could also be fun.

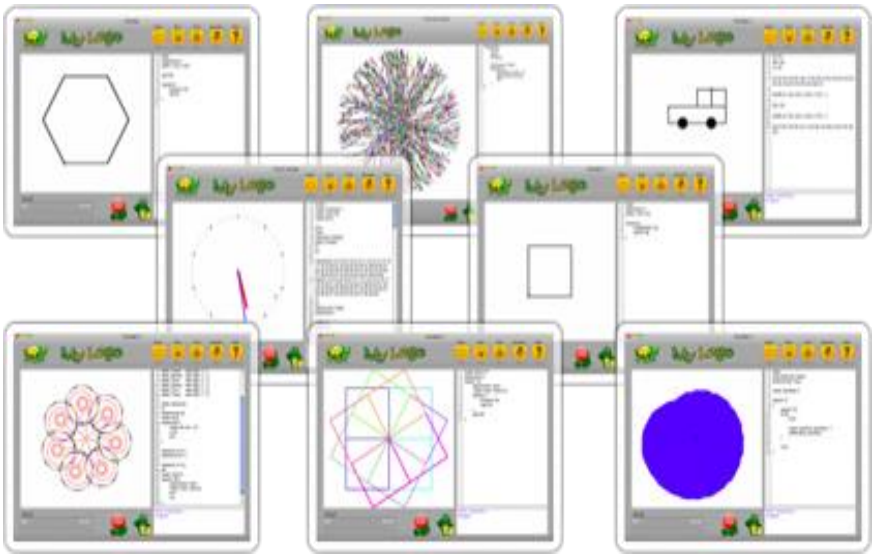

Figure 2: LOGO Programming

## 2.2 Odell Lake

***Odell Lake*** was an early simulation game that challenged players to take on the identity of one of six species of fish living in Odell Lake, a real lake in Oregon. [10] Keep your fish alive by avoiding predators, eating food, and exploring the lake. Smart choices would earn you points, poor ones would take them away or end the game. MECC, the developer also responsible for ***Oregon Trail***, would later release ***Odell Down Under***, which expanded the concept to the Great Barrier Reef. Teaching students about ecosystems and wildlife, ***Odell Lake*** was one of the first science-focused educational games on the market.


Figure 3: Odell Lake

## 2.3 Reader Rabbit

***Reader Rabbit*** is among the most influential and successful educational games of all time. Beginning with the release of the original ***Reader Rabbit*** in 1986 [10], the game has taught scores of toddlers and young students how to read and spell through simple but fun mini-games. Over the years, The Learning Company has added many more titles to the ***Reader Rabbit*** series (branching out to math and higher grade levels), which continue to be popular educational titles in homes and schools today. ***Reader Rabbit*** was one of the first educational gaming brands to become a household name and with a new title for the Nintendo Wii announced in 2011, it remains a powerful force in the edutainment market today.


Figure 4: Reader Rabbit

## 2.4 The Others

Various researchers have applied gamification to their activities aiming to analyze the effects and benefits of gamification in learning contexts.

Scientists of the Brazilian Federal University of Santa Caterina, led by Prof. Dr. Christiane Gresse von Wangenheim. [11] developed a board game, named ***Deliver!*** with the objective to teach students in project management courses to monitor and control a project using Earned Value Analysis. The total duration of a game is about 90 minutes. Players need to plan the human resources, duration and cost of the project, and the results of the plan must be recorded in the project plan. Winners are those who arrive at the destination without running out of money. The game has been applied in the Software Project Management course at the

Federal University of Santa Catarina. The research showed that the game had a positive effect in learning process because it engaged students in the lecture. The researchers states that this teaching method can complement the student's learning process. Professor Guillermo Montero Fernández-Vivancos [12] uses this game at project management courses at the University of Seville. According to student feedback, the game helps to increase students' interest and motivation during the lectures.

Figure 5: The imagination of ***Deliver!***

Dicheva, Irwin, and Dichev [13] provide the One-up Learning Platform that supports the use of gaming elements in training courses. This platform is customizable for each course because it allows to configure course structure, game elements and create challenges. Platform uses these game elements: points that are divided into skill points, challenge points and activity points, badges that are given for mastery of skills: “Novice”, “Journeyman”, Expert” and “Master”, levels that unlock new challenges, leaderboards, avatars, virtual currency, feedback and freedom

to fail. The user study is following. The results of the surveys demonstrated that the One-up Learning platform could successfully motivate and involve students.

