Preventing Cheating in an Audience Participation Game by Adding a Virtual Moderator

Roman Savchyn (M. Eng. Graduate, Graduate School of Information Science and Engineering, Ritsumeikan University)

Febri Abdullah (Doctoral student, Graduate School of Information Science and Engineering, Ritsumeikan University)

Ruck Thawonmas (Professor, College of Information Science and Engineering, Ritsumeikan University)
E-mail ruck@is.ritsumei.ac.jp

要旨
　本稿は、検索エンジンや視覚障害者のために利用される浮世絵の説明文を収集するための JUSTIN ゲームの改善に焦点を当てている。改善版ゲームでは、仮想のアニメキャラクターによる司会進行及び直感的な GUI に加えて、不正行為を防止し、他の参加者から説明文を盗用した人を罰する公正なシステムを導入した。不正行為をなくすことでゲーム体験を向上させるという仮説を検証するために、2 つの実験を行った。2回目は、最初の実験と比較して、上記の改善策を導入した後の楽しさが高く、個人的な満足度が高いことが示唆された。

abstract
　　This study focuses on extending our research on the JUSTIN game - an Audience Participation Game with A Purpose (APGWAP) used to collect descriptions for ukiyo-e artworks utilized to help search engines and people with visual impairments. To improve players' enjoyment and experience during the game, we introduced an entertaining virtual moderator in the form of a Virtual Anime Character, an intuitive Graphical User Interface, and a fair system for preventing cheating and punishing those who are stealing descriptions from other participants. We conducted two user studies to evaluate our hypothesis on improving the gaming experience by ceasing cheating. The latter demonstrates a higher level of enjoyment and personal gratification, compared to the first experiment, after introducing the above-mentioned improvements.

1. Introduction

With the aim of collecting high-quality descriptions of ukiyo-e artworks, researchers from our lab introduced JUSTIN – a game that allows many players to come up with creative descriptions for pictures in a gamified way. Despite JUSTIN being a ground-breaking work that introduced a whole new Audience Participation Game with A Purpose (APGWAP) game concept and made it much easier and more entertaining to create descriptions for Japanese ukiyo-e artworks, it still had some major flaws such as its repetitive nature (doing the same thing repeatedly) and cheaters who are copying best descriptions in hope to win some points. Considering those issues, we decided to improve JUSTIN by solving the above-stated decisions and discovering new possibilities for other games as well.

This study aims to improve players' experience in a JUSTIN game by introducing tools to detect and prevent cheating, a new virtual character who will play the role of a game moderator, and an improved GUI to make the process of playing the game more intuitive. A virtual character is set to warn prospective cheaters and explain the rules of the game. Finally, a new UI is replacing the chatbox to simplify interaction with the game. We
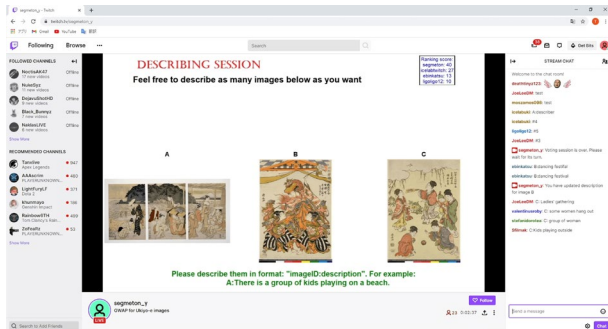
Fig. 1. Original JUSTIN game on the Twitch streaming platform. Chatbox on the right is used to receive game input.
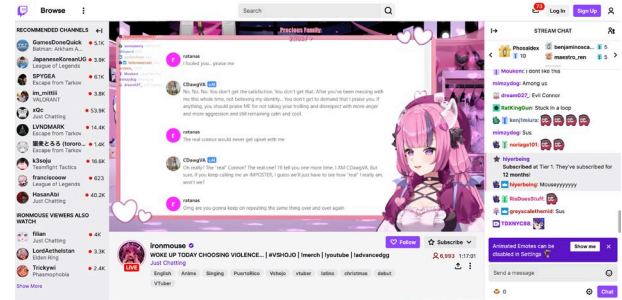

Fig. 2. Ironmouse, a Vtuber affiliated with VShojo company, is streaming live on Twitch. Like most Vtubers, she is using a Live2D model (Virtual Youtuber Wiki, 2020)

hypothesize that our cheating prevention system will increase players' enjoyment and engagement. The quality of the collected descriptions is beyond the scope of this study.

2. Related works

2-1. JUSTIN

JUSTIN (Japanese Ukiyo-e Streaming That Improves Narrative) (Nguyen *et al.,* 2020) is a game system of the APGWAP genre, Audience Participation Game with a Purpose, meaning that this game is created with the purpose of solving some tasks in a fun and entertaining way. In the case of JUSTIN, the purpose is to collect descriptions for ukiyo-e artworks. Among other things, those descriptions can be used to improve search engine results and help people with visual impairment understand what is shown in a particular work of art. The original JUSTIN game uses Twitch - a popular streaming service. Players view the screen of the game as a live streaming video and interact with it using a chatbox on the right side of the screen, as shown in Fig. 1.

APGWAP is a new concept, and JUSTIN is the first game to ever introduce it. It combines the Audience Participation Game (APG) and Game with a Purpose (GWAP) genres together (Nguyen *et al.,* 2019). APG is a genre of games where the audience operates the game together simultaneously - for example, by manipulating the Pokemon game on the Twitch streaming platform (Financial Post, 2014). On the other hand, GWAP games focus on solving problems or finding solutions through entertainment.

