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Leveraging Gamification for Design and Implementation of an Online Learning Platform

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Abstract

Digital transformation of the education sector has garnered a lot of attention in recent times both from the industry and academia. Fueled by increased availability of the Internet and digital technologies, online education is going through rapid evolution. Many educational organizations have adopted online mode of operation, and dedicated e-learning platforms have emerged – making education available to a huge number of learners and encouraging lifelong learning. Taking advantage of the convenience of self-regulated anytime-anywhere education, millions of users enroll in online courses, but unfortunately only about a tenth of them complete these courses. One of the main reasons for this high dropout rate has been pointed out to be learners' incapability to retain motivation, or – putting it the other way round – lack of strategy by content providers to retain learners' motivation. Recently, gamification has been increasingly used in educational contents in order to retain learners' motivation throughout the duration of the course. In the same vein of such research, in this paper, we present Quiz and Treasures, a web-based learning platform which incorporates various game elements. We thoroughly analyzed the pros and cons of our proposed gamified learning system through the lens of Octalysis – one of the most prominent contemporary frameworks for gamification – and juxtaposing that result with Self-determination theory in terms of extrinsic and intrinsic motivation. We also conducted a user study, result of which shows our application influenced positively in retaining learners' motivation, with majority of them rating their experience as enjoying, and expressing intention to continue using the application. In addition, Quiz and Treasures allows instructors and administrators to register quizzes in advance and analyze results, enabling them to visually capture learners' level of progress.

Keywords: Gamification, online education, motivation, game elements

1 Introduction

Even before the COVID-19 pandemic, the education sector had been going through a rapid digital transformation facilitated by increasingly accessible and affordable computer- and Inter-

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net-based technologies and platforms for content creation, distribution, assessment and analytics. In recent years – especially in view of the new normal dictated by the pandemic – online education has been gaining a lot of attention in many countries [1]. For example, with widespread adoption by educational institutions, since their emergence in 2008, Massive Open Online Courses (MOOCs) have proven to be a great tool for lifelong learning, attracting over 110 million users [2]. MOOCs allow users to study and acquire skills relevant to the fast-changing working environments without physically going to universities regardless of age, race and gender. However, high dropout rate has been one of the most challenging problems related to MOOCs [3] with only around a tenth of the users completing courses [4]. The reasons for not completing courses on MOOCs vary greatly from user to user, but one of the main meta-reasons has been reported to be the difficulty in maintaining motivation throughout the duration of the courses [3]. In order to mitigate this motivation problem, there is a growing body of research that suggests incorporating gamification on MOOCs [5]. In simple terms, gamification refers to the use of game design elements in nongame contexts [6]. The basic idea is to inculcate a sense of engagement and competitiveness in each learner with a quasi-game environment [36]. Since such game elements can be easily and effectively implemented on webservices, we believe that the combination of online learning platforms and gamification is a potent way to retain learners' motivation throughout the learning period.

For this reason, we have developed Quiz and Treasures, a web application which can be used standalone or in combination with direct classroom teaching to make learning fun. Quiz and Treasures considers the administrators' or instructors' perspectives as well when online learning is used as complementary to classroom teaching. Monitoring students' progress can impose a huge burden on instructors if traditional approaches like quizzes based on the previous lesson, either pre-defined or on-the-fly, are administered during every lesson. On the contrary, if a gamified quiz template is prepared, instructors can take advantage of that as students are expected to be motivated to take the quizzes on their own outside class hours, thus effectively increasing the classroom hours in presence of instructors. In short, Quiz and Treasures is an effective online tool that leverages gamification for retaining students' motivation, and it helps instructors monitor students' learning status by evaluating and aggregating results. We have implemented Quiz and Treasures using Django, a Python-based web framework, and deployed the service on Heroku. The gamification elements include, among other features, clearing stages and competition with other learners through rankings. We also conducted a theoretical analysis and a user study which showed that using our service had a positive impact on retaining learners' motivation.

The rest of this paper is organized as follows. Section 2 briefly describes the related research. Section 3 and 4 explain the design and implementation of the webservice in detail. Section 5 presents an overview of the interfaces of the webservice. Section 6 analyses the proposed system using Octalysis gamification framework and Self-determination theory. Section 7 discusses the evaluation of Quiz and Treasures based on a user study, and the lesson we learned thereof. We provide some future considerations in the penultimate section before concluding in Section 9.

2 Related Work

Reasons for the low completion rates of MOOCs courses include lack of time, isolation, and lack of interactivity. However, the most significant cause has been cited to be the difficulty in maintaining learners' motivation [3]. One way to keep students motivated is gamification, which according to Kapp is defined as "the use of game mechanics, aesthetics, and game thinking to

engage people, motivate behavior, facilitate learning, and solve problems" [7].

Though originally introduced for a broader business scenario, the "points, badges and leaderboard" approach [8], or the PBL Triad for short is perhaps the most widely adopted game elements for MOOCs and other online education platforms.

- **Points** refer to numerical or symbolic representation of credits that users gain by successfully completing a number of activities. Points are a direct indication of how a user is performing.
- **Badges** refer to a distinguishable (software) token of appreciation that is presented to a user after she achieves a predefined milestone.
- **Leaderboards** refer to the ranking of learners in terms of learning performance. They clearly represent users' current status and level of learning, and provide a way to compare themselves with others.

Rohan et al. [9] conducted a comprehensive survey on gaming elements that are most widely used on MOOCs platforms. They identified 27 different gaming elements analyzing the literature. According to their survey, the top 5 most frequently used gaming elements are Badges, Leaderboards, Progress, Points, and Levels. Note that PBL is included in this ranking. Result comparable to Rohan et al. [9] has also been reported by Rincón-Flores et al. [5]. Our Quiz and Treasures includes a number of these highly ranked gaming elements.

In the following, we introduce a few prominent online learning platforms – MOOCs or otherwise – that use gamification to good effect.

- **Coursera:** Coursera [18] is an online learning platform that partners with top universities and companies of the world to provide universal access to education. It is one of the earliest and most successful MOOC platforms in the world. It provides both free and paid courses on a variety of topics. It incorporates gamification techniques by providing online degrees (reward like PBL) from top organizations – which only a few platforms can do. With its community-driven approach, it also promotes collaboration among teachers and students.
- **Udemy:** While MOOCs giants like Coursera leverages top universities and big companies to generate contents, Udemy [19] allows anyone to upload courses for students to purchase. This empowers any user with expertise in a certain area to take part in the teaching-learning process. Udemy gamifies the courses by providing progress bar to students and setting up rewards like trophy upon successful completion of courses.
- **SoloLearn:** SoloLearn [20] is a gamified application for learning programming languages. It provides coding lessons for a plethora of languages including Python, C++, C#, Java and JavaScript. Besides usual game elements, it also enables users to compete with peers via one-on-one contest. Moreover, it allows users to upload their own code or projects which other users can play with and interact, for example, by providing upvotes.
- **Yousician:** Yousician [21] is a gamified app for learning and practicing the guitar. Users can start with any level of expertise as it provides different levels from beginner to advanced. Yousician listens to the user's music and provide instant feedback. It keeps the user motivated by tracking her progress with analytics. Moreover, it allows users to upload their music of choice enabling them to learn their favorite songs.
- **Duolingo:** Duolingo [22] is smartphone app with huge user base for learning foreign languages. It covers many languages including German, Italian, Spanish, Japanese, Chinese, and Korean. Duolingo makes good use of many game elements. For example, they help the users achieve daily goals by providing progress meters. It also has its own currency called Lingots which users can use to buy tokens for avoiding penalties or customizing their avatars.