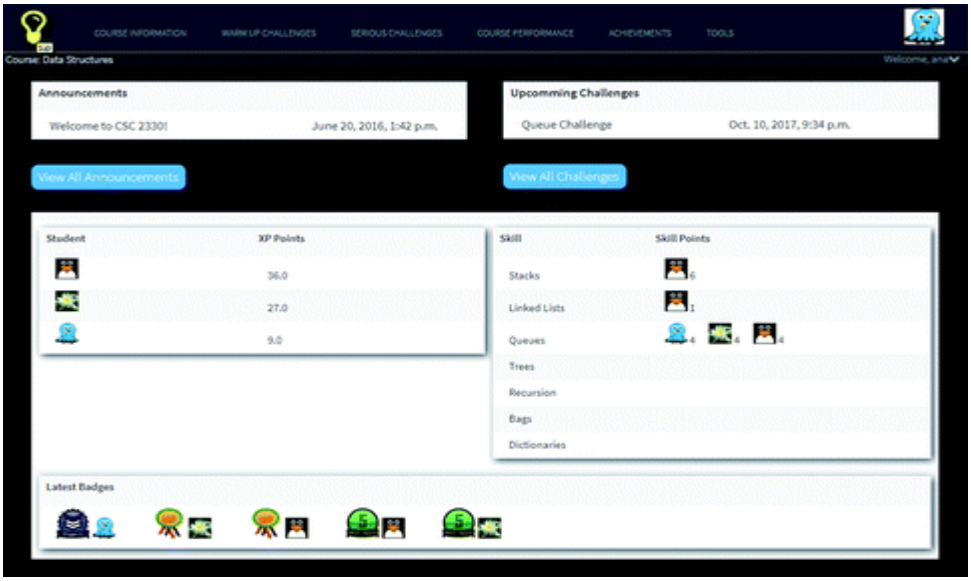


Figure 6: One-up Learning Platform

Researchers of the University of Valladolid [14] apply gamification in a parallel programing course. This course is extensive and students often lack the motivation to learn, so it was decided to gamify the course in order to increase students' interest and engagement. They uses there following game elements: The leaderboards, using awards, which are delivered using the Moodle platform. They are rewarded for well-written program and also for attending the course. They also use badges as rewards. Student activity and behavior data was also logged. The results of the study showed that the course was successful in terms of student motivation, interest, learning and final grades.

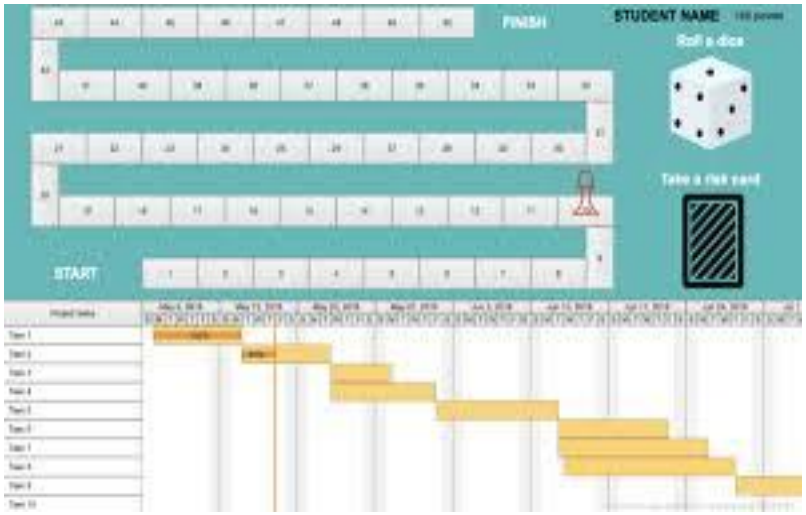


Figure 7: Gamification in a parallel programing course.

Ryder and Machajewski [15] developed an app named ***UIC German*** for gamification of the German language teaching. Students can create their avatar, perform various tasks, receive points for them and view leaderboards. Students who have accumulated a lot of points can exchange them for the certain bonuses. This system uses the following game elements: virtual currency, leaderboards, levels and badges. Huynh, Zuo, and Iida [16] claim that badges are the most important element of gamification, because they are combined with the content of the training course and are used to increase the player's motivation in language learning.

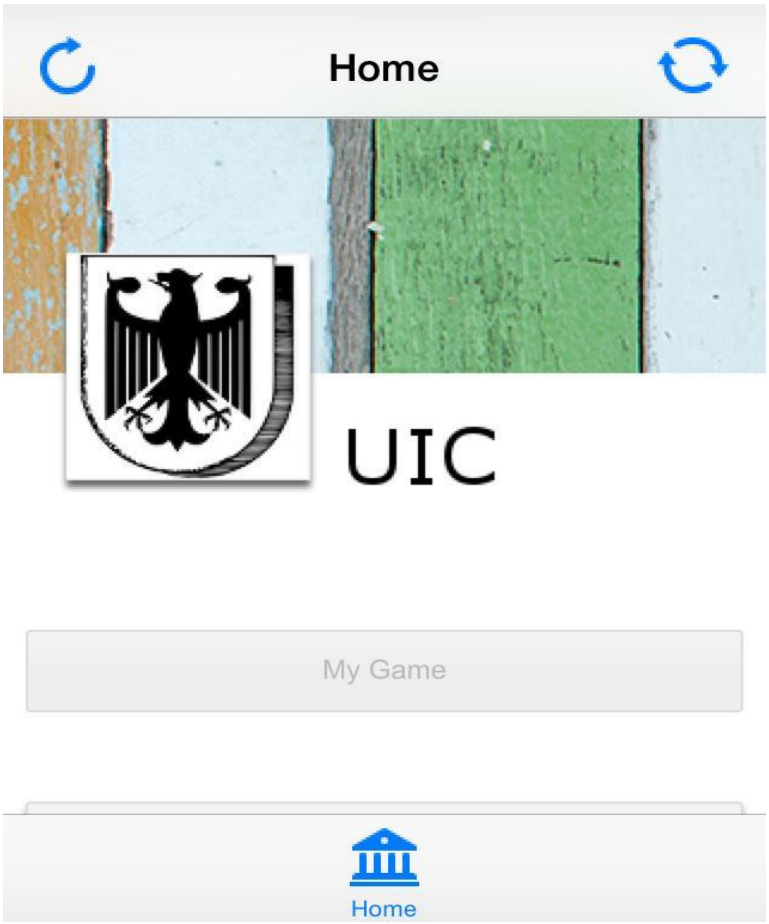


Figure 8: UIC German

Thus, gamify education is not the future; it is already here. At present, many schools in the practice of gamifying learning, has expanded from classroom game to school construction, campus management and curriculum construction and other aspects. Whether it is the game of physical space, the game of curriculum content, or the game of teaching evaluation, all of them are practicing the teaching concept of "teaching with pleasure". Game itself is a tool, people should not be controlled by the game, but should take the initiative to control the game, through game learning to cultivate the game power, and then into learning and innovation.

