ABSTRACT

Each day millions of people are playing digital games with different motivations. These motivations are ranging from time beating to deep immersion into a narration or interacting with a community. To address all these different means, a range of game designs is necessary. Traditional human computation games, although providing great gaming experience, cannot yet present all of this aesthetics.

This work will give a game centered view on game design for human computation. It will therefore analyze existing human computation games by the means of game design theory in the field of game studies. To demonstrate the value of the theoretical findings it will also present a fast-paced action game called OnToGalaxy along with two different human computation tasks.

1. INTRODUCTION

Since human computation was integrated into digital games and became relevant for science and industry, different fields of its application have been explored. The evolved designs have proved to be effective as well as efficient in many situations. Design aspects discussed in recent literature on game design and game studies became part of these games, making them a valuable playing experience. An overview of current human computation games and relevant publications in the field of game studies will be given in section 2.

On one hand human computation games are providing a unique game play experience. On the other hand they are focused on a special task and tightly aligned to it. This design focus is making them a game category on their own. Even though a range of appearances of human computation games was presented, their core design is to some extent homogeneous. Many works on human computation with digital games are centered around a certain task or problem domain and thereby explore a range of applications. Significantly fewer works are investigating the tension field of game design and game studies in the context of human computation.

This paper will concentrate on the paradigm of using digital games for human computation. In section 4 it will discuss the important differences between human computation games and traditional digital games. In this context the current work will discuss human computation games with a focus on the field of game studies. In section 5 the paper will demonstrate how to design a game comparable to other casual games that are played by millions of players every . Therefore it will present and discuss the idea of a disjoint human computation game design in subsection 5.1. It will investigate benefits and drawbacks of using this design and will give examples of how to implement it.

2. RELATED WORK

Digital games with a human computation task have a range of designs, they can be puzzles, multi player environments or even virtual worlds. They also have many application domains. Common tasks for a human computation games are for instance relation learning or resource labeling. A well known example in this regard is the GWAP[40] series. Other games trying to use human computation for natural language processing like Phrase Detectives[10] or TwinMind and Actionary[37]. Yet others, like OntoGame[35] are used to build and learn ontology’s. These games are performing human computation by integrating their task into puzzle like games.

Even though many games are very similar in their use of design elements, some are different. HeardIt, for instance, has a user centered design as its core idea[8]. It makes it different from other human computation games that are mostly designed around a certain task as their core element.
HeardIt also allows direct text interaction between players during the game session, which is prohibited in other games to prevent cheating[41]. KissKissBan[19] is another game with special elements. It is a game that involves a direct conflict between players. One player tries to prevent the “Kissing” of two other players by labeling images.

Another game that is special according to its design elements is Plummings[38]. This game aims at reducing the critical path of FPGAs. Unlike other games the task is separated from the game mechanics. The game is about a colony of so-called Plummings who need adequate air supply. By keeping the length of the air tubes as short as possible the player saves the colony from suffocation. Plummings also provides the possibility to be played as a multi-player game, which is not yet done by the inventors but is quite possible.

Another interesting game is FoldIt[9]. This game aims on folding proteins, which is a complex task. It is a single player game which needs a downloadable client. It presents simplified 3 dimensional protein chains to the player, and provides a score according to the predicted quality of the folding done by the player. FoldIt is special because all actions by the player are performed in a 3 dimensional world.

Other human computation games also incorporate virtual worlds. Give[24] for instance is a single player Java game where the player is guided through a virtual environment by an artificial system. The system generates descriptions for the users to orient themselves in the a labyrinth while testing different NLG algorithms. Another instance of virtual worlds in human computation is the Restaurant Game[32] which aims at exploring natural language in a restaurant situation. It presents a virtual restaurant to the player, where he or she takes either the role of a waitress or a customer. The game records the dialog between players and generates an artificial representation of both roles.

As the presented works show, HC games have already developed in different styles. In the following section of this work these differences will be described and analyzed from the game study perspectives. Therefore it is necessary to take a look at this field, which to some extent is dividable into two schools: narratology and ludology.

Narratology understands games as a form of narration. Important publications in this field were made by Murray[30], Jenkins[21], Lindley[27] and Atkins[6] to name a few.