- **MeuTutor:** Oliveira and Bittencourt explored a tailored approach to education gamification called TGES (Tailored Gamified Educational Systems) [23] through the development of the MeuTutor system deployed in Brazil targeted toward elementary and high school students. This approach essentially categorizes students according to their innate 'gamer type' based on BrainHex player model [24]. Seven different gamer types are identified, namely, Achiever, Conqueror, Daredevil, Mastermind, Seeker, Socializer, and Survivor. MeuTutor provides a customized educational gamification experience to each student depending on their gamer type. Results reported by the authors [23] showed promise for TGES-based approaches, but they may not be suitable for all cases as counter-TGES approaches were also proven effective in some cases.
- **Khan Academy:** Khan Academy [10] is a popular non-profit web-based learning platform that offer courses for almost any age and subject category. It helps the students keep track of their progress by taking self-assessment quizzes, and awards the so-called "energy points" to keep students motivated.
- **TED-Ed:** Another popular web-based learning platform is TED-Ed [11] which takes a more story-telling approach with high quality animated video lessons on various topics. For each lesson, it provides quizzes and manages discussion board for interaction among learners. One particularly popular initiative of TED-Ed in partnership with UNEP is "Earth School" which, in addition to quizzes and discussion, awards certificates to successful students.

3 Design Considerations

Quiz and Treasures is a web-based learning platform. From a webservice development perspective, we considered the following design goals for developing Quiz and Treasures.

- An operation should be completed in as few steps as possible so that administrators and users do not find it cumbersome and continue using the service.
- The platform should be scalable so that multiple lectures and subject areas can be handled on the same platform.
- User intervention should be kept to a minimum so that learners can focus on learning. In other words, the gamification aspect should not distract the users from their main objective, i.e., learning.
- A mechanism should be created in order to allow questionnaires and game data to be linked together for further analysis.

3.1 Main Features of Quiz and Treasures

Quiz and Treasures includes all necessary features expected from an online learning platform. Users can study anytime and anywhere as long as they have a good Internet connection. Use of animation and graphically demanding illustrations are kept to a minimum for smooth loading on browsers running even on moderate-specification computers.

Quiz and Treasures provides three modes of operation: learning mode, game mode, and re-study mode as described below.

- **Game Mode:** Game mode presents a visual map of courses where some courses are "locked", and they can only be unlocked if one or more other courses have been successfully completed. Users are categorized into levels according to the number of courses they have completed. Starting at level 1, each user is promoted to the next level with completion of

each course. For example, if a user has completed 1 course, she belongs to level 2; for 2 courses, level 3; and so on.

- **Study Mode:** Study mode is set up for learners who only want to study by themselves in a non-gamified environment by solving quizzes. This mode is managed for users who are confident that do not need any gamification-induced motivation booster. Therefore, our system can be used in both gamified and non-gamified ways.
- **Re-study Mode:** In re-study mode, the questions, that have been wrongly answered by the user (for both game mode and study mode), are automatically stored in the database for future reference. Therefore, the user can review the wrong answers and take the quizzes again.

Quiz and Treasure considers not only cases of self-learning, but also cases where school instructors may use it as complementary to classroom teaching. Therefore, in addition to the above-mentioned learner-side features, Quiz and Treasures provides a number of instructor-side features. On our platform, the instructors can easily customize the learning content. They are provided with gamified quiz templates which can be used for generating new quizzes by supplying new questions. The instructors can also check the learning progress of any user in real time, and thereby extend feedback or support to applicable learners in a timely manner.

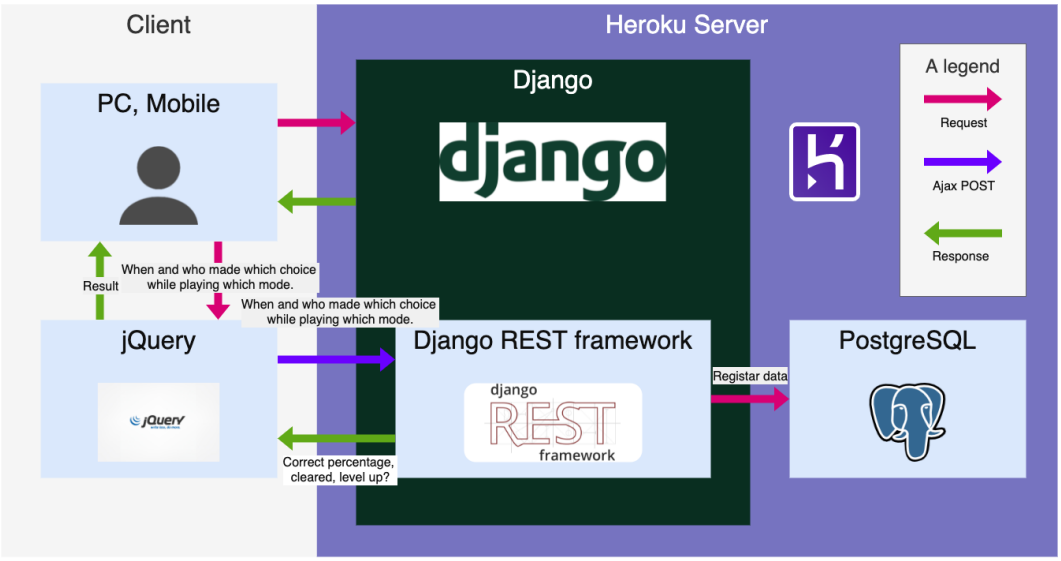

Figure 1: High-level system architecture of Quiz and Treasures

3.2 System Architecture

The high-level system architecture of Quiz and Treasures webservice is shown in Figure 1. Note that as a webservice, it follows the client-server architecture. The internal system of Django [12] is omitted for simplicity in Figure 1. There are two main types of pages in the webservice: static pages and quiz-related dynamic pages. The mechanism for displaying the static pages and dynamic pages is as follows:

- The client side (user or student) sends a request, and the server side processes the response.
- The quiz-related dynamic page first retrieves the quiz from the database.
- After that, when the user answers the quiz, jQuery [13] asynchronously POSTs it to the

Django REST framework [14], which registers the posted data to PostgreSQL [15] database.
- The results returned from the Django REST framework are formatted using jQuery and displayed on the user terminal.

3.3 Database Design

The database is designed as shown in the ER diagram in Figure 2. In the following, we provide a brief description of the ER diagram. Here, congruent to Django parlance, we use the term "model" to mean the same thing as relational-database notions of "relation" or "table".
- The Quiz model includes a foreign key reference to the Genre model.
- The CustomUser model has a many-to-many relationship with Quiz model to keep track of quiz mistakes.
- The Analytics model is used for generating analytics by storing information regarding which user chose which option and when.