# Chapter 3 Basic Design

## 3.1 Summary

In this research, we gamified a software for protein docking. Users can operate two protein models displayed in three-dimensional space. We use the game engine Unity for development. Through various operations of protein and some game elements, we can learn protein related knowledge, make users interested in learning protein, and encourage users to continue learning. In this study, two forms of protein manipulation were designed, one was defined as video game version--players use mouse for operating; another one was defined as Kinect game version—players use body action to control the proteins. The purpose of the two versions is to adjust the protein model to a proper shape and position step by step, and through selecting the level, finally get a higher score, so as to learn the knowledge about protein appearing in the pop-up window after obtaining a high score.

## 3.2 Implementation

### 3.2.1 Protein Models

This research uses the game engine Unity to implement. Two protein models are generated from PDB files which record the protein structure information. As shown in figure 9, PDB files includes amino acids of each

molecule of protein, coordinate information of three-dimensional space and other protein monomer information. Putting PDB files into the program will generate two protein models as shown in Figure 10, which contain the main chains and the side chains of proteins.

```
SCALE2      0.000000  0.013701  0.000000        0.00000
SCALE3      0.000000  0.000000  0.011213        0.00000
ATOM      1  N   SER A 981      20.059  83.616   2.943  1.00 57.29           N
ATOM      2  CA  SER A 981      19.782  82.984   1.648  1.00 58.58           C
ATOM      3  C   SER A 981      18.514  82.123   1.711  1.00 57.32           C
ATOM      4  O   SER A 981      18.589  80.929   2.008  1.00 57.14           O
ATOM      5  CB  SER A 981      20.971  82.112   1.208  1.00 60.15           C
ATOM      6  OG  SER A 981      22.172  82.859   1.068  1.00 62.58           O
ATOM      7  N   SER A 982      17.361  82.724   1.424  1.00 55.03           N
ATOM      8  CA  SER A 982      16.094  81.997   1.468  1.00 55.96           C
ATOM      9  C   SER A 982      15.984  80.890   0.420  1.00 56.06           C
ATOM     10  O   SER A 982      15.972  81.159  -0.788  1.00 55.72           O
ATOM     11  CB  SER A 982      14.903  82.956   1.322  1.00 56.07           C
ATOM     12  OG  SER A 982      14.797  83.846   2.422  1.00 56.20           O
ATOM     13  N   VAL A 983      15.932  79.649   0.893  1.00 53.00           N
ATOM     14  CA  VAL A 983      15.793  78.492   0.019  1.00 53.16           C
ATOM     15  C   VAL A 983      14.397  77.951   0.300  1.00 53.41           C
ATOM     16  O   VAL A 983      14.097  77.556   1.426  1.00 58.28           O
ATOM     17  CB  VAL A 983      16.884  77.413   0.304  1.00 51.92           C
ATOM     18  CG1 VAL A 983      18.261  77.982   0.016  1.00 54.85           C
ATOM     19  CG2 VAL A 983      16.836  76.938   1.746  1.00 48.66           C
ATOM     20  N   PHE A 984      13.517  77.986  -0.692  1.00 50.63           N
ATOM     21  CA  PHE A 984      12.150  77.511  -0.478  1.00 47.75           C
```

Figure 9: PDB file

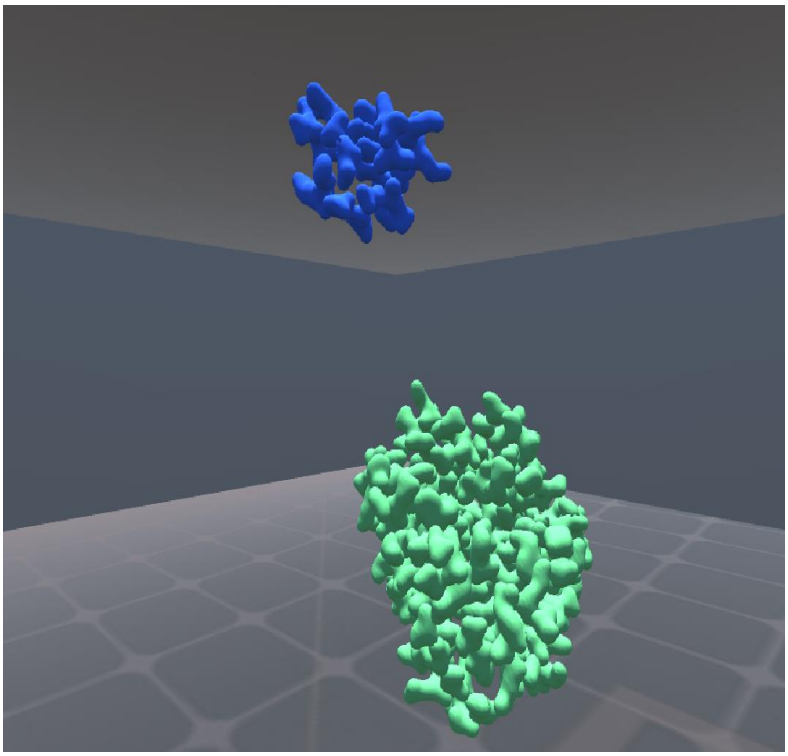

Figure 10: protein models

### 3.2.2 Functions

As shown in figure 11, there is an information interface at the beginning of the game. This interface informed what the purpose of this game, and how to play it. The interface was designed by Unity UI system. Scroll bar can adjust the content of reading.

