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The Inclusion of Gamification Solutions to Enhance User Enjoyment on Crowdsourcing Platforms

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***Abstract*—Games with a purpose offer the opportunity to motivate volunteers to participate in citizen science projects in a fun and engaging manner. In this regard, this paper introduces the gamification concepts present in our browser-based crowdsourcing platform. The aim of these elements is to encourage users to voluntarily use their leisure time on regular basis to record and annotate data in a fun and playful environment. To ensure our platform appeals to a wide range of players, a variety of gamification elements aimed at different player groups are integrated including gamerscore, leaderboards, badges and bonus items to name but a few examples. To evaluate the effectiveness of these inclusions we conducted user surveys of 33 new players. This analysis indicates that the gamification additions increase user engagement and gratification when performing elementary crowdsourcing tasks.**

***Index Terms*—human computation; data annotation; crowdsourcing; games with a purpose; survey**

I. Introduction

Present-day intelligent systems are now more human-independent than ever. Nevertheless, these systems still require human interactions as they are still not capable of processing all aspects of basic human intelligence. Taking the field of speech processing as an example, manual labels are still needed to train the system in the first place; for example to build a speech-based emotion recognition systems requires many hours of speech instances each labelled with different emotions. Unfortunately, labelling data in this manner is a tedious and time-consuming task, which not everyone is willing to spend their time on.

Recently, scientific research projects started to recruit annotators by outsourcing the labelling tasks to the internet in so called crowdsourcing platforms and have reported good experiences with it [1]–[3]. Currently, financial incentives are the primary means to draw people to these crowdsourcing platforms. At the same time, companies or institutions expect the same quality as their own employees would deliver, but at a reduced rate. However, studies have shown that you get what you pay for and low wages result in an even lower annotation quality than not paying annotators at all and perform the tasks by pure volunteers [4]. In this context, researchers are investigating alternate means to motivate people to annotate data, not for financial rewards but for fun in their leisure time.

In this regard, *Games with a Purpose* (GWAP) offer a potential solution to motivate individuals to voluntarily help scientific research projects [5]–[8]. The main idea behind GWAP is that people are enticed to participate due to the joyful experiences of gaming. Consequently, individuals are more likely to annotate data in a timely and reliable manner, as this 'boring' task is embedded in another leisure activity: playing a game. Hence, GWAP have been successfully implemented for many tasks that humans can easily solve without hard effort but computers fail to solve accurately [6], [9]–[11].

Therefore, the combination of GWAP and crowdsourcing offers the opportunity to potentially eliminate (or at least reduce) the costs associated with data annotations while potentially reaching the same quality for the labels compared to employing expert annotators.

A. Related Work

The first GWAP, the *ESP Game* originally conceived by von Ahn [6], focused on image labelling and opened new grounds in human computation. Then, von Ahn also helped devised the music-related game *Tagatune* [9], which focused on retrieving new music annotations via a multi-player game where players had to create annotations according to what they heard and decide whether they were listening to the same song as their randomly-chosen co-player. TagATune is therefore capable of gathering perceptually meaningful descriptions of audio data that are agreed upon by multiple players.

Apart from von Ahn's projects, a variety of different game mechanisms have been proposed and developed. In *Peekaboom* [10], players are awarded points for identifying objects within an image; *Matchin* [11], on the other hand, presents players with two photos and awards points when they agree on which one is more beautiful; and *City Lights* [12], is a music metadata validation approach which makes use of gamification elements to make the validation process more enjoyable and as a result lower the cost of human computations.

ARTigo [13], is an example of a GWAP that attracts people who are interested in art. It supplies artworks with tags while presenting them to two opposing players. The players describe the artwork as detailed as possible using the supplied tags and get points for the tags identical to the ones entered by the co-player. Similarly, *Curator* [14], was introduced as a class of GWAP for building collections where players create collections and are awarded with points based on the collections that match. Another GWAP called *Wordrobe* [15] obtains gold standard data for word sense disambiguation, consisting of a large set of multiple-choice questions on word senses. A highly successful game related to music information retrieval is *HerdIt* [16], where players listen to short song previews and have to choose the correct word describing the song. This method is considered quite player friendly as no typing or creativity is necessary. Both acquisition methods (tag typing and option picking) were later used in the Listen Game [17] where players had to first choose one of several words describing a song and then type the most accurate song characteristics.

