# AN AUDIENCE PARTICIPATION ANGRY BIRDS PLATFORM FOR SOCIAL WELL-BEING

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**ABSTRACT**

In this paper, we design an audience participation Angry Birds platform and evaluate its effectiveness in promoting social well-being. Existing work reported that playing online games together with other players has positive effects on the promotion of communication and improvement of social relations. With the advent of audience participation games, research on methods for cooperative operations is gaining attention. However, in games targeted in existing research, game rules are complicated, so audiences need time to learn how to play them. Therefore, we focus on the Angry Birds game with simple rules and propose a mechanism to let audiences control bird shots via chat. In addition, the maps, levels, or stages of those games in the existing audience-participation-game studies are fixed, so such games may become boring and make the audience give up playing. Therefore, we also propose another mechanism to let audiences generate original game levels via chat, which is expected to increase fun. Our results confirm the effectiveness of both proposed mechanisms.

## INTRODUCTION

Nowadays, more and more people are paying attention to social well-being, such as interpersonal relationship, mental health, and promotion of communication. There are a multitude of applications that aim to solve societal health problems via gamification. In an existing study (Shen and Williams 2011), it was found that online games can help players promote communication with their existing social relations and their family members if they play games together. Our research question is whether audience participation games (APGs), stemming from the current popularity of game live streaming, have similar effects when proper mechanisms are introduced.

In this paper, we focus on Angry Birds and propose two chat mechanisms that transform the game to an APG: the first and the second mechanisms allow audiences to control bird shots and generate levels, respectively. Both mechanisms are evaluated in terms of seven satisfaction factors in Game User Experience Satisfaction Scale (GUESS) (Phan et al. 2016): Usability/Playability, Play Engrossment, Enjoyment, Creative Freedom, Personal Gratification, Social Connectivity, and Visual Aesthetics. According to the results of the conducted user study, the effectiveness of both mechanisms is confirmed.

## RELATED WORK

### Audience Participation Games

An audience participation game (APG) is a recent game genre where the player or the system receives comments from audiences on a live streaming video platform (Twitch, YouTube, etc.) and determines what to do next based on the received comments (Seering et al. 2017). Twitch Plays Pokemon (TPP), a Pokemon game that incorporates audiences' comments (Lessel et al. 2017a), is one of the most famous APGs. Since live streaming video platforms emerged, it has become easier to distribute gameplay directly to audiences. At the same time, research on methods for consolidating cooperative operations in the APG has been drawing attention. Two independent studies (Chen 2014, Margel 2018) discussed the two comment aggregation methods, anarchy and democracy, for cooperative play in TPP. Anarchy is an aggregation method that executes comments transmitted from the audiences in real time in order and reflects them in the game. Democracy selects and executes the most posted command within a certain period of time. More recent work (Lessel et al. 2017b) discussed how to cooperatively play CrowdChess against AI.

However, in the aforementioned existing studies on the APG, the game rules are complex, making it difficult for audiences to participate because they need to learn complex rules and the related skills. In addition, the game contents, such as maps, stages, or levels, are fixed. As a result, audiences might get bored with such fixed contents, leading to a decline in fun or making them quit playing. To solve these issues, in our work, Angry Birds, a game with simple rules, is adopted, by which many game players or audiences should be able to readily start