2-2. Virtual YouTubers

Vtubers (short for Virtual YouTubers) is a recent phenomenon on the internet. It is a virtual celebrity in the form of an avatar with a voice actor behind it that performs online on streaming platforms such as Twitch and YouTube (Lu *et al.,* 2021). An example of how a typical live stream by a Virtual YouTuber looks is shown in Fig. 2. A study by Lu et al. (2021) demonstrated that virtual celebrities are especially popular among young people interested in anime, manga, games, and Japanese culture in general. Since the purpose of our baseline project, i.e., JUSTIN, is collecting descriptions for ukiyo-e artworks, an audience that is interested in Japanese culture may be highly beneficial for our research. In addition, our projects target young people.

More and more researchers are incorporating those new virtual characters in their studies to promote more flawless interaction with application users or game players. As an example, Takagi *et al.* (2021) created a simple application for collecting donations for charity, to which they added a cute anime character that will change facial expressions based on the amount of the selected donation. For their user study, they divided people into two groups - one would see a character that will change emotions using static PNG images, and another group will see a fully animated model that was animated using Live2D technology (live2d.com). The experiment suggested that the group of people with the animated model, in general, donated more money.

The Live2D technology mentioned above is a technique for creating 2D animations without using time-consuming frame-by-frame animation and complex 3D models. The software used to create Live2D models is called Live2D Cubism
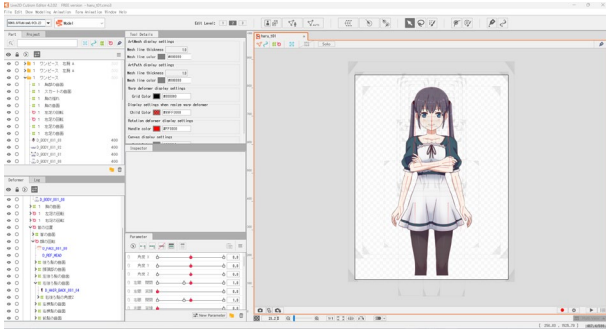
Fig. 3. A Live2D Cubism Editor with Haru model opened.

Editor and is shown in Fig. 3. Models made in this application consist of several layered parts (eyes, mouth, hair, etc.) and together they form a skeleton model. Thanks to that, the user can execute any particular animation at any given moment (Savchyn *et al.,* 2021). No wonder why this technology become popular among Vtubers - it is cheaper, easier, and faster to make Live2D models compared to complex 3D models, but the quality of Live2D is still pretty high.

Virtual YouTubers, along with researchers in the field of virtual characters, also use 3D models. 3D models have better facial and body expressions, but the time and money required to create them are significantly higher compared to Live2D. Nevertheless, Gamage *et al.* (2018) used a three-dimensional avatar in their research to assist students during the lesson, and the results are promising - they noticed that the character increases engagement, and retention of knowledge, and proved to be helpful in learning support. Similar conclusions were drawn by Susanti *et al.* (2023) for online lessons in their research.

All studies above demonstrate highly promising results from utilizing virtual characters in several applications, and the free availability of Live2D technology makes it possible to implement it in various kinds of projects for further testing in a short time. Hence, we decided to try using a virtual avatar as a moderator in the JUSTIN game to improve the player's experience and make the game experience more memorable, enjoyable, and, of course, less repetitive. Our system is described in our previous study (Savchyn *et al.,* 2021), and we successfully implemented it for further research afterward. The implementation will be presented in this paper.

Fig. 4. An example of winning and cheating descriptions in JUSTIN. The bottom one differs only by the inclusion of an ellipsis '…', but the original JUSTIN game won't be able to detect it and will accept both descriptions. The description on the top won in one of the previous game sessions.

2-3. Cheating prevention

Cheating is a big problem in online environments such as online classes and online games, especially after COVID started and many people had to switch online. JUSTIN, being an online environment, is not an exception - describers may copy winning descriptions they see during the "Winning session," slightly modify them (for example, by adding an exclamation mark at the end of a sentence, just as shown in Fig. 4), and submit them as a new one to gain points in the game. Such actions may highly influence the outcome of the game with duplicated descriptions and decrease the player's motivation to come up with unique sentences. In other words, the game won't be as enjoyable and as effective as it could be.

Corrigan-Gibbs *et al.* (2015) tried to solve a cheating issue in online exams back in 2015 by introducing a simple warning message that clearly explained that cheating can lead to the cancellation of exam results, notification of the university, and other unpleasant outcomes. In their experiment, they decided to compare the usage of an honor code (a message just asking students to follow the rules) and a warning message (an extended message showing possible negative outcomes for cheating). Results indicate that a simple warning message before the online exam is more effective in preventing cheating than just an honor code. However, researchers argue that over time participants may become numb to this warning and cheating will rise again.

When it comes to online games, many game companies are incorporating various techniques to detect and warn or even ban cheaters from further participation in the game. Some players are highly frustrated because the reason for the ban is usually poorly or not stated at all. Tao *et*
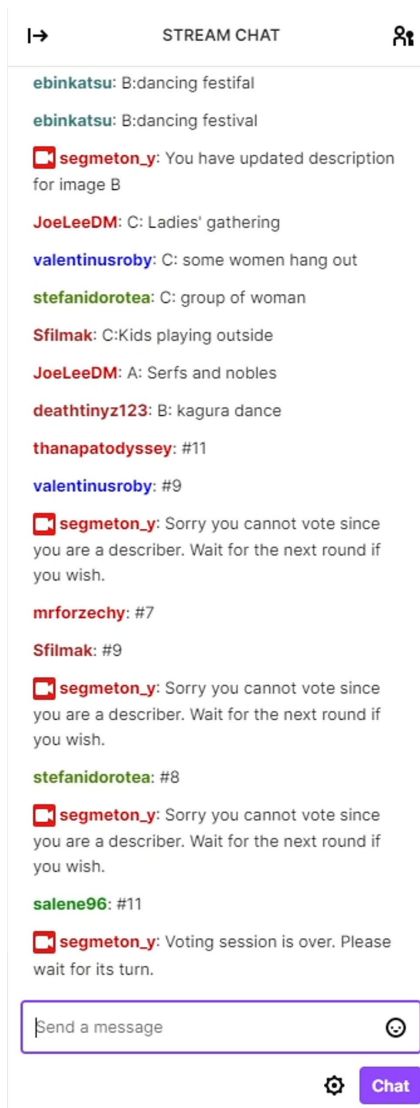
Fig. 5. Twitch Chatbox used as an input method for the original JUSTIN game.