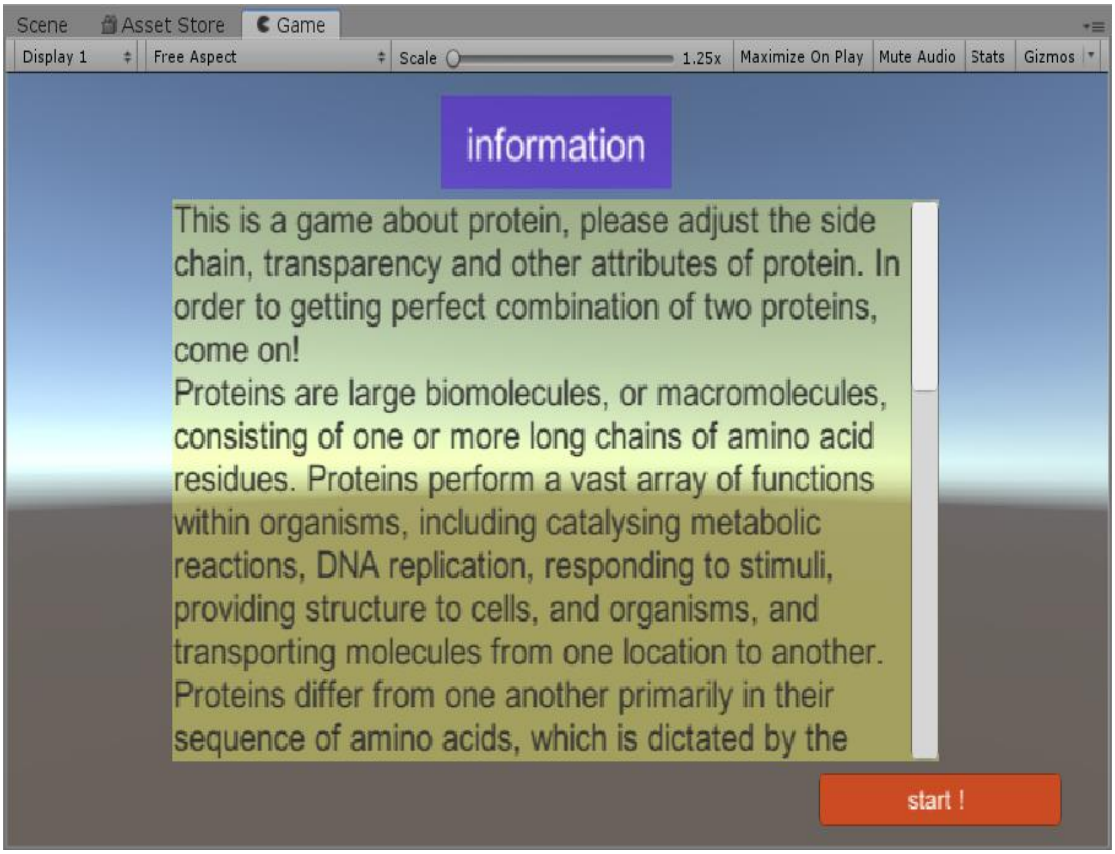


Figure 11: The information interface

After choosing start, players go into the level selection interface, as shown in figure 12. There they can select the different level with different goal. For example, the first level is to move two proteins to a suitable position, the second level is to change the transparency of two proteins in order to observing clearly, and the third level is to rotate the side chain of two proteins to a suitable angle. Each level after the completion will show the corresponding small knowledge, such as what is the side chain.

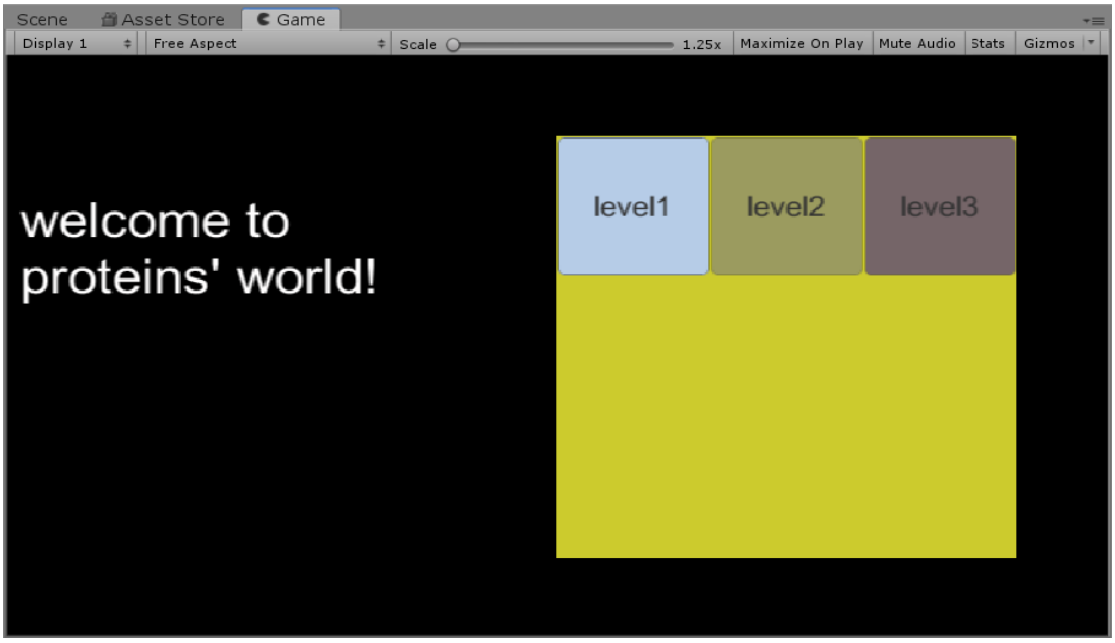


Figure 12: Level selection interface

In the game, players can adjust the proteins' transparency, in order to observing the main chains or the side chains clearly. And also can cut the surface for the same purpose, as shown in figure 13 and 14. And other functions include adjust the viewpoints, change the angle of the side chains, move the position of two proteins. Each function can be assigned to different levels, and each level aim to getting a higher score.