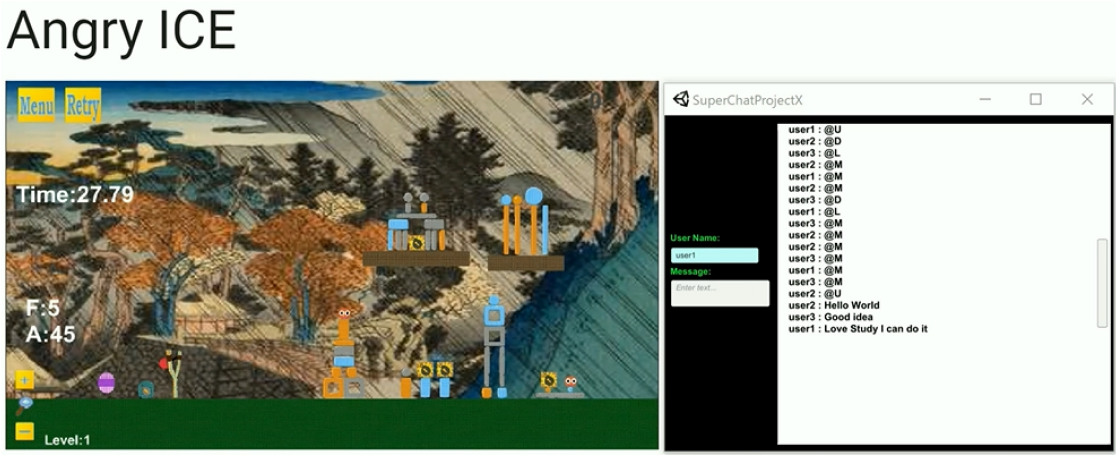


Figure 1: Angry ICE game screen

playing the game with no prior experience or knowledge. Audience-participation mechanisms for controlling bird shots and generating levels, both via chat, are proposed.

### Angry Birds

Angry Birds (https://www.angrybirds.com/games/) is a famous action-puzzle game developed by a Finnish company Rovio Entertainment. The first Angry Birds game in the series was initially released in December 2009. The purpose of the game is that of using a slingshot to launch a bird to destroy all pigs in the stage. If all the pigs are destroyed after the last bird is launched, the level is cleared and the next level can be selected. If all the birds run out but pigs remain, the level is failed and can be tried again. To prevent players from boredom, recently there have been active research activities for automatically generating fun levels, described in the next sub-section, and a competition (https://aibirds.org/other-events/level-generation-competition.html).
We base our work on the Angry Birds clone (Science Birds) (https://github.com/lucasnfe/Science-Birds) used in the aforementioned competition and developed by Lucas Ferreira using Unity. Unlike the original Angry Birds game having several game objects, Science Birds' objects are limited to the Bird, Pig, 12 different blocks with three materials (Wood, Ice, Stone), TNT (detonated after a collision, damaging other objects around it) and finally Terrain, the only block type which is neither affected by gravity nor destroyed.

## AUDIENCE PARTICIPATION ANGRY BIRDS PLATFORM – ANGRY ICE

### System Overview

We create an audience participation Angry Birds platform named Angry ICE, based on Science Birds. Angry ICE is an APG platform that allows participation to the game via comments or messages sent by audiences. By sending a special command as a comment message, an audience can cooperate with others and take part in game control. Furthermore, the most interesting message is selected from the normal – non-command – messages, and the next level displaying the selected message is generated. Details on shooting control and level generation are given later. For live streaming in user evaluation, the background music and sounds are removed. The background, characters, UI and other game objects are replaced by those with our original design. In the game screen, we append the UI for displaying the current force (F) and angle (A) of the current bird, as well as a countdown timer. An example of the Angry ICE game screen is shown in Fig. 1. The system architecture of Angry ICE is shown in Fig. 2.

### Cooperative Play Module

The cooperative play module implements the mechanism for allowing audiences to cooperatively play the game via their chat messages (comments). Angry ICE presents the current bird's shooting power and angle to audiences in real time. The bird's force and angle are initialized to 5 and 45, respectively. Their ranges are [0, 10] and [-180, 180]. Audiences are able to send any of the special comments shown in Table 1 to control the bird together with other audiences. The sent comments from audiences will be reflected in the game in real time, but subject to network delays. For each bird, audiences only have 30 seconds to adjust the force and angle. After 30 seconds the bird will be shot automatically according to the latest received values of power and angle.