al. (2022) tried to solve this problem in popular Chinese online games, and their experiments demonstrated great accuracy of cheating classification in addition to providing rational explanations. In fact, the results were so good that their cheating detection and explanation system ended up being used in actual games played by millions.

2-4. User Interface (UI)

The original JUSTIN (Nguyen *et al.*, 2020) game uses the Twitch platform to receive user input through the chatbox as shown in Fig. 5 - a feature of live streaming platforms that allows viewers to interact with live streamers and with each other in real-time using text and emojis.

Having such a format may confuse some players, and a need to strictly follow it may lead to some unintentional mistakes that would prevent players from submitting input to the game (for example, making a typo or using the wrong character). With the aim of preventing that and making the process more understandable for beginners, we decided to introduce a new UI as a separate extension.

3. Proposed Methods

3-1. Virtual Moderator

This section introduces the concept of a virtual moderator - a 2D animated character that is created to help players of JUSTIN understand the rules of the game and make the game more entertaining. We discuss how the character itself is implemented, how we implemented text-to-speech, and how it can communicate with applications such as JUSTIN.

As discussed above, Virtual YouTubers are taking the world by storm (Lu *et al.*, 2021). They are becoming more and more popular on platforms such as YouTube and Twitch where they are live streaming their gameplay and other activities. And, as noted in the paper by Lu *et al.* (2021), they are particularly popular among viewers who have a deep interest in Japanese culture and history. Since our game is using Twitch - a popular streaming platform - as the main platform to interact with players, and since JUSTIN heavily relies on people who are familiar with Japanese culture, we made a choice to introduce a virtual moderator in JUSTIN to make it more entertaining and interesting.

Our original idea was described in a previous study titled "Cuteness in JUSTIN: Adding a Virtual Moderator for Entertaining User in an Audience Participation Game for Collecting Artwork Description Data" (Savchyn *et al.*, 2021). This study described a system in which a virtual character in the lower right corner of a screen would explain the rules of the game as it goes and, from time to time, cheer on players to submit more descriptions or words by saying some motivational phrases and using a cute facial expression.

Our previous study was made to verify a proposed idea by using a game that had gameplay like JUSTIN. The results, which were presented in another conference paper (Agung *et al.,* 2022) proved our theory - players who had a chance to experience a character with emotions
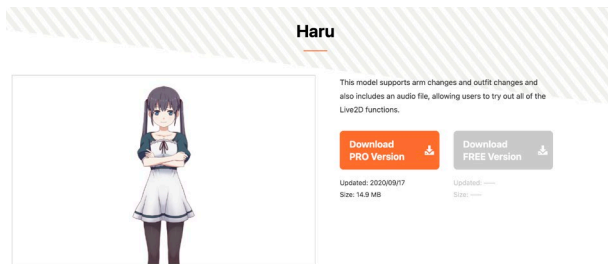
Fig. 6. Haru, a free Live2D model used for our research. Comes with a wide range of facial expressions and gestures.

Fig. 7. Implemented Unity application with Haru Live2D model.

enjoyed the game more compared to the group who just saw the same neutral emotion during the whole game.

In our current research, we utilize the virtual avatar for the following needs:

1. Explain the rules of the game to players.
2. Notify about round change.
3. Warn potential and real cheaters.
4. Cheer on players.

Such promising results from the previous work motivated us to continue our work and implement a virtual character in an original JUSTIN game to solve the issue of repetitiveness and make the game more intuitive, as well as draw the attention of people interested in Virtual YouTubers or/and Japanese culture.

3-1-1. Live2D Technology

Live2D is a method of creating animated 2D models without the need to use frame-by-frame animation (Live2Da, 2023). It is much faster and cheaper to create and animate such models compared to traditional 2D and 3D characters, so it is unsurprising that many Vtubers are using those for creating content (Lu *et al.*, 2021).

For our research, we settled on using a pre-made free model called Haru (Fig. 6) (Live2Db, 2023). Haru comes with a set of pose animations, facial expressions, and support for additional Live2D features such as audio-to-lips synchronization that we will use later. We selected her thanks to the simplicity of the model and the wide range of expressions we can use in our project.