In contrast to these theoretical works on games there are also others that are concentrating on design issues of digital games. One of the earliest works in this regard was written by Crawford[11]. His book deals with questions of what makes a real game, why people play them, and how to design engaging ones. Crawford gives a restrictive definition of the term “game” in his book, which is later analyzed by different works on this topic.

Salen and Zimmerman for instance gave an interesting overview on definitions of games in their book “Rules of Play”[34]. They also described the aesthetics of interactive systems, and defined core concepts like play, design, and interactivity. They looked at games through so-called game design schemes, or conceptual frameworks, including games as digital interactive systems in the context for social play and as a medium for storytelling.

Hunicke, LeBlanc and Zubek are describing a formal framework of Mechanics, Dynamics and Aesthetics to give guides on designing digital games. Mechanics are the particular components of a game, at the level of data representation and algorithms. Dynamics is describing the run-time behavior of the mechanics acting on player inputs [and each others outputs over time]. Aesthetics is describing the desirable emotional responses evoked in the player, when he or she interacts with the game system[20].

In the following section this work will look at human computation from the perspective of game studies. It will present the tension field of human computation with digital interactive entertainment systems and will describe the idea of disjoint human computation game design. This work will then describe how a disjoint design can be applied and discuss the benefits as well as drawbacks of such an approach.

3. A THEORY TO EXPLORE

Looking at games from multiple perspectives is helpful in order to emphasize different aspects of games. In the field of game studies, as in science in general, combining different models brings to complex results. The “virtual” discussion between ludology and narratology is an illustration of it. This section will present different views on games according to both schools and a theoretical vindication for doing so.

For instance, while looking at the abstract patterns of a system like Wikipedia, one will find similarities with games, when some forms of user interaction or community brings rewards. Similarities can also be found in user experience. Hunicke et al.[20] describes different types of so-called aesthetics, which are described as “desired emotional responses” to a system more graspable than “fun”. Fellowship, which is one of this aesthetics, describes the enjoyment of games as a social framework. Expression means the pleasure of games as a form of self-discovery or self-expression to others. Both features are also part of Wikipedia users experiences as described by Forte[17].

These similarities on the other hand can hardly be distinguished by systematic analysis alone. So it might turn out to be insufficient to transfer game elements to another system without looking at the overall ambient connection - which one may call a narration. Both forms of observation - ludology and narratology are different but have similarities as explained by[18, 33]. The rise and disappearance of these similarities between ludology and narratology depend on each system. There is no connecting feature common to all systems, but there are resemblances between these systems as well as resemblances between ludology and narratology.

To explain his concept of Family Resemblance Ludwig Wittgenstein uses the term “game” to illustrate his theory of language. Wittgenstein asks the reader of his book Philosophical Investigations[43] to give a definition of the word game. At first this seem to be a simple task but Wittgenstein demonstrates the problems that are arising with each possible definition. Any definition focusing on amusement leaves us unsatisfied, because the “feelings” of two computers playing a game of chess could not be considered fun or amusement. Any definition focusing on competition will fail to explain a game like solitaire. Wittgenstein shows with his
work that meaning is not graspable by definition.

As this example shows, it is not reasonable to fix an analysis to a single definition, school or form. This is also true for human computation, which combines different fields like interaction design, artificial intelligence, user participation and incentives. Therefore a greater understanding on how games or other systems can be used to support human computation can only be achieved considering all aspects. A systematical approach useful in order to find similar elements in different systems. A narrative point on the other hand helps to find differences in these design elements. Therefore explaining why using a systematically efficient design fails to be effective.

4. ELEMENTS OF GAMES

One way to look at human computation games is by utilizing given definitions. According to such a definition it is possible to emphasize important elements of a certain game or group of games. Katie Salen and Eric Zimmerman gave an overview of eight different definitions of the term game [34] including various perspectives ranging from philosophy to game design. They extracted fifteen elements out of these definitions. This work will concentrate on six of these elements as depicted in table 1. The numbers next to each element indicate how many definitions include this element.

### 4.1 Games as Conflicts

The element of conflict or contest as described by, for instance, [7] can be further refined. Crawford introduced a taxonomy of games in his Book “On game design” [12]. He distinguishes between games and competitions by the ability of the opponents to impede each other. In a contest situation like in a sports competition the opponents are not permitted to take direct actions against each other. Most human computation games presented do not provide a conflict in this regard, even though one may argue that, for instance, the GAWP games have a competitive element through their high-score lists. Crawford motivates his distinction by giving the question: “Is there an active agent against whom you compete?” This is not the case with GWAP games, in which there is no active agent a player could compete with. Some exceptions to this are discussed in greater detail in section 2. For instance KissKissBan [19] provides competitive game play between players. This does not mean that a conflict is necessary for a game but that many theories of games are related to this virtual conflict.