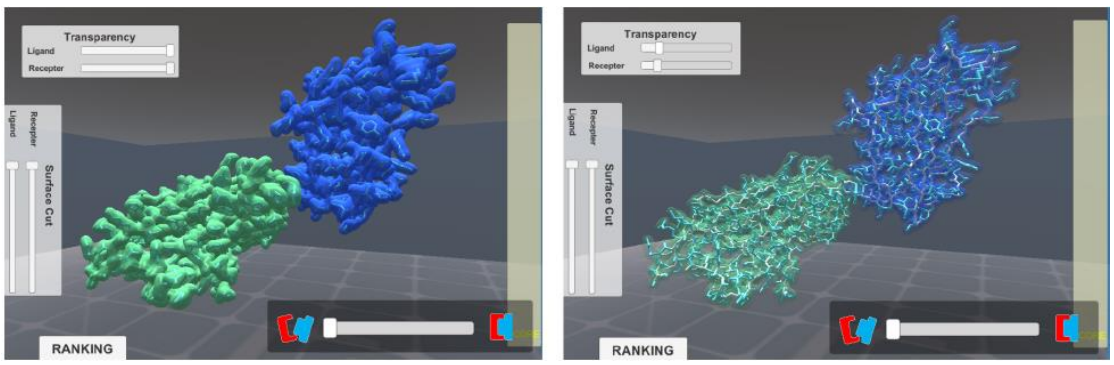


Figure 13: Change the transparency

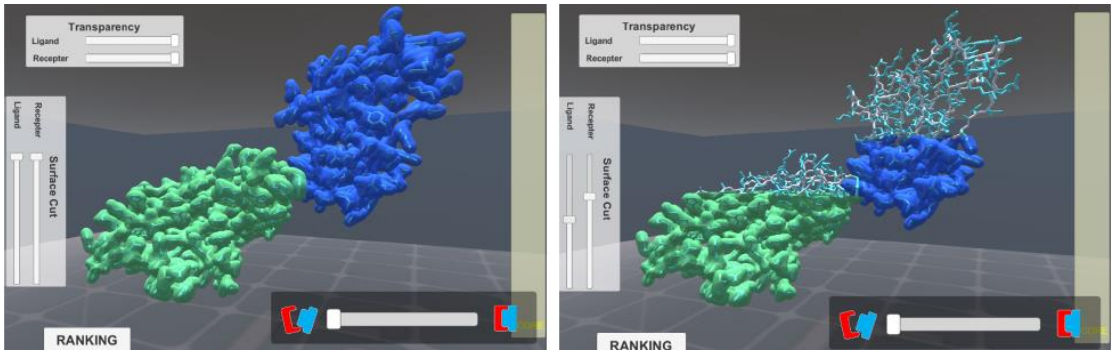


Figure 14: Cut the surface

Finally, when players get a higher score, the pop-up window will be shown like figure 15. It contains some related knowledge of proteins. As a reward, it indicate that players acquire the knowledge by putting some efforts into the games. And because of the knowledge they gained, they will get a higher score in the next time.

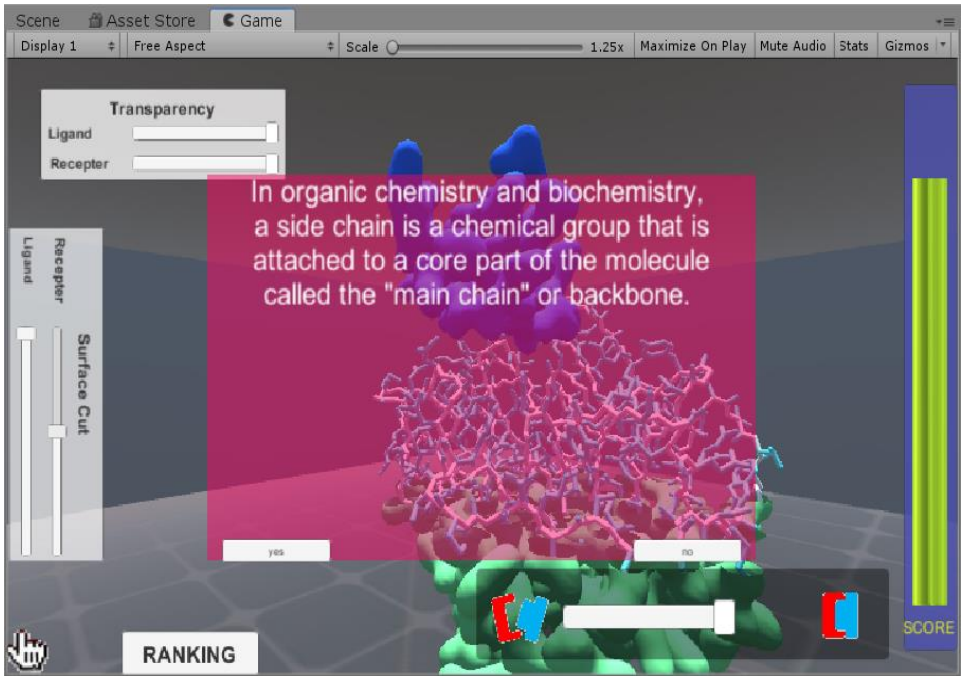


Figure 15: The pop-up window

### 3.2.3 Score Calculation

Regarding the calculation of the binding score, which is a key component representing the goodness of molecular docking, we used the score function in the protein docking software named ***MEGADOCK*** [17]. After inputting the PDB file of two single proteins for which the tool wants to predict complex structure and the moving distance of the three-dimensional space and the rotation angle, the binding score corresponding to the positions is calculated. The detail of this part showed on our previous paper.