Despite their successes, all the above GWAP have been designed with a specific aim and target a single-modal labelling task. Therefore, they can unfortunately only be used for their developed purpose and can not be adapted for other labelling procedures.

B. Contributions of this Paper

Since acquiring annotations is costly, time-consuming, tedious work, and games are a seductive method encouraging people to participate in projects [6], the multi-purposed, gamified crowdsourcing platform iHEARu-PLAY [1] was developed [18]. A key challenge for this platform to succeed will be to inspire the required numbers of volunteers. For this reason, this paper explores a multitude of concepts that will motivate users with the help of gamification, rewarding them with virtual goods instead of money. In all cases, the multi-modal data annotation and recording tasks will be designed like a game in order to motivate people to voluntarily sign up and record and/or annotate data. The aim of these gamification additions is to motivate users and spark their interest, not just in using the platform once, but rather to play (record and annotate) on a regular basis.

II. The Gamified Crowdsourcing Platform

iHEARu-PLAY provides volunteers a game-like environment to record audio or audio-visual data and annotate video, images or audio data. The platforms' web interface for labelling tasks (cf. exemplary Figure 1), presents the player with: their progress for this dataset; the list of answers or a slider to give time-continuous answers; the feedback message after submitting the answer; the earned points; and, the next data instance and question.

The web interface for a speech recording task is similarly to the labelling web interface. Players start their recording

[1] https://ihearu-play.eu

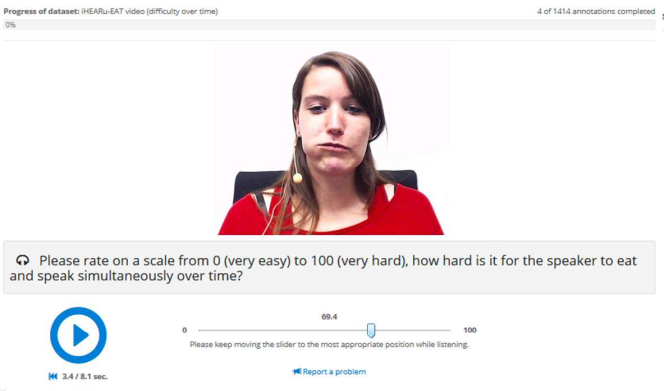

Fig. 1. iHEARu-PLAYs' web interface for an exemplary audio-visual labelling task, showing the progress for the audio-visual dataset and the slider for time-continuous annotations. After submitting the answer, the feedback message will fade in, including the earned points, followed by the next audio instance and question.

Fig. 2. iHEARu-PLAYs' web interface for an exemplary recording task after having recorded a sentence, showing the possibility to listen to the recorded audio file again, to discard it or to upload it to the platform, followed by the next task.

by clicking on a microphone button, and – as exemplary shown in Figure 2 – are asked to read aloud the displayed sentence. During the recording they get presented with a live spectrogram visualizing their recorded speech. After the player stops the recording, they can listen to the recorded speech sample, and decide if they wish to discard the result (and record the same sentence again), or upload the recording to the server.

III. Gamification Concept and Game Elements

Compared to actual games, GWAP can fail to entertain on an equal level. Often there is no narrative involved that keeps the player interested and the interfaces look mundane in contrast to the most powerful 3D gaming engines.Therefore, the motivation for the players has to originate from elsewhere [19]. In this regard, it is important to understand that players are not just one large target group [20]–[22]. Indeed, everyone expects something different from a game and one goal of iHEARu-PLAY is to try to cater to as many of these different needs as possible.

In the literature, different player classes having different gaming goals have been identified [23]:

- *Explorers* are players with a thirst for adventure. They like to try out everything that comes their way and emphasize more on the scope than content.

TABLE I
UP-TO-DATE ACHIEVABLE RANKS AND THEIR CONDITIONS.

Rank	Points needed
Newbie	0
Beginner	1,000
Novice	5,000
Intermediate	20,000
Adept	100,000
Expert	250,000
Veteran	500,000
Master	1,000,000
Ace	2,000,000
Legendary	3,000,000

- *Achievers* enjoy completing most of the challenges they are presented with. These ambitious players aim for collecting badges and achievements.
- *Socializers* participate in the game mainly because other players also do and play in order to stay in this social circle.
- *Winners* look for open battles. They like to show everyone that they have won the game and can usually be found on top of a leaderboard.