On the other hand a conflict can be an important element. A reason for that is that in real life a conflict is related to dangerous situations. Imagine, for instance, an encounter of a 19th century whaler with a white whale in the open waters of the Atlantic ocean. The obvious conflict in the real situation is terrifying, however, the same situation in the virtual world can turn into exciting experience. The reason is that the player experiences the relieve of escaping the whale without the danger of a real physical encounter. This is related to element one in table 1. The same effect can be surveyed with other immersive media like books or movies. This illustrates that narrations can be used to intensify the experienced tension of conflict. This effect is also described in a general way as the aesthetic of narration [20]. A narration is then most intense when it makes the player believe the story. This is mirrored by element 5 in table 1 and can be expressed as the aesthetic of fantasy [20].

### 4.2 Subjective Impressions

A high score list can be considered extrinsic reward in some cases. This sort of reward, if given through gifts or ranks, is not part of the game itself, and can have negative results on player motivation. Indications for this can be found in [23, 26]. This does not mean that rewards are inappropriate. Moreover, it is necessary to integrate a reward system into the game as part of player motivation. The work of Lepper and Kohn differentiate between intrinsic and extrinsic motivations. Intrinsic motivation is the personal motivation of an action. In case of a digital game this can be the aesthetic of a game as described by [20].

An extrinsic reward is given to the player for doing something. For instance, a child constantly motivated by his parents to draw, over time loses his interest to it. This effect is called “overjustification” [26] and can also occur while playing a game. External reward may also give the impression of doing work. If a reward is not an inherent part of the game, player can get the impression of being paid. This impression can be associated with work and therefore decrease the intrinsic motivation as explained here [23]. Furthermore traditional human computation games tend to expose the underlying task to the player in an obvious way. This can also invoke the impression that the game is actually made for a certain outcome². Therefore a good design provides intrinsic motivation through its aesthetics by omitting external rewards.

### 4.3 Means of Progress

The elements of point 3 in table 1 are elements of games in general as understood by [3, 36, 7] and of digital games in particular. Digital games need the player to undertake certain actions to play the game. These actions are mirrored by a meaningful change in the game world called progress. In this context progress is not only a direct reaction of the system like: turning on the light after the player presses a button. It is also an advancement in the story or a step towards a certain goal in the game. In a progressive environment the player acquires more degrees of freedom through his or her actions. This freedom results in new strategies or tactics a player uses to solve encountered problems. An instance for such a progressive element could be: a player receives an item by solving a puzzle which allows him to teleport to another level. In this level the player has to solve a similar puzzle but with a twist that forces him to use a different strategy or tactic.

Progress is the basic element of emerging dramaturgy in a digital game. Different progressive elements allows to control the perception of the game. Building up tension to a

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2 This problem also occurs with learning games, that distract players with too obvious learning tasks in a school like manner.

| 1 | Artificial/Safe/Outside ordinary life | 4/8 |
| 2 | Conflict or contest | 3/8 |
| 3 | Activity, process, or event | 3/8 |
| 4 | Never associated with material gain | 2/8 |
| 5 | Make-believe/Representational | 2/8 |
| 6 | System of parts/Resources and Tokens | 2/8 |

Table 1: Collection of game design elements
climax as well as holding the tension on a plateau. If this dramaturgy is unique it qualifies the gaming experience of a play session to be considered an event. For instance the visitation of a rock festival is an event formed by unique experiences. So everything that adds to the uniqueness of the game session makes the session an event and therefore pleasurable for the player. A good game makes every play session an event.

One way to establish a unique dramaturgy is integrating other players as they are unforeseeable and therefore adding to the event character of a game. Human computation games provide a narrow range of actions the user can perform. For instance the player can type in a label or select an element. Sometimes under the pressure of time. The representation in the game world is mostly a change of a score value. The event character of human computation games is mostly provided through collaborative play. In our pre-evaluation many players are mentioning that they like the idea of a real player to play with. One player commented on for instance ESP: “I really like to think about who is on the other side and what the person is thinking.”.