3-1-2. Implementation in Unity3D

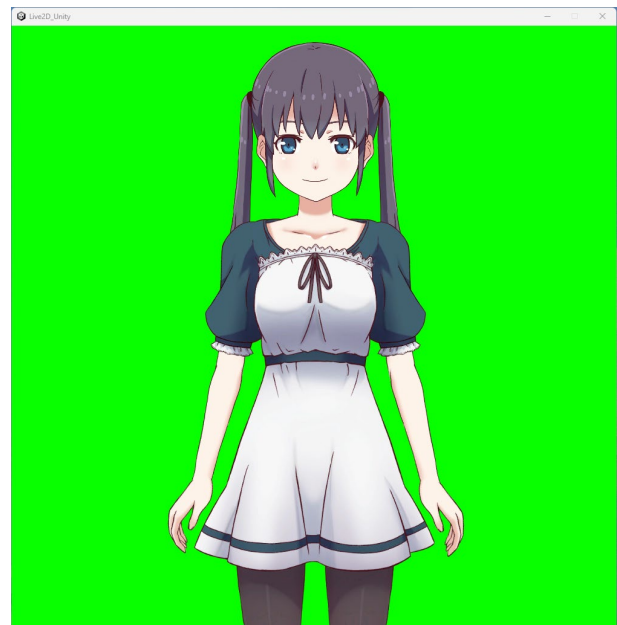Live2D offers an SDK (software development kit) that allows the implementation of Live2D models into games and other kinds of projects. Since our game is live streamed on the Twitch platform and does not require a high computational power, our choice fell onto Unity3D SDK in contrast to C++ SDK which can, in theory, be more efficient but would require more time spent for implementation. The SDK has built-in commands that allow us to execute pre-made animations and change the facial expression of the character (Fig. 7).

3-2. New GUI

Nowadays, most modern applications are using Graphical User Interfaces to simplify the interaction and make it more intuitive for a broad group of users. The initial version of the JUSTIN (Nguyen *et al.*, 2020) game uses a Twitch chatbox to interact with players - they can submit votes or descriptions using a pre-defined format.

However, the chatbox was not created to be a game interface. Players often made typos in formatting that led to some great descriptions not being submitted at all. This is why one of the ways in which we decided to improve our APGWAP game is to introduce a GUI that will allow players, especially beginners, to submit descriptions or votes faster and more conveniently.

To implement GUI, we selected the React.JS framework for creating an actual GUI and Firebase Realtime Database to receive and
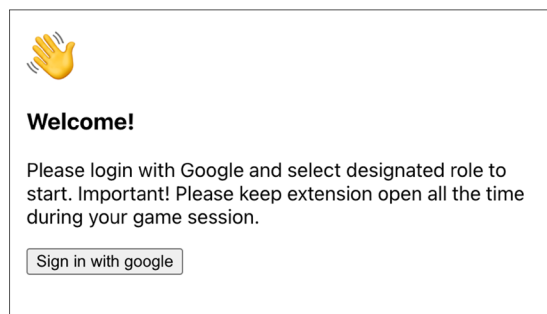
Fig. 8. Welcome screen of the new UI extension.

send data to JUSTIN. This section covers the implementation of GUI itself and how it interacts with JUSTIN through Firebase. React.JS[3] is a popular JavaScript framework for developing web applications with user interfaces based on UI components. It is open-source, free, and well-maintained by the community of enthusiasts who are using it in their projects as well.

Figures 8 to 12 demonstrate the application. For this research, we decided to use a Google account instead of a Twitch account because it gives us the opportunity to use the same extension on platforms other than Twitch.
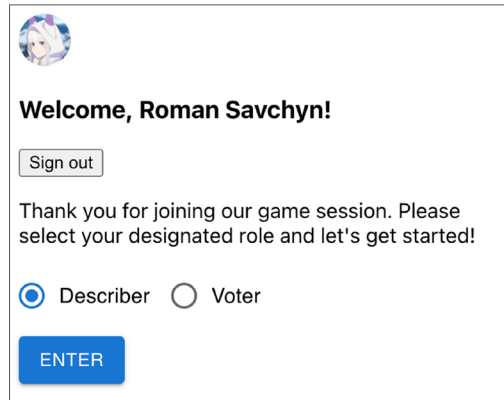

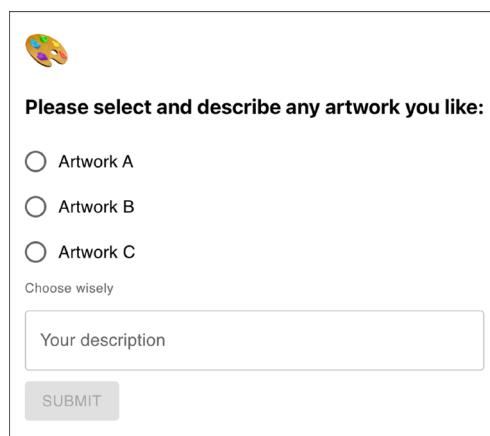Fig. 9. The main screen of the extension.
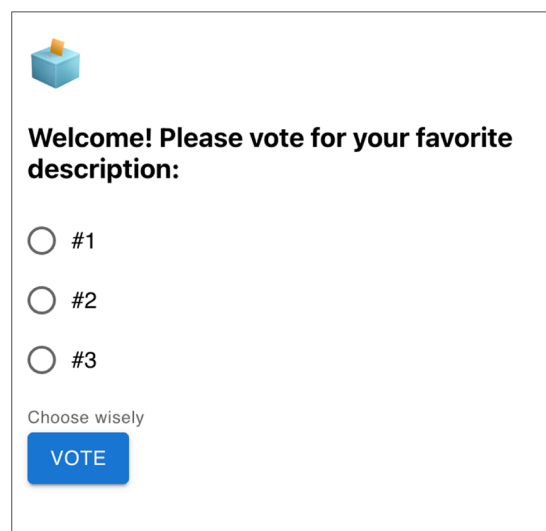

Fig. 10. UI for describers.
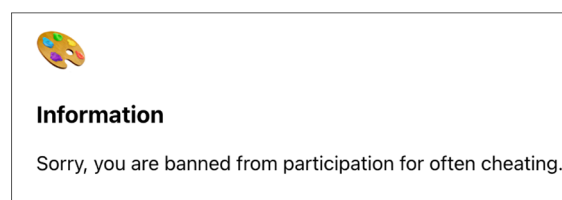

Fig. 11. UI for voters.