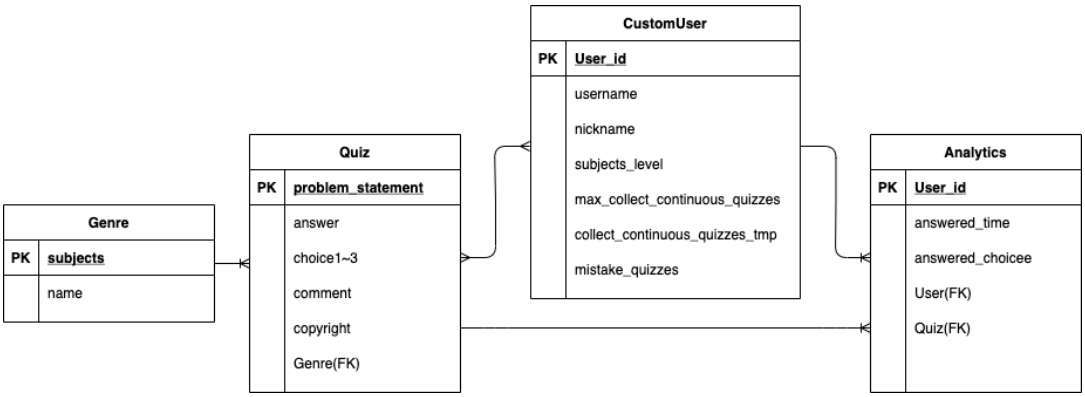

Figure 2: ER diagram

3.4 Contents of the Quizzes

In the current implementation, we created quizzes in the subject areas of informatics, mathematics, and English as specified in the Genre model. Questions for the informatics quiz were collected from the past questions of the Basic Information Technology Engineer exam conducted by the Information-technology Promotion Agency, Japan (IPA) [16]. The mathematics quizzes cover factoring and expansion, while English quizzes cover grammar, vocabulary, and idioms sections. Needless to mention, the platform is not limited to these subject areas only; it is scalable and other subjects can be seamlessly included as necessary.

4 Implementation

4.1 Flow of Interaction between User and Web Application

The interaction between a user and Quiz and Treasures is implemented by two main processes. Let us call them Process A and Process B as defined below.

- **Process A:** This process manages display of quizzes on web browsers.
- **Process B:** This process manages the task of analyzing quiz results and showing those to the user.

As shown in Figure 3, a user initiates interaction with the webservice by Process A which in turn invokes Process B. The steps involved in Process A and Process B are described below.

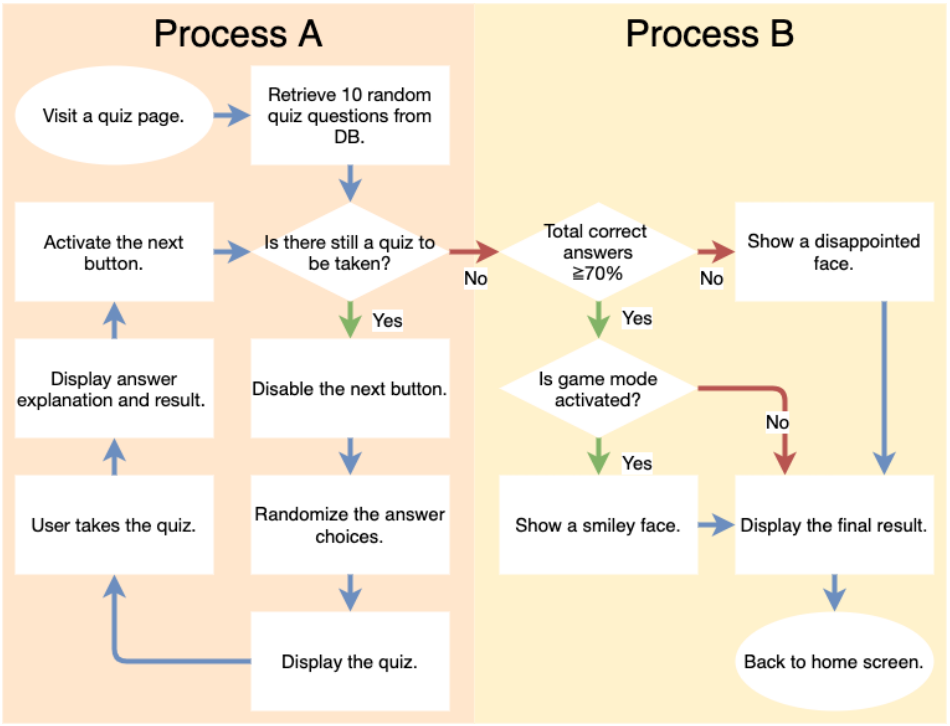

Figure 3: Flowchart of Process A and Process B

4.1.1 Steps in Process A

1) At first, the user visits a quiz page.
2) The server randomly retrieves 10 quizzes that match the conditions from the database.
3) Check if there are any quizzes left to be taken. If this condition check returns false, go to Process B.
4) Otherwise, enable the Next button.
5) Randomize the choices.
6) Display the quiz.
7) The user takes the quiz.
8) Display answer explanation and result.
9) Repeat as long as the result of step- 3 is true.

4.1.2 Steps in Process B

1) Check if the percentage of correct answers is 70% or more. If the result is less than 70%, show a disappointed face image.

2) If the result is 70% or more, check if game mode is selected. If game mode is selected, show a smiley face and display the final result. If game mode is not selected, display the final result only (without showing the laudatory smiley face).
3) Finally, return to the home screen.

4.2 Web Framework

We chose to use Django, a Python-based web framework, because it prevents common security misconfigurations, and allows developers to focus on developing the main functions of the web service. Additionally, the Django REST Framework is powerful and programmer friendly.

4.3 Application Programming Interfaces (APIs) for Quizzes

The Django REST framework provides a mechanism called serializer using which complex data can be handled and converted to Python data types for post-rendering in formats like JSON, XML and so on. This is mainly done by two classes, Serializer and ModelSerializer which provide the primitives for manipulating the output format and handling model instances and querysets objects. Using this serialization technique, we have created and utilized the following serializers in our webservice.

- QuizSerializer: For retrieving a quiz from the database.
- AnalyticsSerializer: For managing the quizzes to keep track of user's performance.
- QuizResultSerializer: For processing user's answers for a given quiz.

The following code snippet shows how these serializers are implemented by creating subclasses of the serializers.ModelSerializer class defined in the rest_framework package.

```
from rest_framework import serializers
from ..models import Quiz, Analytics, Genre

class QuizSerializer(serializers.ModelSerializer):
    class Meta:
        model = Quiz
        fields = '__all__'
        read_only_fields = ['__all__']

class AnalyticsSerializer(serializers.ModelSerializer):
    user = serializers.HiddenField(
        default=serializers.CurrentUserDefault()
    )
    class Meta:
        model = Analytics
        fields = ['user', 'answered_choice', 'quiz']

    def save(self, **kwargs):
        # snipped

class QuizResultSerializer(serializers.Serializer):
```

```
    numbers = serializers.IntegerField(min_value=0) # Quiz Length
    collect_numbers = serializers.IntegerField(min_value=0)  # Quiz Collect length
    genre = serializers.PrimaryKeyRelatedField(queryset=Genre.objects.all())
    mode = serializers.CharField(max_length=32)

    def save(self):
        # snipped
```

5 Interfaces of Quiz and Treasures

We deployed Quiz and Treasures web-based application using the Heroku cloud application platform [35]. It can be accessed through the following link: https://qtre.herokuapp.com/

The following color scheme was chosen for designing the webpages. On white canvas, two colors are used: orange (#FFA726) and blue (#0D97FF). These are complementary colors on the color wheel, and they also represent so-called warm and cool color respectively. Therefore, they were chosen to provide a balanced experience to the user. Orange is mainly used on the header and footer areas, and blue is used mainly for the buttons to make them easily visible.

