

# Gaming to Master the Game

## Game usability and game mechanics

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**Abstract**— Health intervention aimed at children using serious games are starting to grow on popularity, however, Interactive Digital Storytelling (IDS) paradigm for serious games is in its infancy. In this article, we present a series of IDS educational games developed with the aim of promoting responsible antibiotic use and hygiene part of the edugames4all project. Despite commercial success and market popularity of IDS games one of the major challenges we encountered when the games were distributed to schools for evaluation was that many children never played a similar game before and found the concept challenging. As a result, some of the children enjoyed the game while others were frustrated and gave up at a certain point. Although the phenomenon is not new, and it present even in commercial games, we proposed a new approach to ensure that all children understand the message delivered and at the same time, they enjoy playing the game. This paper proposes the introduction of a *training mission* that teaches children in a game like environment the basic concepts necessary to progress through the game. The *training mission* was evaluated in experimental settings with two groups of children, one playing the *training mission* before playing the game and another one who did not. The results showed that there is no statistically significant difference in terms of usability between the two groups, however the group that did not play the *training mission* found the game more “awkward” to play, and the difference between the groups in this case was statistically significant.

**Keywords**— *serious games; games for health; games for children; interactive digital storytelling; tutorial; educational games.*

### I. INTRODUCTION

Responsible antibiotic use and hygiene have been promoted through various campaigns [1], [2], however few of them are aimed at children [3]. The aim of the edugames4all, building on the e-bug project funded by DG SANCO, was to address this gap, by creating educational resources for children. The educational resources edugames4all is focused on are serious games for health. The games target children between 9 to 15 years old and are based on the European curriculum. The topics covered are responsible antibiotic use which are increasingly prescribed especially for children [4], but also microbes’ transmission and hygiene that contributes to the spread of Arespiratory and gastrointestinal infections, a major cause of children illness and absenteeism in schools [5]. According to Piaget [6], [7], engaging children in play-like activities is the

best way for them to learn, and Papert’s [8] work showed that gaming foster students deep learning. The potential of games in teaching children in an enjoyable manner has been shown in different projects [9], [10], one of these being the edugames4all. As part of this project, platform games [11], and interactive digital storytelling games [12] were created to promote knowledge about health issues among children. In this paper, we will focus on the latest category, digital storytelling games.

Digital storytelling games, although successfully used for teaching purposes, with over 60 000 players just between January 2009 and March 2010 [13], are confronted with players dropping-out before finishing the game. When the evaluation of the game was performed in a controlled environment at four schools in the UK, 50%, 54%, 42%, and 29% of the students from the visited schools found the game frustrating and too hard to play [3], despite a tutorial being provided as part of the game to help the players.

This research presents how we addressed this challenge by introducing a new game mission, called the *training mission* that helps children that were not so savvy game players, or that did not play this kind of game, to acquire the basic skills for playing the game. We then evaluate our approach and test how the presence of the *training mission* affects the game usability. To the best of our knowledge, this is the first study seeking to look into this connection.

The rest of this paper is organised as follows. The next section presents a short background on the previously reported game drop out problems and providing players with help in the game. The following section introduces the games, followed by their evaluation. The following section presents the *training mission* and briefly discussed previous evaluations. The evaluation of the *training mission* is presented afterwards. We continue with discussions and conclusions and the paper ends with the future work.

### II. BACKGROUND

Game drop-out is reported not only for other serious games [3],[9], but also in industry projects [14]. Often, when games are introduced in a classroom setting, they seem too complicated for students [15], or from an educational point of view, students are not performing as well as their peers, get discouraged and give up on the game on the long run [9]. In

this paper, we focus on the first problem, games that are found too complicated by children.

Teaching players how to play is considered a “key challenge in video game design” [16]. Although there are successful games that did not provide any help for players, such as Super Mario Brothers [17], tutorials are a frequent method of teaching new players the game mechanics [16]. The usefulness of a tutorial is not always guaranteed, research showing that tutorials are not always a reliable method [16], [18] for increasing the game play, their performance depending on the game complexity [16]. Although having a tutorial integrated in the game was the first method of choice in this project it has not been successful and we opted for a tutorial presented as a *training mission* in the game [18].