Fig. 12. UI for banned cheaters.

3-3. Cheating Prevention System

This section covers the implementation of a cheating prevention system into JUSTIN to warn and ban players who misbehave by copying and modifying descriptions of other players. To make the system as effective as possible, we are utilizing BERT (Devlin *et al.,* 2018) together with cosine similarity to detect similar descriptions and a virtual moderator to publicly warn or punish prospective cheaters.

3-3-1. Online environments

With the growing popularity of online environments such as online classes and online games in recent years, activity from people who would like to gain an unfair advantage over other participants also skyrocketed. Such people are often called cheaters (The Guardian, 2023), and their actions are punished in various ways in different online communities. For example, they are banned from online games, or their exam results are not counted.

As written in the introduction section, researchers try to find various ways to prevent further cheating from players by, for example, introducing a warning message that clearly

explains what the consequences of cheating could be (Corrigan-Gibbs *et al.*, 2015). While this method was proven to be effective, the authors of the paper themselves suggest that it may not be sustainable in the future - participants may simply get used to it and start to ignore it.

3-3-2. Cheating in JUSTIN

The problem with cheating in JUSTIN is quite straightforward - participants can see winning descriptions (hence, the best descriptions based on votes from players) and it is not hard for them to simply copy one of those descriptions and submit it again during the following round. Originally, JUSTIN had protection for such cases, but it counted only exact matches in sentences. Thus, if a cheater would add a dot or any other character at the end of the sentence, JUSTIN would consider it unique and accept it for voting.

Cheating in JUSTIN has a few negative effects:

1. Copied and slightly modified descriptions would highly increase the number of duplicated descriptions and affect the goals of JUSTIN.
2. Players whose descriptions were stolen would feel cheated and helpless and may lose interest in the game.
3. Finally, the ability to cheat allows many people to not try their best in coming up with magnificent descriptions for artworks.

To identify descriptions that were slightly modified and prevent cheaters from getting winning positions in the game, we had to find something that would be able to evaluate and return the uniqueness of each sentence compared to previously submitted descriptions from the JUSTIN database.

3-3-3. BERT

BERT, or Bidirectional Encoder Representations from Transformers, is a language representation model introduced by researchers at Google (Devlin *et al.,* 2018). The main benefit of BERT is its simple design thanks

Sparse vector
[0, 0, 1, 0, 1, 0, 1... 0, 1, 0]

30,000+ values

Dense vector
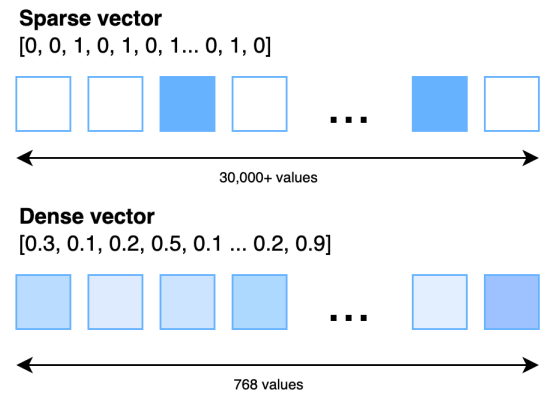[0.3, 0.1, 0.2, 0.5, 0.1 ... 0.2, 0.9]

768 values

Fig. 13. Comparison of sparse and dense vectors.

to which we can utilize it for a wide range of tasks with unlabeled text for Natural Language Processing (NLP). Nowadays, it is used for a huge variety of NLP tasks, including by Google in their search engine. Only one additional output layer is required to tune BERT for required purposes.

The vast popularity of BERT comes from the fact that it embeds the meaning of words into densely packed vectors for further processing (Towards Data Science, 2023) - these are called "dense vectors." The difference between sparse vectors, which were highly popular before, is that every value in a dense vector has some meaning and is not set to zero.

It can be illustrated using a simple example. For example, let's take the sentence "Hello from our lab" and encode it into sparse and dense vectors:

- A sparse vector may look like this: [1, 0, ..., 0, 1, 0]
- While dense vector would look like this: [0.2, 0.3, ..., 0.7, 0.9, 0.5]

Hence, dense vectors are more information-rich and information within them is more densely packed compared to sparse vectors. It also makes dense vectors a lot shorter - for example, the same sentence may take 30,000 values in a sparse vector and only 768 in a dense vector (Fig. 13) (Pinecone, 2023).

BERT uses vectors that contain 768 values, and each value contains a numerical representation of a single sentence called a "token". Each token is represented by one vector, so the size of our tensor will be 768 multiplied by the total number of tokens (Towards Data Science). After embeddings are done, we use
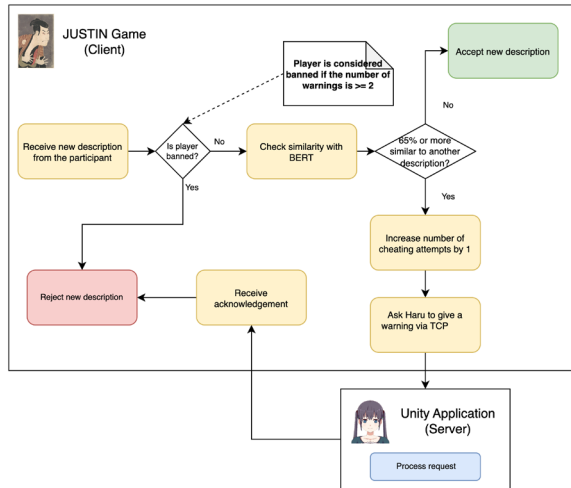
Fig. 14. The first version of the cheating prevention algorithm.