## 3.3 Video Game Version

The video game version use one laptop computer, and the players use mouse to control the proteins by click buttons shown in the screen. Because video game version can control the side chains of proteins more precisely with the mouse, it needs more skills

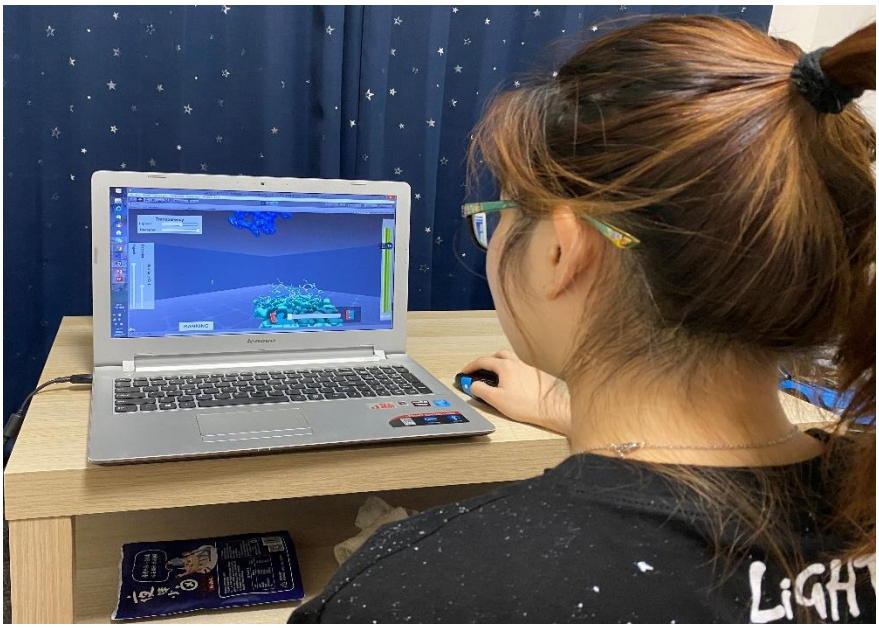


Figure 16: Play with the video game version

## 3.4 Casual Game Version

The casual game version use a Kinect to recognize body action, and use body action to interact with proteins. In the process of playing game, people seem to dance, players' inadvertent actions may bring a surprising result. The buttons were hidden in the main interface. The figure 18-19 and the table 1 shows the action of each function.

Figure 17: Play with the casual game version

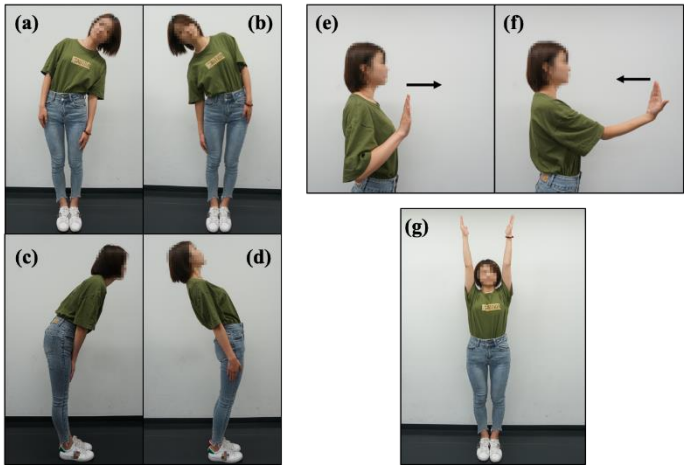


Figure 18: The action of each function (1)

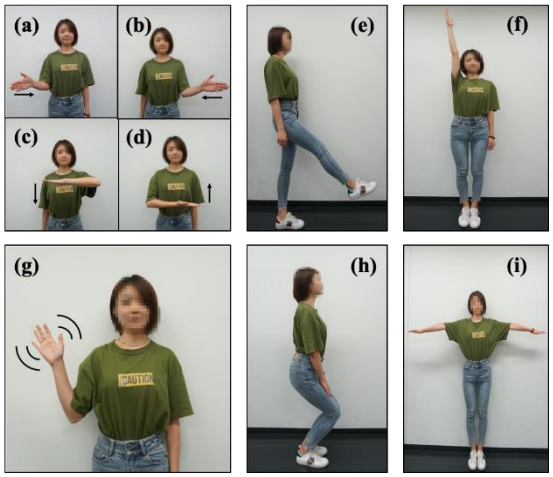


Figure 19: The action of each function (2)

| | |
|---|---|
| Figure 18-(a) and (b) | Change the horizontal view angel. |
| Figure 18-(c) and (d) | Change the vertical vies angel. |
| Figure 18-(e) and (f) | Zoom in/out. |
| Figure 18-(g) | Back to the original view point. |
| Figure 19-(a) to (d) | Increase/decrease the transparency. |
| Figure 19-(e) and (f) | Cut/recover the surface. |
| Figure 19-(g) | Move two proteins closer. |
| Figure 19-(h) | Get two proteins farther. |
| Figure 19-(i) | Stop moving. |

Table 1: The action of each function

# Chapter 4 User Study

This paper conducted two type of questionnaires to investigate the potential of this gamified software. The first questionnaires is to investigate the potential opportunities of this gamified software and evaluate the participants' emotion, in order to indicate whether they are motivated to learning. The second questionnaire is to compare video game version and casual game version, which one is more potential.

## 4.1 User Study Design

In this paper, I hired 15 participants from different age (P1-P15, age m= 24.86667). Some of them are still students, and others have already been an office man. Each participant was introduced how to play this gamified software, and then they experience the video game version and the casual game version one by one. When they experience the casual game version, they also were introduced the action of each function. After experiencing, they answer the two questionnaires and make a short interview. From the interview, the participants present some interesting opinions and give me some useful comments.

The two questionnaires are shown in table 2 and 3.

Questionnaire 1 sets score options, which are integers from 0 to 4, 0 stands for not at all, and 4 stands for very much. Two options are set in questionnaire 2, namely video game version and casual game version.