Quiz and Treasure follows responsive design technique; therefore, the view automatically adjusts to different types of devices including laptop and smartphones. For example, Figure 4 shows how the homepage renders on laptop and smartphone. Also, note that the pages show information in both English and Japanese.

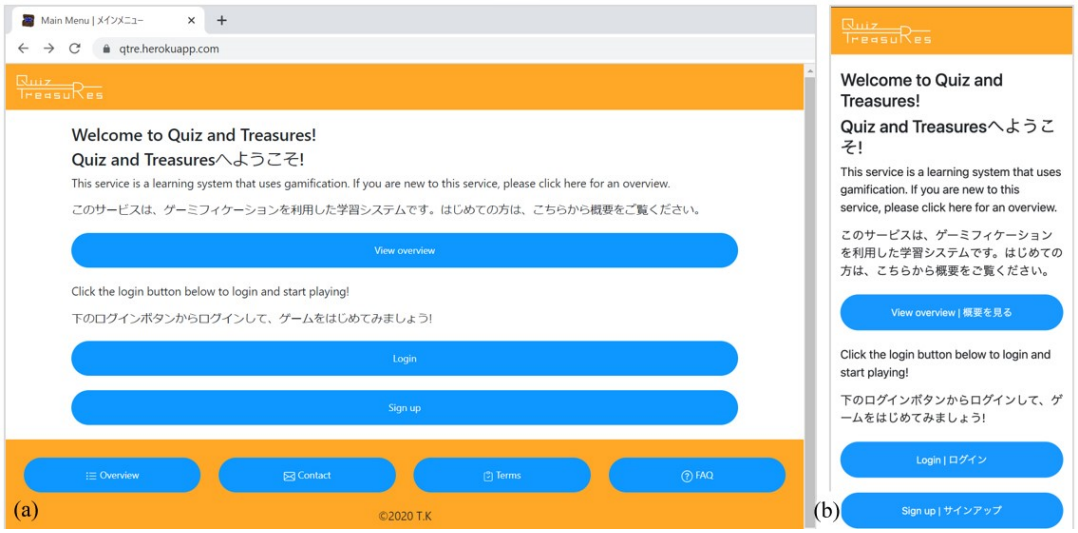

Figure 4: Responsive design: (a) Rendered on laptop, (b) Rendered on smartphone

In the following, we show screenshots of a few of the representative pages of the application. Figure 5(a) shows the screen where the user can select the subject they want to learn and play with. Figure 5(b) shows the ranking screen, where the levels are sorted in descending order. As shown in Figure 5(a), the background color of the selected course will change to orange, and a green "clear flag" will appear when the course is successfully completed. Each "locked" course

is visually represented by a padlock mark on top of the course name. The course at the center of the map will only be unlocked when all other courses have been successfully completed. In the current implementation, the center course (marked as 'secret' in Figure 5(a)) is composed of randomly selected quizzes from the entire database. The game mode menu (Figure 5(a)) keeps track of a user's nickname (to provide some sort of anonymity for the ranking chart), level, total number of correct answers (N) and total points (P). There are 10 levels, and the color of the crown (akin to badges) in the ranking chart or leaderboard depends on the level. For example, level 10 (highest level) is gold, level 9 is silver, level 8 is red, and so on.

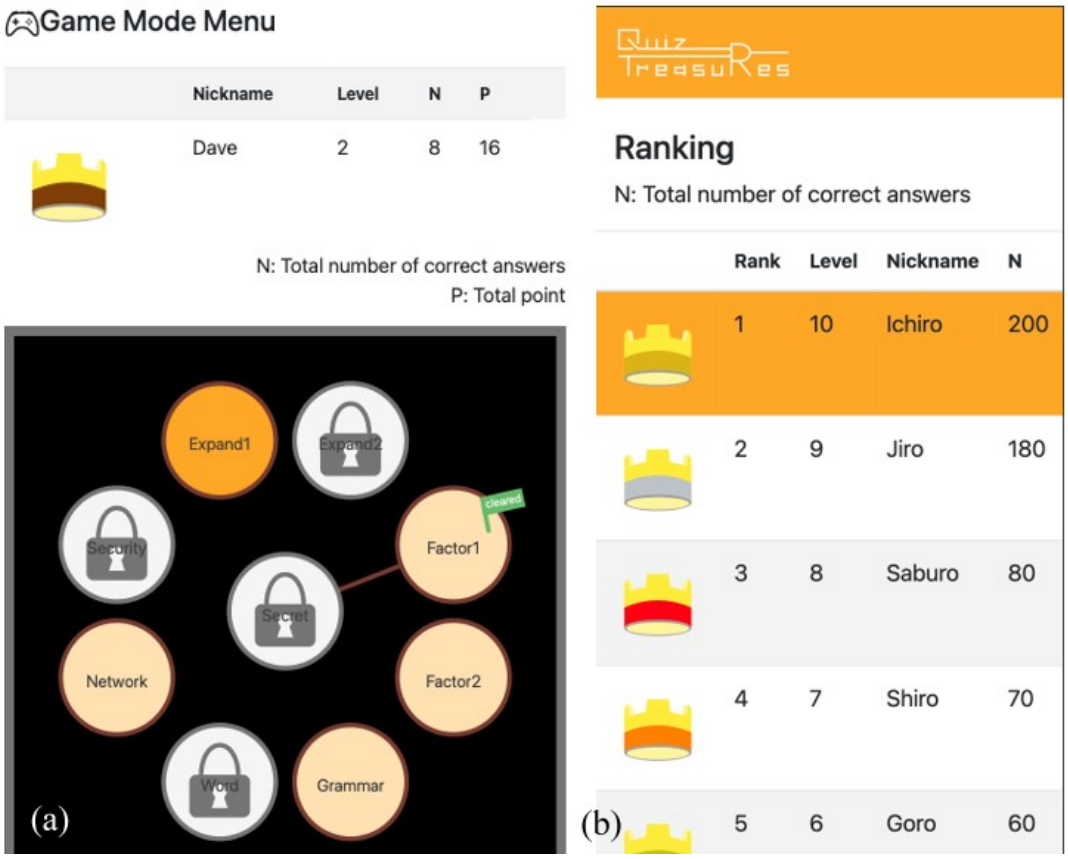

Figure 5: (a) Game mode menu screen, (b) Ranking screen

Figure 6 shows the results. In the game mode, a smiley face is displayed if the percentage of correct answers is 70% or more, and a disappointed face image is displayed if the percentage is less than 70%.

6 Analysis of the System using Gamification Framework

We analyzed Quiz and Treasures based on Octalysis [25] which is one of the most prominent gamification frameworks. This framework emanates from the dichotomy of function-focused design and human-focused design of systems design. Function-focused systems essentially focus on efficiency, while human-focused systems primarily deal with engagement of users with sys-

tems by retaining their motivation.