Fig. 15. The improved (second) version of cheating prevention algorithm.

those tensors to transform them to create semantic (or logical) representations of the selected sentence. Finally, we utilize representations to find the similarity between two sentences. In other words, we use BERT to convert text to a vector in an embedding space, and then we use cosine similarity to calculate similarity between two vectors.

The great advantage of BERT is that it allows us to compare sentences in two ways at the same time - word-by-word and comparing sentences by their meaning. A short summary of how we implemented BERT in JUSTIN is covered in the next section.

3-3-4. Cheating Prevention System Implementation

To detect and appropriately notify cheaters during the game, we designed an algorithm that will first give a warning through Virtual Moderator to someone whose description will be found similar to previously submitted descriptions. If this situation repeats, the player will be banned temporarily or permanently.

The first version

In August 2022, we presented the first version of our algorithm shown in Fig. 14. 0.65 was chosen as the threshold based on research by Arabi *et al.* (2022) who proposed it in their paper about identifying plagiarism in the text. By using cosine similarity and BERT, we are comparing a new sentence one by one with descriptions accepted within the same in-game round until we find a pair whose similarity is higher than 65%.
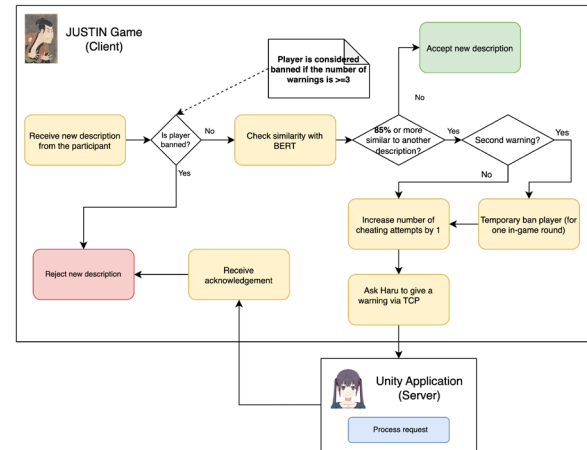
We do not check the similarity between descriptions from the same author.

Improved version

After evaluating the results and receiving feedback from participants, we decided to slightly modify our algorithm. Here are the two main changes compared to the first version (Fig. 15):

1. Increased similarity threshold to 85%. Many participants complained that they did not cheat yet their descriptions were marked as copies of previously submitted descriptions. This was because of the 65% threshold, as suggested by Arabi *et al.* (2022), was considered low in our case, and because some descriptions were extremely short. Hence, we increased the threshold by 85% which means that this time we have a smaller window for mistakes. Hence, based on several tests we conducted after the first user study, we found out that setting the threshold to 85% will be the possible solution.
2. Added additional warning mechanism - temporary ban from participation. Previously, the participant received a warning for the first time and then a permanent ban for the second cheating attempt - the same rule as in soccer games (PFSA, 2023). However, we decided

to introduce an additional step before banning participants for one in-game round, and now our algorithm looks like this:

    a. First cheating detection - warning by a virtual character.
    b. Second cheating detection - warning and ban for one in-game round.
    c. Third cheating detection - warning and permanent ban from further participation.

4. Experiment

4-1. August 2022 User Study

To verify our proposed strategy, we conducted a user study to learn if warning and then banning cheaters from participation had a positive effect or not. We present the results of the experiment in this section. For the questionnaire, we used GUESS (Phan *et al.,* 2016) - the Game User Experience Satisfaction Scale - which is widely used in game-related research for evaluating games during user studies.

Participants

Fifteen participants joined the user study - mostly Ritsumeikan University students between 19 to 32 years old. Participants majoring in Computer Science accounted for 81.3%. In terms of the familiarity with Japanese ukiyo-e artworks, 56.3% participants had a low familiarity (2 on a 1 to 5 scale where 1 is not familiar at all and 5 is highly familiar), and 37.5% had quite a high familiarity (4 on a 1 to 5 scale). All responses were collected anonymously.

4-2. December 2022 User Study

We established a new user study to test the effectiveness of our proposed method once again and to see if there were any improvements compared to the first experiment.

Participants

This time we had 14 participants who also were students from Ritsumeikan University between 21 and 27 years old. Compared to the previous time, most of the participants were not

familiar with ukiyo-e at all (53.3%) and all of

Table 1 Results of the December 2022 study

	AVG (STD, Cronbach's Alpha) for N	AVG (STD, Cronbach's Alpha) for C	Cohen's D
F1	15 (4.01, 0.66)	16.5 (2.82, 0.65)	0.43
F3	11.78 (3.46, 0.69)	12.5 (4.01, 0.81)	0.19
F4	13.78 (3.04, 0.73)	14.07 (3.60, 0.73)	0.08
F5	15.5 (2.50, 0.6)	15.71 (3.87, 0.94)	0.06
F6	13 (3.61, 0.73)	13.5 (4.07, 0.96)	0.12
F7	14.14 (3.15, 0.81)	14.5 (3.67, 0.81)	0.1
F8	12.71 (3.31, 0.63)	13.5 (3.85, 0.84)	0.21
F9	14.92 (3.54, 0.84)	15.35 (3.62, 0.97)	0.11

them were Computer Science students. As before, responses were anonymous.