### Level Generation Module

In order to avoid players' boredom stemming from limited or immutable game content, we propose another

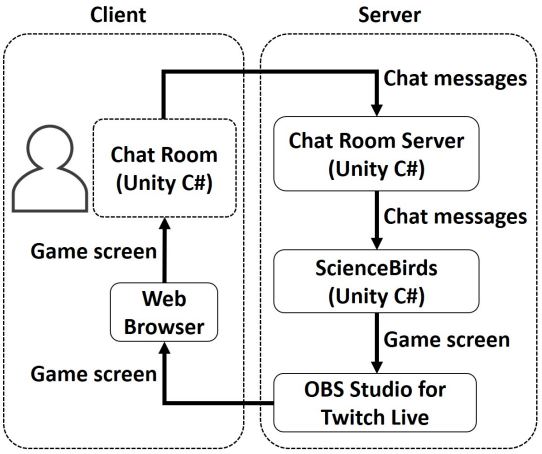


Figure 2: Angry ICE System Architecture

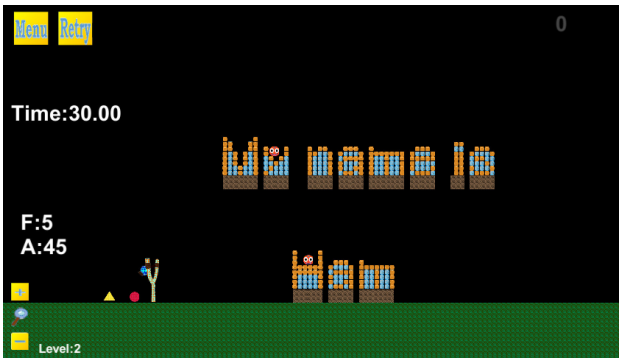


Figure 3: An example of a generated level displaying a humorous message, "My name is Ham," sent from an audience

module that implements the mechanism for generating humorous-message levels automatically. The purpose of this module is that of promoting communication among audiences through humorous messages and at the same time increasing fun through competition for which message to be selected for the next-level. When the audiences send normal messages other than special comments, the system collects them. All the collected messages during a given interval are then filtered, and those messages containing bad or impolite words are removed. Characters other than alphabetical letters and numbers in the chat messages are deleted. Remaining messages longer than 20 letters (including spaces) will also be truncated to the first 20 letters, because of the limited screen width. After the current level is finished, the Duluth system (Yan and Pedersen 2017) is used to evaluate the humor degree of each of the remaining messages, whose lengths are up to 20 letters, and find the most humorous one.

Duluth is a system that can judge the degree of humor of words and won Subtask B of "SemEval-2017 Task 6 # Hashtag Wars: Learning a Sense of Humor". Our system uses the Duluth news model which won the aforementioned task to evaluate messages sent by audiences. The most humorous message, the one most deviated from typical news messages, is used to generate the next level via Funny Quotes Generator (Jiang et al. 2017).

Table 1: List of special comments

| Comment | Action |
|---|---|
| @M or @m | Increase the force by +1 |
| @L or @l | Decrease the force by -1 |
| @U or @u | Increase the angle by +1 |
| @D or @d | Decrease the angle by -1 |

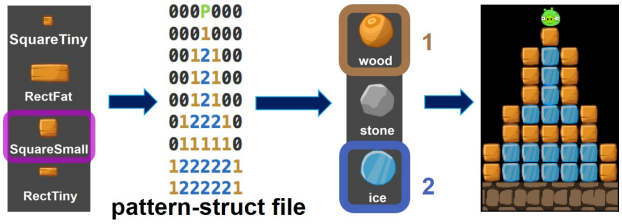


Figure 4: Generation of a character by Funny Quotes Generator

Funny Quotes Generator is an Angry Birds level generator developed previously by us. It won the first Angry Birds Level Generation Competition Fun Track in 2016. It was designed to generate interesting levels by expressing funny words or quotes. In order to make the word level easy to identify, the black background is used in this work. An example of a generated level displaying an audience message is shown in Fig. 3.