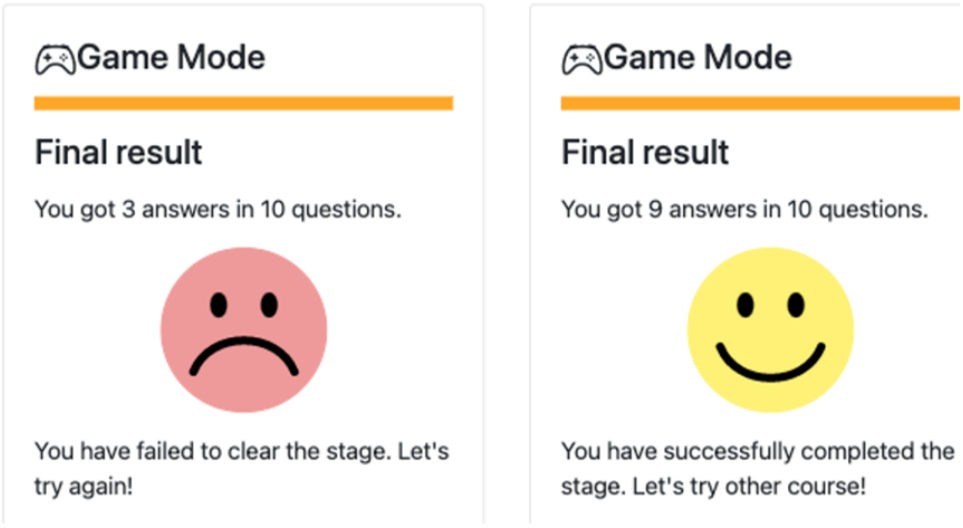

Figure 6: Final result screens (failure on left; success on right) on game mode

6.1 Analysis with the Octalysis Framework

The Octalysis framework identifies 8 "core drives" or motivating factors of human engagement that correspond to various game mechanics. It is visually represented with an equilateral octagon, as shown in Figure 7(a), where each side represents a core drive (CD). This framework has been widely used for analyzing and designing gamified systems, including plenty of educational gamification studies [27-32].

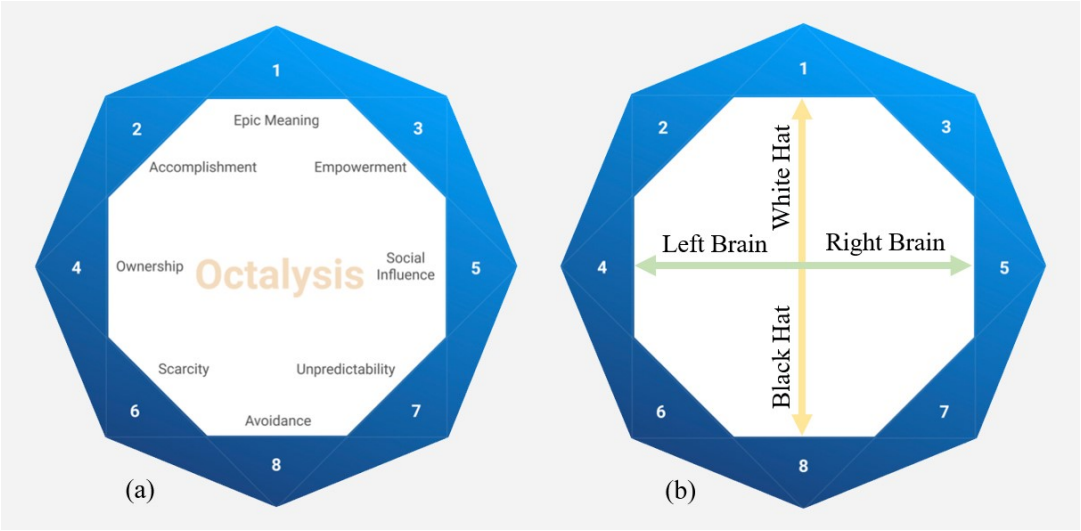

Figure 7: (a) The 8 core drives of Octalysis framework, (b) Depiction of left-brain/right-brain and white-hat/black-hat orientations in the Octalysis framework (adapted from [33])

The Octalysis website provides an intuitive interface, called Octalysis Tool [26], where users can score each CD of their systems out of 10. Based on the score of each CD, the size of each corresponding side of the octagon grows or shrinks proportionally, creating a graphical representation of the CD-score distribution. In the following, we explain the 8 CDs and how our system performs on each. The final result obtained using the Octalysis Tool is shown in Figure 8.

- **CD1 (Epic Meaning and Calling):** This is the core drive where the user believes that his pursuits are contributing to bigger cause compared to the direct objective of the system being used. For example, people who are voluntarily managing open-source projects are driven by CD1. At present, CD1 is implicit in our system as we assume that instructors in charge of classes will help students discover their epic calling and meaning beyond the main purpose of Quiz and Treasures, i.e., education. In future, we intend to create interfaces that will enable students to submit their own quizzes to help other students practice. This opportunity to contribute will help students find their epic meaning and calling in terms of helping the system grow.
- **CD2 (Development and Accomplishment):** This represents the drive which motivates human beings to innately strive for overcoming challenges and achieving recognition for successful pursuits. Quiz and Treasures satisfies this drive by implementing widely used game elements like points, badges, leaderboards, and progress to upper levels.
- **CD3 (Empowerment of Creativity and Feedback):** This drive serves a player's tendency to exercise creativity by trial and error. Timely and appropriate amount of feedback plays an important role in harnessing the best from this process of trial. Quiz and Treasures tantalizes learners' creativity by setting up a secret level which can be accessed only after clearing all other levels – making them try different creative ways of solving problems. Instant feedback about correctness of answers is provided to the learners. Moreover, the re-study mode helps learners keep trying and not give up on their creativity.
- **CD4 (Ownership and Possession):** The sense of ownership and possession naturally drive motivation. In Quiz and Treasures, the learners own their virtual points and badges. Although originally not implemented with this specific CD in mind, the re-study mode helps create a sense of ownership and belonging to the system.
- **CD5 (Social Influence and Relatedness):** This drive encapsulates different social aspects of motivation, including collaboration, teamwork, and competition. The current version of Quiz and Treasures does not include any collaborative or team-oriented activity to be performed by peer learners. Instead, we piggyback on implementation of CD2 which creates an atmosphere of competition among peers by motivating them to gather higher status in terms of recognition and incentives gained from the system.
- **CD6 (Scarcity and Impatience):** This drive takes the advantage of the fact that human beings usually have preference for instant gratification. By delaying desired gratification and creating a sense of scarcity, engagement and longing can be enhanced. Quiz and Treasures does exactly that by implementing a secret level to reach which all other levels have to cleared successfully.
- **CD7 (Unpredictability and Curiosity):** This drive taps into the intrinsic human behavior to explore the unknown and fascination for the unpredictable. Story-based gamification techniques make great use of this CD. Quiz and Treasures is not based on story where characters unfold or evolve at different stages, but we implement CD7 by randomizing question order making the system less predictable and keep the learners engaged.
- **CD8 (Loss and Avoidance):** This drive utilizes our fear for losing something we worked hard for, and thus retain engagement. Quiz and Treasures does not implement any thing specific pertaining to CD8. However, learners will naturally lose their points or badges if

they leave the system. Moreover, quizzes have to be retaken if the minimum score requirement is not achieved, and previous scores will not be taken into account.