Participants choose according to the actual experiment results.

| | |
|---|---|
| Question 1 | This system make you feel interested. |
| Question 2 | This system motivate your interests about proteins. |
| Question 3 | This system help you learning about proteins. |
| Question 4 | This system make you feel boring if you learn a long time. |
| Question 5 | This system make you feel impatient. |
| Question 6 | This system make you feel creativity. |
| Question 7 | This system make you feel successful. |
| Question 8 | This system make you feel skillful. |
| Question 9 | This system make you feel frustrated. |
| Question 10 | This system make you feel challenged. |

Table 2: potential opportunity of this system

| | |
|---|---|
| Question 1 | Which one do you feel more interests? |
| Question 2 | Which one do you think can help you for learning more? |
| Question 3 | Which one can attract you more? |
| Question 4 | Which one do you prefer to use for learning? |
| Question 5 | Which one make you feel more challenged? |
| Question 6 | Which one can motivate your creativity more about learning proteins? |
| Question 7 | Which one do you think more interactive? |
| Question 8 | Which one do you think more gamified? |
| Question 9 | Which one do you think content more? |
| Question 10 | Which one do you think can help for education more? |

Table 3: compare with two version

## 4.2 Result

In the experiment, the participants answered the two questionnaires. By collecting the data from the questionnaire, we can get some results for this system.

By calculating the average score of each question in questionnaire 1, we can get a bar chart table 4.

As shown in the table 4, the participants were very interested in the

system, and they felt that it could stimulate their interest in protein and that it could help them learn protein related knowledge. The first three questions also show a phenomenon that the value of question 3 is slightly higher than that of question 1 and question 2, which indicates that interest can improve the efficiency of learning, which indirectly indicates that the system has improved people's interest. The values of question 4, question 5 and question 9 are far lower than those of other questions, which indicates that participants have less negative emotions in the process of learning protein by playing games. It is precisely because of this that they can continue to learn and will not lose interest in this knowledge because of negative emotions, thus missing the opportunity to understand it. Questions 6, 7, 8, 10 show that the participants have a good experience, creativity, skill and challenge, which indicates that the system is playable. Different from the rote memorization of traditional education, participants can also acquire the knowledge they want through their own attempts and explorations. However, the value of question 10 is slightly lower than that of other positive emotions. In the subsequent interview, some participants also mentioned that the setting of the level is relatively simple, only a few steps can be used to pass, and the system needs to be further improved.

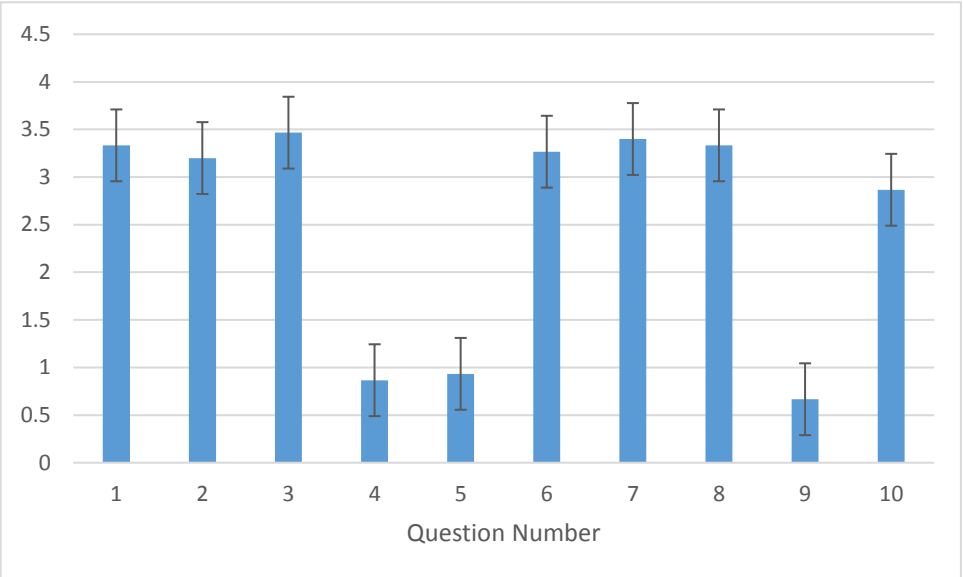


Table 4: the Result of Questionnaire 1

For questionnaire 2, by counting the percentage of each question selection result, the histogram as shown in the table 5 below is obtained. Blue indicates the number of people who choose “casual game version” for the current problem, while red indicates the number of people who choose “video game version” for the current problem.

It can be seen from the chart that more people choose the casual game version than the video game version for each question. First of all, it shows that the casual game version is more interesting than the video game version and can attract participants to experience the system. Secondly, 50% of the participants are hard core players. However, for game oriented software for education purposes, they still tend to choose the casual game version, which shows that the casual game version attractive them more in the field of education. Question 6 also shows that the freedom of the casual game version is higher. Compared with the

video game version, the casual action of the participants may become the key to pass the test and be more creative in the process of protein learning. Question 8 shows that the casual game version is more playable. Question 9 shows that participants are more satisfied with the casual game version. However, the result of question 5 on the one hand shows that the casual game version is more interesting. On the other hand, it also shows that it is more challenging to adjust the shape and position of protein to the appropriate position because the action cannot control the protein flexibly and accurately as the mouse click. Although the data of questions 2, 3, 10 are not very different, which shows that everyone has his own favorite learning style. Some participants think that video game version can help him learn better, but some participants like the casual game version. They may not want to pass the level, but enjoy the pleasure of twisting their bodies to explore proteins invisible to the naked eye, it can be seen that all type game based education is very helpful to modern society.