5. Results

5-1. August 2022 User Study

Unfortunately, the first user study did not demonstrate any promising results - there was no significant difference in collected data between games with and without a cheating prevention system. Based on participants' feedback, we made a conclusion that the threshold of 65% is too low for detecting cheaters - most participants did not have any intention to cheat, but because their descriptions were simple and short, they were considered quite similar by an algorithm; in other words, participants blamed the mechanism to be too severe. That also includes phrases that Haru used to publicly announce that someone is cheating.

On the other hand, we also received positive feedback about the character itself and how it feels more interesting compared to the original JUSTIN game. Some even noticed that Haru can display even more emotions and be a little bit less serious. The full results along with feedback from participants are available at the link in the appendix.

5-2. December 2022 User Study

Our second user study demonstrated more interesting and promising results compared to the first one. To evaluate our findings, we used a Cronbach Alpha value - a measure of internal consistency of a scale (SPSS FAQ, 2023). Each factor that we selected contains 3 questions, and we calculated Cronbach Alpha for all 8 factors we selected from GUESS (Phan *et al.,* 2016):

    1. F1 - Usability Playability
    2. F3 - Play Engrossment

3. F4 - Enjoyment
4. F5 - Creative Freedom
5. F6 - Audio Aesthetics
6. F7 - Personal Gratification
7. F8 - Social Connectivity
8. F9 - Visual Aesthetics

Usability Playability, Play Engrossment, Creative Freedom, and Social Connectivity factors are unreliable according to Cronbach Alpha - their values are lower than 0.7 which is an acceptable internal consistency. The most probable reason for such unreliable results is the small participant size. For this reason, we do not discuss the results of those factors in this paper.

When it comes to Enjoyment, Audio Aesthetics, Personal Gratification, and Visual Aesthetics, results are quite promising - C (game with cheating prevention system) outperforms N (game without cheating prevention system) with a small effect size for each of them, according to Cohen's D. However, based on the feedback from participants, future work is needed to further improve the system, such as adding more interactions with players to the Virtual Moderator application, improving the Text-To-Speech (TTS) voice of a character, and more. User studies with a larger population of participants should also be conducted.

The mean value, along with standard deviation, Cronbach's alpha, and Cohen's D are shown in Table 1, where N stands for "Without cheating prevention system" and C for "With cheating prevention system." Full detailed results are available in the spreadsheet accessible via the appendix to this paper.

6. Discussion

Results from the first user study indicated that our idea has some potential when it comes to the introduction of a new virtual moderator - players praised such advancement and noticed that it makes the game more interesting than before. However, we also concluded that our cheating prevention system needed a lot of polishing to ensure that only real cheaters are punished.

After making the required adjustments, we conducted a second user study that demonstrated first promising results for further development. While the results are promising, there is still a lot of space for improvement. This time we need to focus on increasing the number of participants and improving the interaction of players with a moderator.

7. Conclusion and Future Work

This paper introduces an extended and improved version of JUSTIN - an audience participation game with the purpose of collecting ukiyo-e artwork descriptions. We focused on improving the existing system in three main directions:

1. Making the game more interesting and less repetitive by introducing a virtual moderator (also known as a virtual avatar, Virtual YouTuber, or VTuber).
2. Preventing cheating by adding an algorithm that can detect and ban cheaters.
3. Improving interaction with the game by introducing an intuitive Graphical User Interface (GUI).
4. Improve the design of an avatar in future work.

To evaluate our hypothesis on improving the gaming experience by preventing and punishing cheating within the game, we prepared and conducted two user studies. The first one did not show interesting results but gave us essential feedback from players on what should be improved. The second one, in which we presented a new and improved algorithm for preventing cheating, demonstrated a lot more promising results and, yet again, gave us feedback on what should be improved even more in our future work.

For future work, we would like to focus on improving the interaction between the virtual avatar and players by making it more intelligent. It includes introducing an AI, and adding some additional interactions that are not related to the JUSTIN game (for example, asking the avatar "How are you today?"), and more. Besides that, introducing a virtual avatar to games other than JUSTIN seems interesting to understand its importance and influence on the game experience. Lastly, user studies with a much bigger number of participants would be essential to keep improving our system and collecting new feedback from a wider range of audiences.

To strongly elaborate on the efficiency of

visual moderators in preventing cheating, user experiments with a large number of participants from various backgrounds need to be conducted. Additionally, the effects of the virtual moderator's art style when applied to different participants' backgrounds need to be identified in order to optimize the participants' experiences. Finally, the applicability of the virtual moderator concept in contexts other than APG, such as education or training, needs to be explored.

Appendix

User study results

1. August 2022 User Study results: https://tinyurl.com/bdhf9sc4
2. December 2022 User Study results: https://tinyurl.com/bdt2a2d7
3. Questionnaire copy: https://forms.gle/Yj8oFtPS6GDXWaFg6

Note 1: We used the same questionnaire form for both user studies. The link above presents a copy of the original questionnaire. **Note 2:** Files are accessible only with the Ritsumeikan University e-mail address.

User Interface

New UI Extension for JUSTIN: https://justin-live2d-cheating.web.app/

[Annotations]

1) https://unity.com/
2) https://www.pygame.org/news
3) https://github.com/facebook/react
4) https://firebase.google.com/docs/database

〔References〕

Agung, Albertus, Roman Savchyn, Pujana Paliyawan, and Ruck Thawonmas. "Cute Helper: A Study on the Effect of Virtual Character Expressions on Players' Engagement in a Game for Collecting Artwork Descriptions." In *2022 IEEE Conference on Games (CoG)*, pp. 588-589. IEEE, 2022.

Arabi, Hamed, and Mehdi Akbari. "Improving plagiarism detection in text document using hybrid weighted similarity." *Expert Systems with Applications* 207 (2022): 118034.