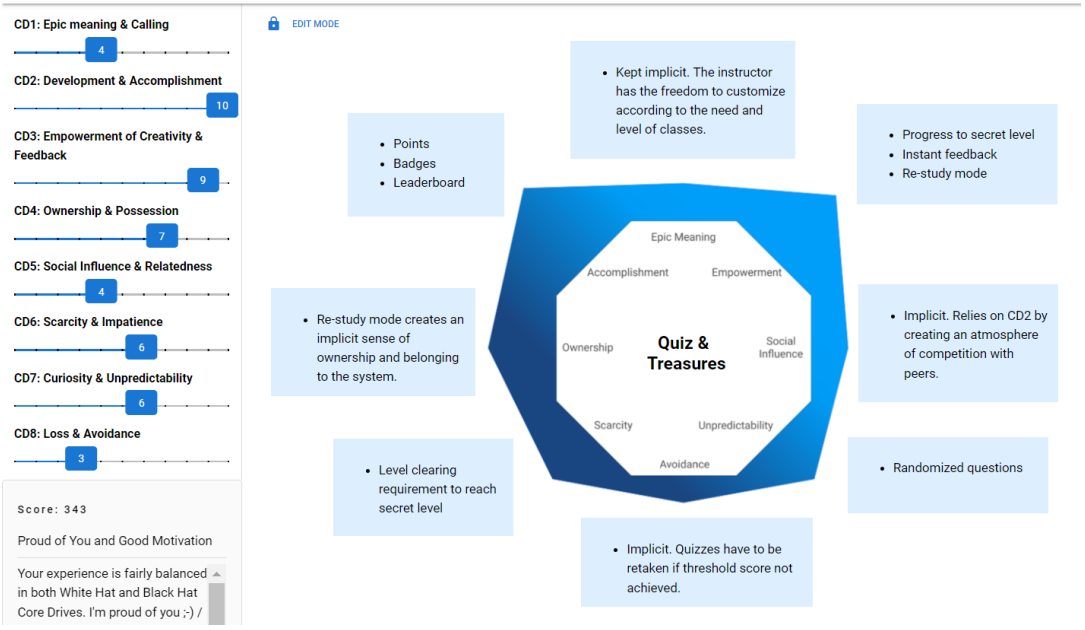

Figure 8: Analysis of Quiz and Treasures using Octalysis Tool

6.2 Interpreting the Octalysis Score

Using the Octalysis Tool, each CD can be scored on a scale of 0-10 (where 0 means complete absence of a CD, and 10 means completely developed CD) based on subjective judgement or user experience data. The final score is calculated by adding the squares of individual CD scores. As can be seen in Figure 8, Quiz and Treasures obtained a final score of 343. It should be noted that the score itself merely serves the purpose of numerically and graphically representing the CD distribution, and the Octalysis framework posits that "a good gamified system doesn't need to have all of the Core Drives, but it does need to do really well with the ones it does implement" [33]. As demonstrated in Figure 8, Quiz and Treasures has its strengths and weaknesses, but overall – as reported by the Octalysis Tool – it exhibits a fairly balanced experience in term of both left-brain/right-brain and white-hat/black-hat gamification, which are discussed next.

6.3 Left Brain vs. Right Brain Gamification

The symbolic – and not necessarily scientific in terms of brain anatomy – left-brain/right-brain dichotomy categorizes the core drivers based on rationale or emotion associated with them. The left-brain core drives are more related to logic, analysis, and ownership. These include the core drives depicted on the left side of the octagon (Figure 7(b)), namely, CD2, CD4 and CD6. On the other hand, right-brain core drives are more related to creativity, sociality, and curiosity. These include core drives depicted on the right side of the octagon (Figure 7(b)), namely, CD3, CD5

and CD7. Though Quiz and Treasures is quite balanced on either side of the octagon, it is slightly left-brain heavy. Specifically, we have to improve on CD5 (Social Influence) by implementing collaborative group activities, and CD7 (Unpredictability) by incorporating more unpredictable elements to enhance curiosity of learners respectively. It is important to note that – with slight semantic difference – right-brain core drives are more associated to intrinsic motivation, a notion made popular by the influential Self-determination theory [34], while left-brain core drives coincide more with extrinsic motivation. With this notion, Quiz and Treasures focuses more on extrinsic motivation mainly by providing incentives to learners. However, in the long run, over-reliance on extrinsic motivation may impede intrinsic motivation – motivation that thrives even in absence of direct incentives. Therefore, we are currently working on honing the intrinsic motivation aspect of Quiz and Treasures.

6.4 White Hat vs. Black Hat Brain Gamification

The Octalysis framework also classifies the top half and bottom half of the octagon based on so-called positive motivators and negative motivators (Figure 7(b)). The top half consists of CD1, CD2 and CD3, and gamification that focuses on these are referred to as white hat gamification. In contrast, the bottom half consists of CD6, CD7 and CD8, and gamification that focuses on these are referred to as black hat gamification. According to the Octalysis Tool, Quiz and Treasures is fairly balanced with both white and black hats, however, the white-hat nature is slightly more dominant. Our white-hat approach focuses on user engagement mainly based on positive reinforcement in terms of sense of accomplishment and empowerment. On the other hand, black-hat techniques rely on retaining user motivation based on fear of losing incentives. Alike white hat gamification, black hat gamification is also a widely used technique, and many successful games or gamified systems effectively use it to harness user motivation. However, black hat gamification may sometimes cause addiction and obsessiveness, and hence, we are satisfied with our slightly white-hat-dominated approach of Quiz and Treasures.

To summarize, the Octalysis framework represents a comprehensive picture of sources of human motivation. Definitely, different people are motivated in different ways; therefore, a gamified system with a good mix of the 8 core drives would cater to a good number of users. In this respect, Quiz and Treasures performs well.

7 User Study

We conducted a user study to evaluate our Quiz and Treasures application using online questionnaire survey which was conducted over two weeks. A total of 27 subjects used the application, and 21 of them responded to the survey. 17 of the subjects were males, 3 were females, and 1 subject preferred not to disclose their gender. Most of the subjects were in their twenties.

7.1 Evaluation Method

The user study was conducted both face-to-face and online. Subjects were asked to follow three steps: (1) get themselves accustomed to using the webservice (we prepared an introduction video

for this), (2) Use Quiz and Treasures, and (3) answer the questionnaire. This procedure is described on the webpage as well.

7.2 Evaluation Items

The evaluation items were categorized into three sections: A, B and C with a total of 16 questions as shown in Table 1. Most of the questions were based on 4-point or 6-point Likert scale.