4.4 Artistic Quality
Another important aspects of digital games, which is not part of any definition is the artistic quality, for instance, audio or graphical quality. As pointed out by [11, 34] these qualities do not necessarily enhance or influence user experience. Games like Tetris[4], for instance, are joyful because of their mechanics, which graphics, representing a falling block, are not essential for this game. Katie Salen and Eric Zimmerman[34] also demonstrate that graphics are not relevant for the formal quality of the Donkey Kong game[31].

Figure 1: Second version of OnToGalaxy. The human computation task is to populate an ontology. The blue ship on the right is a labeled freighter. The red fighter ship in the middle is controlled by the player. On the lower right is the mission description. It tells the player to collect freighters labeled with words of touchable objects like hammer. In the example the freighter is labeled with leaf which fulfills the relation of being a touchable object. The explosion close to the fighter originates from a freighter that was shot down by the player.
On the other hand, graphical quality can be an inherent part of a game, as shown by Assassin's Creed II[39]. In this game a sophisticated graphical environment provides an immersive and convincing ambiance, which is a major aspect of play in this game. Other games provide motivation through pleasing graphical elements. Final Fantasy XIII[15], for instance, provides excellent cut scenes. These cut scenes accentuate the storyline of the game. This kind of effects add to the aesthetics of fantasy and sensation as described here [20] as well. Graphics can support the player’s immersion. This is related to element 5 in table 1 making the player believe that he or she has an active role in the game world and its story. That sets games apart from other forms of narration, where the player cannot influence the storyline. The effects of graphics in this regard are discussed in more detail by [42].

### 4.5 Where to Go

As this discussion shows, the tension field of human computation with digital games is not explored to the full extend. Many aspects and elements of games, as described by the field of game studies, are not yet seen in human computation games. The following section will demonstrate the theoretical findings with an implemented example and prove the claims made in this section along with the presentation of the OnToGalaxy game.

### 5. AROUND (THE) FRONTIER

Every month 200 million people are playing casual games. Some of them spend up to two hours a day. The games they are playing can be of any genre and any type. This claim was made by [1]. As already argued, most human computation games provide a valuable, but specific sort of game play. To reach as many players as possible, it is necessary to expand the designs of games used for human computation.

Designing a game, that is different from traditional human computation games that is able to perform human computation, is a complicated and complex task. To give an impression how such a design can look like this work will present OnToGalaxy. OnToGalaxy is a fast-paced action-oriented science fiction game comparable to games like Asteroids[5] or Starscape[29]. Some participants also compared OnToGalaxy to games such as Frontier and Wing Commander, at least to a certain extent. OnToGalaxy provides a simple storyline and a progressive game play. Progressive elements used in the design of OnToGalaxy are, for instance, different levels with different agents, as well as upgrade elements of the players spaceship. This is comparable to other browser-based casual games. The design was chosen because of its stereotypical elements, seen in many games of its genre. It also allows a good comparison to other human computation games because of its difference in many aspects. To evaluate the outcome in regards to human computation OnToGalaxy was designed to reproduce different gold standards. The two different tasks used to evaluate the data quality are described in detail in section 6.

#### 5.1 Disjoint Design

Tightly coupled designs may not allow to take into account issues of game design as desired. A possible solution is a so-called disjoint game design. In a disjoint human computation game the design and the actual task do not correspond to each other directly. The task to be solved has to be part of the mechanics, but is no longer the dominant element. This way the distracting effects of the task can be hidden from the player.

Since OnToGalaxy is a space shooter game, it is not obvious how to integrate the desired relation extraction task into the game. In the game the player is the commander of a spaceship. He or she receives missions from an imaginary headquarter, represented by an agent, which is his or her copilot. Beside the storyline, these missions are presenting different tasks to the player like: “Collect all freighter ships that have a call sign that is a synonym for the verb X”. A call sign is a text label on top of each freighter. If a player collects a ship according to the mission description he or she confirms this label to fulfill the given relation. In the given example that means that the collected label is a synonym for X. Even though only two different tasks were integrated, the underlying game engine is capable of fulfilling other tasks where one needs to establish arbitrary relations between two elements. These elements could be words as well as resources like images or audio files.