Therefore, to include as many players as possible, iHEARu-PLAY utilises a combination of leaderboards, badges, and a social platform. The aim of these gamification elements is to provide all players with an increased motivation boost, while making up for the deficits gamification concepts have compared to real games [19].

Other important issues to focus on while designing GWAP are: (i) attractive level design and simple gameplay, (ii) proper and motivating scoring, and (iii) building up a player base.

As with conventional games, these aspects can be addressed in GWAP by having a clear objective that is easy for the player to understand [24] and a simple ruleset, so that players do not get scared off by a large number of complex rules [25]. This is paramount, as complex and explicit instructions do not only demotivate people, but also directly affect the resulting quality of the completed task [26].

Moreover, if the game is too challenging, players will become frustrated, but if it is not challenging enough, players will easily feel bored [27]. Ideally, the main goal the player has to reach should be compromised of multiple intermediate goals as steppingstones, each becoming incrementally more challenging. Complicated rules or controls that need to be learned and memorized before any gameplay, results in a steep learning curve and can turn people away from the game [28]. Finally, feedback needs to be immediate, otherwise the player does not know what effect their action caused, and they will quickly become distracted and lose focus on the task at hand [27].

A. Gamerscore

The proposed gamerscore is a counter of gamepoints that is individually maintained for each player. New points can be gained by recording audio or audio-visual prompts or annotating audio, video or image instances. As players do not lose points that they have gained earlier, the gamerscore is therefore an indicator for the amount of work a player has contributed to date, and forms the basis for the rankings on the iHEARu-PLAYs' leaderboard. As in most games, points are earned by simply playing the game. However, depending on how 'well' the player performs, they can earn a greater number of points. Therefore, points can get earned for recording and annotating data as follows:

Recording: Points are computed based on the length of words of the recorded prompt and a static multiplier for a given dataset. Since the recording is not immediately analysed or rated by other players, there are very few possibilities in order to grade the recording. The system already blocks recordings that are too short in relation to a given prompt. Overly long recordings are currently not penalized, however the system will stop a recording after a certain time span in order to avoid filling the servers' filesystem with random data from some malicious player.

Annotation: The number of points a player will get for an answer depends on how well their answer matches the answers of all other players that have already annotated the respective instance. In order to allow for efficient comparisons of a new answer to all existing ones, answer statistics summarizing all answers received so far, are maintained for each media file and annotation task.

The exact score calculation for a new answer is dependent on the annotation question type (e. g., single-choice, multiple-choice, discrete or time-continuous numeric, pairwise comparison, or self-assessment manikin), but always follows a common scheme:

1) The answer statistics for the instance are updated by incorporating the new answer.
2) The score is derived from the new answer and the updated statistics.

In case a score cannot be determined in a sensible way (e. g., if the player is the very first to annotate an instance), a baseline score of 0.75 is assigned. In the following, the exact formulas used for computing scores for the most prominent labelling tasks are detailed.

For *discrete (single-choice)* tasks, the answer statistics take the form of a histogram hist, counting how often each annotation option was chosen by players. Letting $\mathrm{OPTIONS}$ denote the set of annotation options and $\mathrm{hist}(a)$ denote the number of players that have chosen option a so far the score for a new answer $A \in \mathrm{OPTIONS}$ can then calculated according to:

$$\mathrm{score} = \begin{cases} \mathrm{hist}(A) \,/\, M & \text{if} \quad M \geq 2 \\ 0.75 & \text{if} \quad M < 2, \end{cases} \tag{1}$$

where $M = \max\{\mathrm{hist}(a) \,|\, a \in \mathrm{OPTIONS}\}$.

For *discrete (multiple-choice)* tasks, answer statistics are maintained identically as in the single label case. The score for a new answer $A \in \mathcal{P}(\mathrm{OPTIONS})$ is calculated as follows:

TABLE II
UP-TO-DATE ACHIEVABLE TYPES OF BADGES AND THEIR CONDITIONS.