Table 1: Evaluation items

Section	Question No.	Question
A	Q1-Q5	Questions about user's personal information related to age, gender, area of study, etc. for statistical analysis. Such information was collected anonymously.
	Q6	Have you used cram schools, or any other learning material in the past?
B	Q7-Q8	If you have used cram schools, study materials, etc. in the past, compared to them, how would you rate *Quiz and Treasures*?
	Q9	How easy or difficult was it understand the gaming elements?
	Q10	Did you have fun using our app?
	Q11	Rate the difficulty level of the quiz problems.
	Q12	Would you like to try *Quiz and Treasures* in the future for other fields of study?
	Q13	Did you feel that you improved in your chosen subject area after using *Quiz and Treasures*?
	Q14	Overall, how was your experience?
C	Q15	List the good points about this application (optional/comment type)
	Q16	List the points to be improved for this application (optional/comment type)

7.3 Evaluation Result

Here we present the results of evaluation for section B and C. Figure 9(a), corresponding to Q9, shows that it was easy for most people to understand the superficial concept of gamification. Note that only a brief description of gamification was given in the overview. Figure 9(b), corresponding to Q10, suggests that there is a certain level of enjoyment in this application, as 71% of the respondents thought so. Figure 9(c), corresponding to Q11, shows that the respondents were divided in rating the difficulty level of the quiz problem, which probably indicates that the problem selection had a good mix of problems to attract users form different levels of intellectuality. As shown in Figure 9(d), corresponding to Q12, 80% of the respondents expressed their desire to continue using the application or try the application for other subject areas currently not provided. From Figure 9(e) corresponding to Q13, we can see that majority of the respondents were able to experience personal growth after using the application. Likewise, Figure 9(f), cor-

responding to Q14, indicates that most of the users were satisfied with their overall experience with Quiz and Treasures.

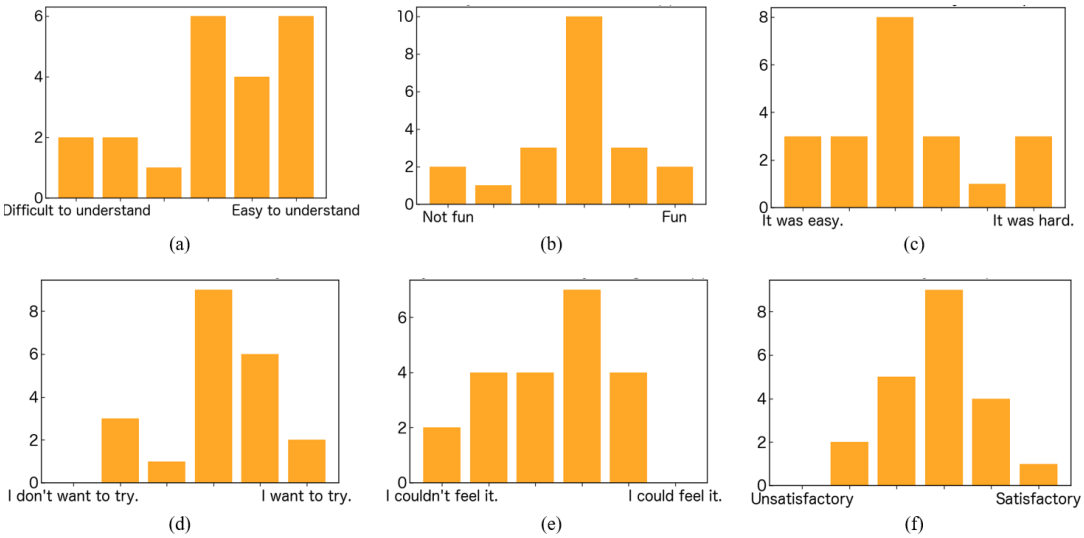

Figure 9: Evaluation result. Bar charts (a) though (f) correspond to questions Q9 though Q14 respectively as mentioned in Table 1

Table 2 summarizes the result of evaluation Section C of Table 1 in which users were asked to freely comment on the merits and demerits of the application. From the demerits mentioned, we acknowledge the fact that there is ample room for improvement in terms of making the gaming elements more appealing in order to provide a more fun experience, and consequently make the application stand out more prominently.

Table 2: Evaluation result summary for section C of Table 1

Section C	Respondents' comments	No. of response
Good points	Ranking Display	1
	Easy to understand User Interface	7
	For each answer, immediate display of result by auto screen-dwon-scroll	3
	Re-study mode	4
	Scope of study	2
Points to be improved	Not so much fun	2
	Not much different from other apps	2

For Q15 and Q16 of Section C, the users also provided some insightful feedback that are not directly related to gamification. For instance, we used Bootstrap [17] for the front-end design, and it turned out that many users appreciated the responsive design which dynamically adjusts

for different screen sizes and viewports including laptops, smartphones and tablets. Moreover, a number of users found the feature of automatically adding ill-performing users to re-study mode useful. Users are grouped into re-study mode when their performance is not satisfactory, and hence this mode allows them to review the contents for better performance in future. We believe this has a direct or indirect impact in retaining learners' motivation as they are not left alone with poor performance; instead, they are given chances to study again. Since several respondents pointed this feature out as a merit, we can infer that it is an essential feature for learning applications. Finally, the general impression about the user interface of Quiz and Treasures was good.

8 Discussion and Future Considerations

As discussed in section 6 and 7, Quiz and Treasures performs satisfactorily in terms of both Octalysis gamification framework, and the user study conducted. The system manifests a good balance with regard to distribution of the 8 core drives delineated by Octalysis. However, the score for core drive 5 (social influence and relatedness) is below average. In the current implementation, we model the social influence aspect by promoting competition among learners using game mechanics like points, level progression, and leaderboards. However, one important dimension of social influence is missing, and that is collaboration. Social influence is driven not only by competition, but also by our inherent propensity for collaboration and teamwork with peers. Quiz and Treasures at present does not provide any activity that promotes such collaboration and group work among learners. Since social influence and relatedness is a crucial factor for retaining intrinsic motivation according to the Self-determination theory, improvement on this aspect is our most important ongoing and future work.

Majority of the participants of the user study provided positive feedback. However, the following points are worth noting. First, we were not able to conduct a comparison experiment. We could not compare people who used the application with those who did not, in order to firmly conclude the effectiveness of our application in assessing learning progress. We intend to address these issues in our future research. In addition, to understand user progress in a more objective manner, we are planning to conduct a longitudinal study by having the same set of users learn a subject area without using the app, and then using the app – to finally examine how their performance differs. Second, since most of the subjects were students who use computers on a regular basis, it may not be possible to conduct the same kind of user study expecting same kind of result if the subjects are not adept in using computers and webservices. However, this will not be a practical problem as in today's information age, young adults and digital natives use webservices and smartphone apps for many day-to-day activities.

9 Conclusion

In this paper, we explain the design and implementation of a web-based learning platform developed incorporating gamification. Our application features widely used game elements including the PBL triad. A gamified environment is created where users can study retaining their motivation by gathering points, unlocking levels, competing to get a place in the ranking chart and so on. Apart from theoretical analysis with a widely used gamification framework, a user study was conducted to evaluate the effectiveness of the application. Most of the users rated their

overall experience as satisfactory and expressed their interest in continuing using the app beyond the three subject areas that are currently offered. This result matches the analysis based on Octalysis gamification framework where a balanced distribution of motivational drivers was confirmed. Therefore, we believe our application was able to have a positive impact in retaining user motivation, lack of which is often cited as the main reason for dropouts in self-study type online educational platforms. Furthermore, our application provides a range of tools for instructors to administer the quizzes and collect and analyze the results for keeping track of users' performance. We intend to further develop the application by implementing a richer set of game elements for a wider audience covering more subject areas.