Beside OnToGalaxy there are already games with a similar approach (Plummings introduced in section 2). There is no direct connection between providing air supply for the Plummings colony and the minimization of the critical path length. There is certainly a relation in the actions that a user has to undertake to provide air supply and to solve the path problem.

#### 5.2 What a Difference a Story Makes

A frontier that was explored very early during the design of OnToGalaxy was the coupling between task and game design. The first attempt towards a disjoint design was however not very successful, as player experiences the decoupling of the task and the game elements to be “odd”. This happens because solving a task like populating an ontology in a game looking like a space shooter leaves a gap in the players experience. This effect is related to the explanations given in section 4.2. Players of OnToGalaxy made jokes about this disturbing effect and tried to give various stories to solve the perceived discrepancy.

Taking this observation, as well as the resulting stories into account, the second version of OnToGalaxy provides a storyline trying to close this gap. Even though the first attempt does not solve the problem of impression in total, it however enhances the experience of the players and closes the described gap. After introducing a storyline, no comments regarding this gap were given in the interviews. As explained by some participants of the pre-evaluation interviews the story allows them to close this gap and therefore experience the task as an inherent element of the game play.

However the second version of OnToGalaxy was still perceived as “work” or an ordinary task by some players. They do not complain about the gap but still perceived the task as too dominant. Although only very few persons gave comments, the question was whether it would be possible to overcome this issue. Considering possible differences between “normal” games and OnToGalaxy, it turns out, that the conflict situation was different from other games. The
element of conflict is described in more detail in section 4.1. In contrast to other games OnToGalaxy permits to shoot down freighters, but do not include equal reaction. After integrating aggressive behavior from the system in version three, the game was accepted by the players. The players in the pre and final evaluation of the third version did not describe the task as distracting any more. Some persons still argued about missions perceived to be too challenging. This, however, is a problem of game balance and is not a problem specific to the human computation task.

5.3 A Matter of Speed

As already mentioned a critical issue to some games is speed. This is true for games like OnToGalaxy, which like other games of this genre rely on fast interactions. As presented by [13, 25] fast interactions can be achieved by using binary verification. In contrast to traditional human computation games, the player is not asked to give his or her personal impression, but should decide whether a given relation is valid. An extension to this is categorization where the player decides to which category a certain element or relation belongs[35, 8]. Both approaches can be faster than typing personal thoughts into a text field.

In case of OnToGalaxy the chosen interaction form is binary verification. The game presents a certain relation to the player via the mission screen, and asks to find elements represented by game elements that fulfill the given relation. The major drawback of binary verification and possible solutions are also described by[13, 25].

6. EVALUATION

Different evaluations were made with the different versions of OnToGalaxy to verify the quality of collected data, as well as the user experience. All versions of OnToGalaxy are build
to reproduce a gold standard. Two different tasks were used with three different versions of OnToGalaxy.

### 6.1 Ontology Population

The first two experiments tried to populate the DOLCE (Descriptive Ontology for Linguistic and Cognitive Engineering) with common words of the English language. The gold standard was generated by an expert. The test bed uses 8 base categories of the DOLCE D18[28] and a corpus of 2189 common words of the English language. Only five categories could be used because three categories were underspecified. These categories were not removed from the game, but from the evaluation. A category was considered to be underspecified by having less than six elements. An element is a word in the given corpus. Also some words were removed from the list of common words to prevent confusion. For instance if the list contains “go” and “went” than the term “went” would be removed. All modifications to the word list could be done automatically by using for instance a part of speech tagger. The task performed by the player was to associate a word A to a certain category C of the DOLCE: ELEMENT_OF(Word: A, Category: C).

Figure 3 shows the results generated by 32 players with a total amount of 26 hours of play. An amount of 552 words were classified with 1393 votes. Thereafter every player categorized approximately 19 words with 48 votes, which means that each word required 2.5 votes to be classified. These numbers are expected to differ in a real scenario. The reason is that no player playing OnToGalaxy so far actually tried to cheat. In the category Society there were no false positives as well as false negatives. The task performed by the player was to decide whether a given verb A is a synonym of verb B: SYNONYM(A, B). The verb B was also given the mission description but chosen randomly.