In order to make word levels more easily identifiable to enhance the fun of the game, Funny Quotes Generator was also improved to make the word level more recognizable. In order to generate word levels, Funny Quotes Generator originally uses two approaches called pattern-struct and preset-model. The pattern-struct approach generates each time different appearance for one of the alphabetical letters, numeral numbers, or some specific symbols. The preset-model approach is used for increasing the diversity, where models are built in advance for certain capital letters and numbers. Because the preset-model approach cannot be well recognized, compared to the other approach according to our experience, the improved version of Funny Quotes Generator does not use the preset-model approach. For the purpose of enhancing legibility, the pattern-struct approach (Fig. 4) in this work only uses four types of blocks (RectFat, SquareTiny, SquareSmall, RectTiny) and only the material wood and ice to express the letters or numbers.

In addition, due to the limitation of the game screen space, no more than 10 characters per layer in the word level are allowed. If a chat message of interest does not

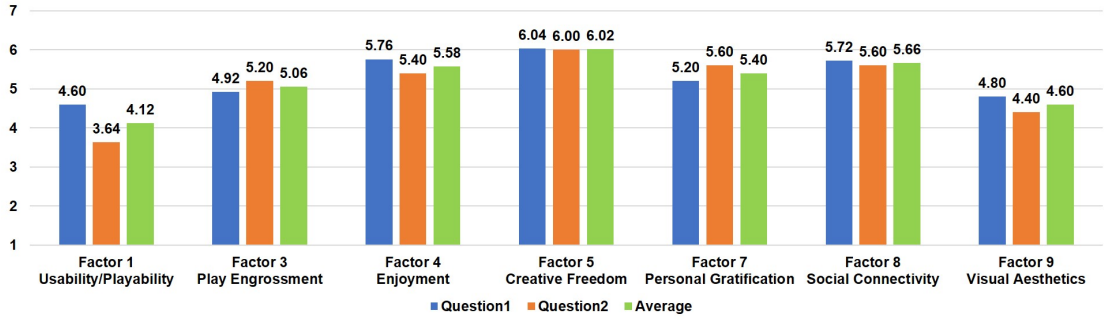


Figure 5: Results of each satisfaction factor of Angry ICE

exceed 10 characters, the message will be configured as a single layer. However, if it is longer than 10 characters, the message will be split into double layers (upper layer and lower layer, each layer up to 10 characters). In order to form a double-layer message, first all possible solutions that can split the message in double layers separated by a space (blank) are found, and if such solutions exist, one will be selected randomly; otherwise, the message will be equally divided to two character strings, one for the upper layer and the other for the lower layer. When no normal message is sent by audiences or all sent normal messages are considered not appropriate, we use a level generated in advance by a baseline level generator provided by the competition organizers as the next level. When using a pre-generated level, from an aesthetic viewpoint, Ukiyo-e (a Japanese traditional style of art) is used as the background. An example of such a level is shown in Fig. 1. In addition, in order to improve the playability of the game level, only pre-generated levels that can be cleared by an AI called Eagle's Wing AI are used. Eagle's Wing AI won the 2017 Angry Birds AI Competition.

## EXPERIMENT AND RESULTS

### Experiment

We carried out an experiment in order to verify Angry ICE's effectiveness regarding social well-being. In addition, we investigated if there were any issues that required further improvement. This experiment involved 25 multi-national college-student participants – the audiences in the experiment – having the age range of 20-26 with the average age of 22.5.

Each participant first learns how to control bird shooting and level generation via chat messages. Then, we show them a demonstration game. The participants are then asked to answer a questionnaire on their game experience so far and participate in the game for five levels with other participants. During this period, they can freely choose to simply watch or to chat for shooting control/ level generation. In addition, The first level is always a pre-generated level. Each level, either a pre-generated level or a word level, has three birds and two pigs and allows one retry of play. Finally, they are asked to answer a questionnaire about their experience on Angry ICE.