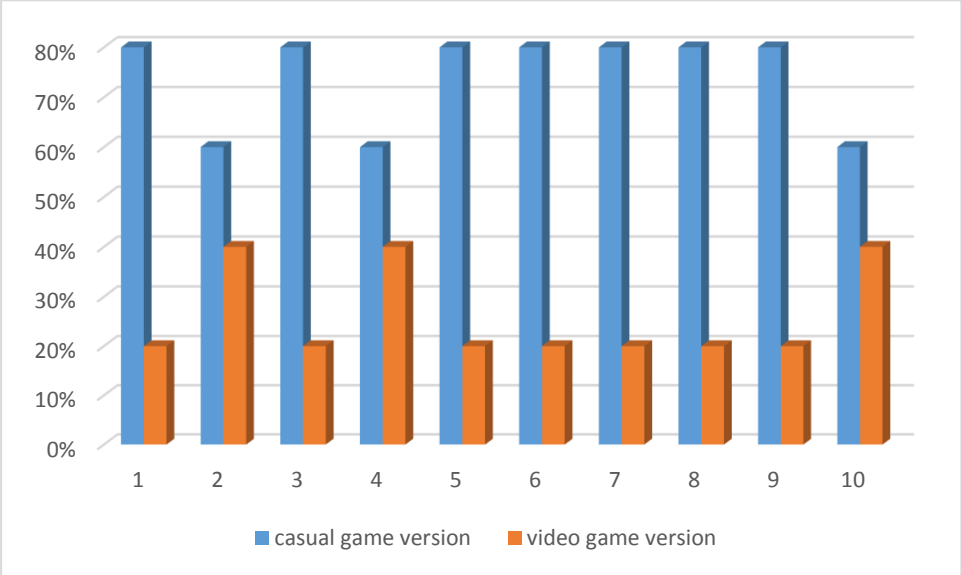


Table 5: the Result of comparing two versions

## 4.3 Extracting Insights from Interview

I conducted semi-structured interviews with the participants of the experiments. After completing the user study, I interviewed each participant and the comments from them are summarized.

Each participant is not specialized in protein learning. They come from various fields. Except P2, P11 and p12, no one has been interested in learning protein related knowledge before. But after experiencing the game, they were interested in learning protein and wanted to continue. P3 said, "I think it's a very interesting idea. I've never thought about contacting protein related content before, but I still want to continue through this game. It may be more interesting to have VR version. P12 said that when I was in college, I had a little knowledge of this aspect, but later I found it a little boring, so I gave up. Now I can see that this aspect can be

made into a game. I feel very surprised, which makes me regain my interest in protein learning. P8 said, "I'm not a person who loves learning. I feel sleepy when I read a book, let alone learn protein, which sounds very profound. But after playing this game, I found that the structure of protein can be observed through the control of the body. It makes me feel fresh, and I am immersed in it unconsciously. Now I have a certain understanding of protein. P10 said, "I've always liked playing games, but I never thought about learning anything through games. After experiencing this system, I found that I learned about protein unconsciously, which was very interesting.

All participants believe that gamification of education has great potential, because people's life is becoming more and more colorful, and education can be implemented in more and more scenes, not just in the classroom. They believe that systems like this can make more people interested in proteins and sprout the seeds of learning protein knowledge. P15 said that the system may be used in the science and Technology Museum. People are interested in learning by experiencing it, and they can learn some basic knowledge, especially for children. Maybe because of the use of this system, they can make contributions to the field of biology in the future. P6 said that my major has something to do with education. The game factors in this system can encourage students to explore further.

As for the comparison of the two versions of gamification, most participants preferred to use their bodies to manipulate proteins. P7 said, "I don't think it's very interactive to sit in front of the computer. The casual game version can make my whole body move, which may let me have a richer imagination. P10 said, "I think the casual game version is more like a game, and the game mode is very fresh, because after all, the system cannot have as rich content as large-scale games. I hope that the content of this game will be more abundant in the future. But some participants like video game version, P4 said. I think clicking with the mouse is more accurate, which can let me learn more things and observe more carefully. It will encourage me to get a high score and learn something.

Finally, the participants gave a lot of suggestions and opinions on some functions of the system, which is helpful for future research. Most of the participants mentioned optimizing the interface, and P1 said it would be better to attract participants by a good user interface. Almost all participants think that pop-up mode is a good function, no matter for which version, participants can learn knowledge by playing the game, and then play the game better with this knowledge. P8 said that after getting a high score, the contents displayed in the pop-up window will pay special attention to, because it is the result of my own efforts, so the impact will be more profound. As for the level selection function, some participants think that it should be designed more challenging. P1 said that level

selection can provide more information, such as difficulty, so that I can learn knowledge step by step. Some participants thought that there were too many actions and it was not easy to remember them. So in the future the researcher could optimize the actions or have some hints.

# Chapter 5 Conclusion and Future Work

## 5.1 Conclusion

In this work, improving the dullness of education and stimulating people's interest in learning as a research motivation, through gamifying, makes education more interesting and acceptable. At the same time, it discusses the potential of educational game. In this paper, we design a game system to let participants learn about protein. The results show that participants who have no interest in protein can accept this knowledge, which indicates that educational gamification can stimulate and encourage people to learn a kind of knowledge and motivate their learning ability. At the same time, this paper also compares the two versions. The results show that the casual game version can attract more people's attention and interest more people. This may be a trend in the future. However, no matter which version is, it obviously promotes the motivation of participants to learn protein knowledge, which also shows that educational gamification has a very important meaning. In the future, it may be able to change the existing educational environment, which has a certain significance for the development of education.

## 5.2 Future Work

In the future, I will improve the user interface and optimize the body

action. As a gamified system, there should have more game elements. I will enrich the contents of this system, make it more attractive. And design more challenged levels for users exploring. As casual game indicate more potential in the educational filed, may be in the future, I will develop a VR version. However, some people still like choose video game version for learning, the comparison of these two version need to discuss deeply.

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