Note: An earlier version of this paper was presented at the 10th International Congress on Advanced Applied Informatics (IIAI-AAI), 2021 [37].

References

[1] "How Countries are Using Edtech (Including Online Learning, Radio, Television, Texting) to Support Access to Remote Learning during the COVID-19 Pandemic," The World Bank, 2020. [Online]. Available: https://tinyurl.com/world-bank-remote-learning [Accessed: Feb. 28, 2022].

[2] D. Shah, "By The Numbers: MOOCs in 2019," classcentral.com, 2019. [Online]. Available: https://www.classcentral.com/report/mooc-stats-2019/ [Accessed: Feb. 28, 2022].

[3] M. Morales, R. H. Rizzardini, and C. Gütl, "Telescope, a MOOCs initiative in Latin America: Infrastructure, best practices, completion and dropout analysis," In Proc. IEEE Frontiers in Education Conference (FIE), 2014, pp. 1-7.

[4] K. Jordan, "MOOC Completion Rates: The Data, Researching Education and Technology," June, 2015 [Online]. Available: http://www.katyjordan.com/MOOCproject.html [Accessed: Feb. 28, 2022].

[5] E. G. Rincón-Flores, M. S. R. Montoya, and J. Mena, "Engaging MOOC through gamification: Systematic mapping review," in Proc. 7th International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM'19), 2019, pp. 600–606.

[6] S. Deterding, D. Dixon, R. Khaled, and L. Nacke, "Gamification: Toward a definition," In Proc. Annual Conference Extended Abstracts on Human Factors in Computing Systems (CHI), 2011, pp. 12-15.

[7] K.M. Kapp, The Gamification of Learning and Instruction: Game-based Methods and Strategies for Training and Education. CA: Pfeiffer, 2012.

[8] K. Werbach, and D. Hunter, For the Win: How Game Thinking Can Revolutionize Your Business, Wharton Digital Press, 2012.

[9] R. Rohan, D. Pal, and S. Funilkul, "Mapping gaming elements with gamification categories: Immersion, achievement, and social in a MOOC setting," In Proc. 14th IEEE International Conference on Innovations in Information Technology (IIT), 2020, pp. 63-68.

[10] Khan Academy. [Online]. Available: https://www.khanacademy.org [Accessed: Feb. 28, 2022].

[11] TED-Ed. [Online]. Available: https://ed.ted.com/ [Accessed: Jun.1, 2021]

[12] Django Software Foundation, Django. [Online]. Available: https://www.djangoproject.com/ [Accessed: Feb. 28, 2022].

[13] Open JS Foundation, jQuery. [Online]. Available: https://jquery.com/ [Accessed: Feb. 28, 2022].

[14] Encode OSS Ltd., Django REST framework. [Online]. Available: https://www.django-rest-framework.org/ [Accessed: Feb. 28, 2022].

[15] PostgreSQL Global Development Group, PostgreSQL. [Online]. Available: https://www.postgresql.org/ [Accessed: Feb. 28, 2022].

[16] IPA: Information Technology Promotion Agency, Japan. [Online]. Available: https://www.ipa.go.jp/ [Accessed: Feb. 28, 2022].

[17] Bootstrap Team, Bootstrap. [Online]. Available: https://getbootstrap.com/ [Accessed: Feb. 28, 2022].

[18] Coursera. [Online]. Available: https://www.coursera.org/ [Accessed: Feb. 28, 2022]

[19] Udemy. [Online]. Available: https://www.udemy.com/ [Accessed: Feb. 28, 2022]

[20] SoloLearn. [Online]. Available: https://www.sololearn.com/home [Accessed: Feb. 28, 2022]

[21] Yousician. [Online]. Available: https://yousician.com/ [Accessed: Feb. 28, 2022]

[22] Duolingo. [Online]. Available: https://www.duolingo.com/ [Accessed: Feb. 28, 2022]

[23] Oliveira, W., Bittencourt, I. I., "MeuTutor: Personalizing an Educational Technology Based on Students' Gamer Types," In Tailored Gamification to Educational Technologies, pp. 71-84, Springer, Singapore, 2019.

[24] Nacke, L. E., Bateman, C., Mandryk, R. L., "BrainHex: A neurobiological gamer typology survey," Entertainment computing, 5(1), pp. 55-62, 2014.

[25] Chou, Y. K., "Actionable gamification: Beyond points, badges, and leaderboards," Packt Publishing Ltd., 2019.

[26] Octalysis Tool. [Online] Available: http://www.yukaichou.com/octalysis-tool/ [Accessed Feb. 28, 2022].

[27] Marisa, F., Ahmad, S. S. S., Yusoh, Z. I. M., Maukar, A. L., Marcus, R. D., Widodo, A. A., "Evaluation of Student Core Drives on e-Learning during the Covid-19 with Octalysis Gamification Framework," Evaluation, 11(11), 2020.

[28] Christopher, L., Waworuntu, A., "Java Programming Language Learning Application Based on Octalysis Gamification Framework," IJNMT (International Journal of New Media Technology), 8(1), pp. 65-69, 2021.

[29] Sulispera, T., Recard, M., "Octalysis Gamification Framework for Enhancing Students' Engagement in Language Learning," JURNAL DIALEKTIKA PROGRAM STUDI PENDIDIKAN BAHASA INGGRIS, 8(2), pp. 103-128, 2020.

[30] Irawan, A. J., Tobing, F. A. T., Surbakti, E. E., "Implementation of Gamification Octalysis Method at Design and Build a React Native Framework Learning Application," In 2021 6th International Conference on New Media Studies (CONMEDIA), pp. 118-123. IEEE, 2021.

[31] Diena Rauda, R., Dian Sa'adillah, M., Yana Aditia, G., Novian Anggis, S., Muhammad Ali, R., "Octalysis Audit to Analyze Gamification on Kahoot!," Advances in Science, Technology and Engineering Systems Journal, 6(1), pp. 457-463, 2021.

[32] Toasa, R. M., Celi, E., Herrera, L., "Using accomplishment from Octalysis Framework in a Dynamic Game," In 2020 15th Iberian Conference on Information Systems and Technologies (CISTI), pp. 1-5, IEEE, 2020.

[33] Chou, Y., Octalysis: Complete Gamification Framework. [Online]. Available: http://www.yukaichou.com/ [Accessed: Feb. 28, 2022]

[34] Deci, E. L., Ryan, R. M., "Self-determination theory," In P. A. M. Van Lange, A. W. Kruglanski, & E. T. Higgins (Eds.), Handbook of theories of social psychology, pp. 416–436, Sage Publications Ltd., 2012.

[35] Heroku Cloud Application Platform. [Online]. Available: https://www.heroku.com/ [Accessed: Feb. 28, 2022]

[36] T. Katanosaka, M. F. F. Khan, K. Sakamura, "PhyGame: An Interactive and Gamified Learning Support System for Secondary Physics Education," International Journal of Advanced Computer Science & Applications. 2024 Jun 1;15(6).

[37] T. Katanosaka, M. F. F. Khan and K. Sakamura, "Quiz and Treasures: Development of a Web-based Learning Platform using Gamification," 2021 10th International Congress on Advanced Applied Informatics (IIAI-AAI), Niigata, Japan, 2021, pp. 166-171, doi: 10.1109/IIAI-AAI53430.2021.00029.