Badge Name	Conditions
Autobiographer	Complete your profile
Nothing To Hide	Fill out the metadata form
First Steps as Annotator	Submit your 100th annotation
First Steps as Recorder	Upload your 50th recording
Blabbermouth	Submit recordings totalling 4 hours in length
Busy Bee	Make it into the top 3 players of the last 7 days
Busy Beaver	Make it into the top 3 players of the last month
Champion	Make it into the top 3 players of all time
Treasure Hunter	Collect 50 bonus items on a single day
Regular Customer	Answer at least 20 questions every day for 14 days in a row
On a Roll	Answer 25 questions with excellent answers in a row
Streak of Bad Luck	Do not find any bonus item for 28 questions in a row
Early Bird	Answer 200 questions in one morning between 4 am and 8 am
Night Owl	Answer 200 questions during a single night between 23 pm and 3 am
On The Go	Play on a mobile device
Feedback	Provide us feedback by filling out a survey
Bug Reporter	Report a previously unknown website bug or recording issue

$$\text{score} = \begin{cases} \left(\frac{1}{|A|}\sum_{a\in A}\text{hist}(a) \quad / M \right. & \text{if} \quad M \geq 2 \\ 0.75 & \text{if} \quad M < 2. \end{cases} \tag{2}$$

For *discrete numeric*, *Self-Assessment Manikin* and *continuous numeric (2D)* tasks, the mean of all player answers $\mu \in \mathbb{R}$ ($\mathbb{R}^2$) is maintained as answer statistic. The score for a new answer $A \in \mathbb{R}$ ($\mathbb{R}^2$) is calculated according to:

$$\text{score} = \begin{cases} (1 - |A - \mu| \,/\, |\text{MAX} - \text{MIN}|)^2 & \text{if} \quad N \geq 2 \\ 0.75 & \text{if} \quad N < 2, \end{cases} \tag{3}$$

where MIN and MAX are the minimum and maximum values a player can select, $|\cdot|$ denotes the Euclidian norm, and N is the number of answers that μ is based on.

For *time-continuous numeric* tasks, an answer consists of a finite number of numeric samples recorded over time. The per-sample average of all received answers is maintained as answer statistic. The score of an answer is calculated by first calculating the score for each instance, then taking the mean of all scores.

The number of points a player is awarded for an annotation is obtained from the score by first scaling it to the range $[2, 10]$ and then applying the current multiplier

$$\text{points} = \lfloor(\text{score} \cdot 8 + 2) \cdot \text{multiplier}\rfloor. \tag{4}$$

B. Multiplier

The multiplier acts as an additional factor that is incorporated into the calculation of the game points. The purpose of the multiplier is to weight different gamification elements depending on specific aspects of a single player, and to promote some datasets over others by rewarding more points for completing 'high priority' tasks. The multiplier consists of four components:

$$\text{multiplier} = M_r + M_b + \frac{T_u}{100} + M_d, \tag{5}$$

where M_r denotes the rank multiplier, M_c denotes the bonus multiplier, T_u is the players' trustability score, and M_d is the dataset multiplier. The rank multiplier defaults to 1 and gets increased for every rank promotion of the player. The bonus multiplier defaults to zero and is temporarily increased by bonus items that the player earns. The trustability score of a player defaults to 100 and gets decreased for (i) every picked "control answer", which is an answer included into a wider set of answers which is definitely wrong, (ii) inconsistent answering on repeated certain questions from within the data, and (iii) inconsistent answers focusing on the relation of the given answer to other players answers towards the same instance. Giving 'inconsistent' or 'wrong' answers decreases a players trustability score whilst a 'correct' answer increases or maintains it. The dataset multiplier exists for each dataset and defaults to 1. It acts as a way to prioritize datasets by rewarding players with more points on some datasets than on others.

Depending on the total number of points collected, a player can climb up in rank. Each player starts as a "Newbie" and there are currently nine achievable ranks integrated into iHEARu-PLAY (cf. Table 1). The aim of the ranks is to motivate players to collect even more points by annotating data or recording speech instances.

C. Badges and Bonus Items

Apart from the rule set, structure, and goals of the actual game, developers often provide additional services like a reward system or collectables [29]. These are awarded and do

not affect the game progress and as such are fully optional. Collectibles can be seen as fan services, offering frequent players a reason to keep on playing despite having finished a game or as a variation of what the goal in the game can be. When players feel like they have beaten a game, they can still turn to collecting badges, achievements or other secondary objectives. Awards that have been granted to a player can be shown publicly so that players are able to see just how committed others players are. Many large gaming platforms such as Xbox Live and Steam have implemented their own take on such reward systems [30], which resulted in many players putting in extra time just to get these.

iHEARu-PLAY includes badges which are awarded to players who fulfill special requirements that are unique to each badge. Examples of badges include (cf. Table 2): the number of questions answered, number of times logged in, or usage of the platform at special times such as during the night, to name but a few. New content and badges are constantly added to the system to keep it interesting. Players are also able to view the profile of other players and see a list of their acquired badges to compare to their own achievements so far.