AudioSource. Unity - Scripting API: AudioSource. https://docs.unity3d.com/ScriptReference/AudioSource.html (accessed: 2023-03-12).

BERT For Measuring Text Similarity. Towards Data Science. https://towardsdatascience.com/bert-for-measuring-text-similarity-eec91c6bf9e1 (accessed: 2023-03-12).

Corrigan-Gibbs, Henry, Nakull Gupta, Curtis Northcutt, Edward Cutrell, and William Thies. "Deterring cheating in online environments." *ACM Transactions on Computer-Human Interaction (TOCHI)* 22, no. 6 (2015): 1-23.

Dense Vectors: Capturing Meaning with Code. Pinecones. https://www.pinecone.io/learn/dense-vector-embeddings-nlp/ (accessed: 2023-03-12).

Devlin, Jacob, Ming-Wei Chang, Kenton Lee, and Kristina Toutanova. "Bert: Pre-training of deep bidirectional transformers for language understanding." In *Proceedings of naacL-HLT Vol. 1*, pp. 4171-4186. 2019.

Financial Post. Matthew O'Mara, Twitch Plays Pokémon a wild experiment in crowd sourced gameplay. https://financialpost.com/technology/gaming/twitch-plays-pokemon-a-wild-experiment-in-crowd-sourced-gameplay (accessed: 2023-02-22).

Football Discipline - Yellow Cards, Red Cards and Suspensions, explained. PFSA. https://thepfsa.co.uk/football-discipline-yellow-cards-red-cards-and-suspensions-explained/ (accessed: 2023-03-13).

Gamage, Vihanga, and Cathy Ennis. "Examining the effects of a virtual character on learning and engagement in serious games." In *Proceedings of the 11th ACM SIGGRAPH Conference on Motion, Interaction and Games*, pp. 1-9. ACM, 2018.

Ironmouse. Virtual YouTuber Wiki. https://virtualyoutuber.fandom.com/wiki/Ironmouse (accessed: 2023-02-22).

Live2Da. What is Live2D? – How to Make and Use a Live2D Model. https://www.live2d.com/en/about (accessed: 2023-02-22).

Live2Db. Live2D Sample Model Collection. https://www.live2d.com/en/download/sample-data/ (accessed: 2023-03-12).

Lu, Zhicong, Chenxinran Shen, Jiannan Li, Hong Shen, and Daniel Wigdor. "More kawaii than a real-person live streamer: understanding how the otaku community engages with and perceives virtual YouTubers." In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, pp. 1-14. ACM, 2021.

MouthMovement. Live2D Manuals and Tutorials.

https://docs.live2d.com/cubism-sdk-manual/mouthmovement-unity/ (accessed: 2023-03-12).

Nguyen, Ngoc Cuong, Ruck Thawonmas, Pujana Paliyawan, and Hai V. Pham. "JUSTIN: An audience participation game with a purpose for collecting descriptions for artwork images." In *2020 IEEE Conference on Games (CoG)*, pp. 344-350. IEEE, 2020.

Nguyen, Ngoc Cuong, Pujana Paliyawan, Ruck Thawonmas, Hai V. Pham, Harada Tomohiro, Keiko Suzuki, and Masaaki Kidachi. "Potentials of Games With a Purpose and Audience Participation Games for Descriptive Data Collection in Humanities Research." In *Proceeding of Japanese Association for Digital Humanities Conference 2019* (JADH2019), pp. 104-106. Japanese Association for Digital Humanities, 2019.

Phan, Mikki H., Joseph R. Keebler, and Barbara S. Chaparro. "The development and validation of the game user experience satisfaction scale (GUESS)." *Human factors* 58, no. 8 (2016): 1217-1247.

Savchyn, Roman, Pujana Paliyawan, and Ruck Thawonmas. "Cuteness in JUSTIN: Adding a Virtual Moderator for Entertaining User in an Audience Participation Game for Collecting Artwork Description Data." In *2021 IEEE 10th Global Conference on Consumer Electronics (GCCE)*, pp. 843-844. IEEE, 2021.

Susanti, N. P., M. I. P. Koesoemadinata, and R. Belasunda. "The use of virtual YouTuber for online learning." In *Embracing the Future: Creative Industries for Environment and Advanced Society 5.0 in a Post-Pandemic Era*, pp. 247-251. Routledge, 2023.

Takagi, Hisashi, and Kazunori Terada. "The effect of anime character's facial expressions and eye blinking on donation behavior." *Scientific reports* 11, no. 1 (2021): 9146.

Tao, Jianrong, Yu Xiong, Shiwei Zhao, Runze Wu, Xudong Shen, Tangjie Lyu, Changjie Fan, Zhipeng Hu, Sha Zhao, and Gang Pan. "Explainable AI for cheating detection and churn prediction in online games." *IEEE Transactions on Games* (2022).

Text To Speech using Google Cloud - Pro. Unity Asset Store. https://assetstore.unity.com/packages/add-ons/machinelearning/text-to-speech-using-google-cloud-pro-115170 (accessed: 2023-03-12).

The Guardian. Keith Stuart, Medal of dishonour: why do so many people cheat in online video games?. https://www.theguardian.com/games/2021/feb/24/medal-of-dishonour-cheating-video-games (accessed: 2023-10-22).

What does Cronbach's alpha mean? SPSS FAQ. https://stats.oarc.ucla.edu/spss/faq/what-does-cronbachs-alpha-mean (accessed: 2023-03-12).

What is Transmission Control Protocol TCP/IP? Fortinet. https://www.fortinet.com/resources/cyberglossary/tcp-ip (accessed: 2023-03-12).