The experiment was done with the third version of OnToGalaxy. In this experiment 25 players classified 360 possible synonym relations. The player played 14 hours in total, so each relation takes 2.3 minutes to be evaluated. Even though the overall precision is high (0.97) the game has also a high rate of false positives (0.25). A reason for that can be a misconception in the game design. The number of elements (words) that did not fulfill the relation presented to the player was too high (over 0.9). To give an illustration for that, each mission starts with a defined amount of freighters populating the game world. Each freighter has a label attached to it. This label either fulfills the relation given in the mission or does not. The probability that a freighter carries a valid label is lower than 0.1. This situation was also commented by some players and is considered to be the reason the numerous false positive results. An accurate analysis of this issue cannot be given yet.

### 6.3 User Experience

Every version was investigated with an evaluation of player experiences. Therefore open interviews were made to capture subjective impressions of OnToGalaxy. In the pre-evaluations a total of 54 players gave their opinion either via e-mail or in a face-to-face interview. No obvious differences where observed between these two groups. The last version of OnToGalaxy was compared with ESP. ESP was chosen because many human computation games are using ESP as a baseline for their own design. The 6 participants of the study were watching a video sequence of the game play of OnToGalaxy and ESP[41]. The video showed both games at the same time and the participants were allowed to play, stop and rewind the video as desired. Watching the video the participants gave their impression on the differences between both games. During these sessions 69 comments on both games were collected. ESP was commented 24 times (0.39) and OnToGalaxy 45 times (0.61). The comments were grouped into the following categories:

- **Aesthetics**: Comments on the aesthetics of the game as described throughout section 4.
- **Progress**: Comments about the perception of progressive elements in the game as discussed in section 4.3.
- **Association**: Comments comparing the game to other games not related to human computation.
- **Focus**: Comments indicating that the player is focusing on solving the human computation task.
- **Task**: Comments indicating that a game element perceived as made for a certain outcome as discussed in section 4.2.
Figure 4: Results of final evaluation of OnToGalaxy

Two comments could not be classified. The results as depicted in figure 4 show that ESP is more efficient in focusing users attention where OnToGalaxy distracts the user. On the other hand, OnToGalaxy is perceived more as a game, according to the definitions analyzed in section 4.

6.4 Data Quality

In game situations where two players are paired a consensus can give as an estimation of the trustfulness of an input. This is different for single player games like OnToGalaxy. To solve this problem OnToGalaxy uses a so-called trust function. The function uses test relations to evaluate user behavior and scores a certain user input. The function generates a trust-value for every player according to the answers given by the player for test relations. The trust value is increased if a player gives a correct answer to a test relation. The trust value is limited to a certain value and not increased above this limit. If a player fails a test relation the trust value is decreased by a value, which is 1.5 times bigger than the increase. If a player’s trust value is higher than the trust limit, the vote changes the current weight of the relation. Otherwise the vote is ignored. A relation is considered evaluated if it gets two qualified votes with the same result, either valid or invalid. The test relations were not marked, but the players were informed about the existence of test within the game. The trust value generated for the players were also not presented to them but influences their score values.

7. ETHICAL ISSUES

With a disjoint design it is more important to inform players about their actions and how they will be used. This might be less important in other human computation scenarios. A disjoint design allows to hide the distracting effects of the task from the players. On the other hand it also hides the task itself. This can prevent players from asking questions about the use and effect of their actions. As this paper demonstrates player do not gain the impression of doing something “serious” when playing OnToGalaxy. In our opinion it have to be mandatory to make clear that the actions of the player are used for a certain purpose and to give sufficient information about that purpose.

8. CONCLUSION AND FUTURE WORK

Casual games played are having different genres and styles. This paper presented a theoretical foundation to build human computation games of different genres introducing the concept of disjoint human computation games. It also presents an example implementation: the action game OnToGalaxy. This game is comparable to other casual action games in terms of aesthetics as well as progress. It demonstrates that human computation tasks can be as well integrated into such games. This work also gives an analysis of the presented concept of human computation with disjoint game designs through the evaluation of different gold standards and player experiences.

Nevertheless, this work can be improved for different reasons. The first reason is that the player group was small, represented by only 54 players in total. The second reason is that only gold standards were recreated. While this is valuable for scientific reasons, it does not show the usefulness of this concept in a productive environment. The next step is therefore to integrate an interesting task into OnToGalaxy and publish the game on casual games website.

9. REFERENCES

[40] Luis von Ahn. www.gwap.com (Games with a Purpose).