Furthermore, iHEARu-PLAY has integrated bonus items which are collectibles that temporarily give certain advantages or are linked to unique actions in the game. Currently, four different bonus items are available. The 'New Member' bonus item is given to every player after registering with the game, and increases the bonus multiplier by 3 for their very first 25 annotations. Similarly, the 'Daily Bonus' item that is awarded to every player at midnight and increases the bonus multiplier by 2 for the first 25 annotations that a player submits each day. Other bonus items include an item that permits players to skip instances during annotation, and an item increasing the bonus multiplier after more than 150 annotations have been made on a single day. Further bonus items are planned and will be added in the following versions of the platform.

IV. User Evaluation

An evaluation study was conducted to assess the current development status of iHEARu-PLAY and to identify the needs and wishes of the players for improvements or new features. Therefore, over the course of five days, 33 people signed up to play the "game". Among the players – now referred as participants – were 19 male and 14 female volunteers, their age ranging from 15 to 57 years (mean: 28.42 years old (standard deviation (SD): 10.95).

The participation in the survey was purely voluntary and was conducted in an uncontrolled environment. First, the participants received a short introduction to the game as it also is shown on the website itself. Then, participants were instructed to play the game by annotating some audio instances and recording their own data, but without any guideline, given tasks, or specific instructions in order not to influence the results. In total, 921 annotations and 191 recordings were collected within this first short-term evaluation.

TABLE III
Results of the evaluation survey. Overall results are displayed as star ratings (intervals incrementing in 20 % steps), followed by absolute numbers.

	Rating	%
Tasks		
Annotate	★★★★½	78.36
Record	★★★★½	81.63
General		
Content	★★★★½	84.71
Design	★★★★½	75.78
Usability	★★★★½	82.74
Fun	★★★½☆	67.26
Interesting	★★★★½	72.65

Finally, the participants were asked for their general impressions and their ideas on possible improvements. In detail they were asked to answer the following questions:

- What is the usability of the current iHEARu-PLAY form and how can it be further improved?
- How much fun is it to play the game?
- What functional improvements can be done?
- How successful is the current gamification design?
- What do players dislike about iHEARu-PLAY and how can this be improved?

The subjective evaluation indicated that all participants agreed on a good usability (82.74 %), informative content (84.71 %) and fancy design (75.78 %) of the platform. Participants' responses can be classified into responses regarding the gamification approach, comments on usability issues, suggestions for feature extensions, comments on the data quality, and the personal motivation to play the game. The feedback for the gamification of both of the recording and annotation features was highly positive. The participants rated collecting points and challenging on the leaderboard very emphatically, e. g., "I enjoyed climbing up the Leaderboard". Most of the participants liked the idea of a citizen science project and would further contribute by playing iHEARu-PLAY, e. g., "I liked the fact that it is a research which could improve the communication between machine and human beings". One major needed improvement that was identified, is to give more detailed information on how these annotations help science. Acting on this feedback, the latest additions to the platform have included a more detailed description of the work and we introduced "VoiLA" our Voice Analysis Application feature [31]. Within VoiLA player can record their voice and have it analysed in terms of gender or different kinds of emotions, and learn more about the underlying machine learning processes.

Overall, all participants agreed that iHEARu-PLAY made them curious about how it works and the science behind it. The participants could imagine helping science by annotating and recording data in a gamified and fun environment through iHEARu-PLAY.

V. Conclusion and Outlook

In this contribution we introduced different adapted gamification elements used within the crowdsourcing browser-based platform iHEARu-PLAY [18] to motivate people to voluntarily record and annotate data for scientific purposes. To evaluate the success of our methods, we conducted a pilot study of the game prototype, which indicated that the gamification elements made the annotation and recording tasks in iHEARu-PLAY fun and challenging for players. We have already started to incorporate the suggestions for improvements into the platform.

Planned gamification additions to the platform include a more sophisticated grading system for the recoding feature and will take additional factors, besides just the length of the prompt, into account, such as the number of individual recordings for a single prompt. Furthermore, there will also be additional bonus points when a player finishes a complete task and/or dataset, but also a penalisation if the recording has long silences at the beginning or end. A betting system is also being developed, where players can bet points on their given answer and compare themselves with other players. Through the addition of these and other new feature, we expect the platform to even be more fun to use in the future, and that players will annotate and record data on a regular basis.

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