All of the questions in the questionnaire were modified from GUESS accordingly. The aim of their study was to develop and psychometrically validate a new instrument that comprehensively measures video game satisfaction based on key factors, resulting in nine factors. However, because there is no story and sound/music in Angry ICE, due to not in the scope of this research, our questionnaire excluded Factor 2 (Narratives) and Factor 6 (Audio Aesthetics). Each of the remaining seven factors is evaluated in a 7 point Likert scale from 1 (Strongly disagreed) to 7 (Strongly agreed). For each factor, the first question assesses the level-generation mechanism while the second one the cooperative-play mechanism. A total of 14 questions were presented in random order to each participant after they had completed their participation in all the five levels.

### Results and Discussions

The results of each factor are shown in Fig. 5. We can see that, except for Factor 3 (Play Engrossment) and Factor 7 (Personal Gratification), the level generation mechanism receives higher evaluation than the cooperative play mechanism. Moreover, there is a statistically significant difference for Factor 1, $p$-value = 0.02 for a Wilcoxon Signed-Rank test.

For Factor 3 (Play Engrossment), the time given for adjusting the direction of the bird to be shot was 30 seconds. In order to clear the level by shooting the bird at a proper location, audiences had to adjust the bird's force and angle accordingly. This made most of the audiences focus on collaborative play and thus be more immersed. For Factor 7 (Personal Gratification), after a level is finished, only the most humorous message sent is used to generate the next level, while the other messages are not accepted. As a result, the level generation mechanism is of slightly lower evaluation for this factor. For Factor 5 (Creative Freedom), both mechanisms received very high evaluation score. This indicates that

both effectively foster the audiences' creativity and curiosity. For Factor 9 (Visual Aesthetics), the word level generated by Funny Quotes Generator is more visually appealing than those generated by the baseline level-generator.

From our other work using Science Birds without the two chat mechanisms deploying 20 participants (Yang et al. 2018), Factors 1 and 3 and 4 scored 5.82, 5.58, and 5.78, respectively. There is a statistically significant difference for Factor 1 between Science Birds and Angry ICE ($p$-value $< 0.01$ for a Mann-Whitney U test). For Factors 3 and 4, Angry ICE's evaluation is slightly lower than Science Birds. However, Science Birds and original Angry Birds do not have functions that allow collaborative play game and that generate levels based on audiences' messages. Therefore, Factor 8 (Social Connectivity) could not be evaluated. We note that the score of Angry ICE for Factor 8 is the second highest and that according to previous work (Shen and Williams 2011, Hall et al. 2013, Spillers and Asimakopoulos 2014, Hamari and Koivisto 2015), this result indicates the potential of Angry ICE to help promote communication and improve relationships as well as mental health, subject to further verification through clinical studies.

For Factor 1 (Usability/Playability), the cooperative play mechanism in Angry ICE is more difficult than the level generation one, while having much lower evaluation than Science Birds. Our reason for this is that in Science Birds the players only use the mouse to play while in Angry ICE they need to collaborate the control with the other players. Furthermore, due to network delays, those command-messages cannot be reflected in the game in a real-time manner. This is an issue we need to improve in the future.

## CONCLUSIONS AND FUTURE WORK

This paper proposed an audience participation Angry Birds platform. The conducted user studies confirm that this platform is useful for social well-being and has the potential for improvement of human relations and promotion of communication via participating cooperative gameplay. Our findings indicate the potential of APGs for social well-being promotion provided that proper mechanisms are introduced. In addition, both mechanisms that we proposed also help promote creativity. Our future work includes investigation of methods for comment aggregation and development of mechanisms to lessen the influence of network delays. We will also improve the graphic and aesthetic aspects in level generation.

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