A similar approach was followed in the BeadLoom Game [19]. The BeadLoom Game is aimed at middle school children and teaches Cartesian coordinates and geometry. Half of the puzzles in the game are guided and afterwards the student is asked to solve them independently. In edugames4all, the *training mission* is provided so that the children who did not play a similar game before can familiarize themselves with the game play. The *training mission* is not mandatory to play and the students can skip directly to the game. This is the best approach because students that master an activity do not appreciate short and very easy activities within the game [20].

### III. E-BUG/EDUGAMES4ALL INTERACTIVE DIGITAL STORYTELLING GAMES

The detective games that are part of edugames4all consist of four games/missions. During these missions, the players need to solve a mystery. The games are created following problem based learning principles [21], and a series of red herrings and puzzles as described in the Storytelling for educAtional inteRventions (STAR) framework [12]. During the missions, the player takes the role of an investigator that has to solve the mystery/case. Each of the missions follows different learning objectives and they are focused on:

- Bad Bacteria at BBQ [22] and the Global Handwashing Day Game [23] focus on the importance of hygiene in general and hand washing in particular.
- When Bugs go Wild [24] and Gambling Never Pays [25] focuses on responsible antibiotic use.

The aim of these games is to teach children about health issues and when children take the message home. This could lead to awareness about responsible hygiene and antibiotic use in the family [5]. It has been shown that the people that have more knowledge behave more responsibly [26] and it will facilitate behavior change in the long term through changes in social behavior [26]. These games were part of a large multi-language European educational initiative aimed at improving children awareness of basic hygiene principles and the issue of antibiotic misuse [27] and serious games were used as key interventions [28]. The games have been evaluated in various occasions and the results have shown that statistical significant knowledge change can be obtained as a result of playing the game [10].

The player must resolve the puzzles presented in the game that lead to solving the main mystery. During this process, the player learns about microbiology. To solve the puzzles, the player has to interrogate possible suspects, collect data and analyze it, draw and re-evaluate conclusions. In order to help the player, s/he has a partner that can make use of the so called *microvision* – which is a special tool in the game that allows her/him to see the microbes (see Fig. 1), analyze the collected evidence in the lab that in the game is called, the *e-Cooper*.



Fig. 1. Using microvision to “see” the microbes.

We will expand on the GHD Game [23] mission as this was used during this evaluation, but the other missions follow a similar pattern by using a different mystery to be solved and different learning objectives are covered. In this game the player has to solve the mystery around a famous actor getting poisoned. The player, who assumes in the game the role of an investigator, has to answer different puzzles during the game play, in order to determine what has actually happened to lead to the poisoning.

First, the player is situated in the e-Bug agency and he is introduced to her/his boss, Big C. Big C is the chief of the agency, the best agency when it comes to microbes’ problems. Also here, the player meets Alyx who would be the player’s partner and would help him during the investigation. The role of Alyx throughout the game is to guide the player. After introductions are made, Big C introduces the problem, Hugh Grant, a famous actor, is supposedly poisoned, and the player has to decipher the mystery: whether it was a case of an alleged poisoning or not, and who is the guilty one, if any, for poisoning Hugh.

To help with his investigation, the player has at his disposition a tool to see the microbes on the field, microvision, and a lab, e-Cooper. In the lab, Alyx is the one who performs the analysis of the samples collected by the player during her/his investigation. Moreover, the player can make use of the microbial vision. Microbial vision is a special feature of the game that allows the player to see the microbes.

The player has to gather evidence from different scenes that could be related to the investigation. Most of the evidence has to be analysed most of the times, to determine what kind of microbes are in the sample. Moreover, the player has to talk

with the witnesses (Fig. 2), and interrogate the suspects. The player must be able to use the evidence collected during the interrogation, as well as to see who the actual suspects are. Based on the evidence gathered and testimonies, the player has to decide who the guilty party is. The non-linear nature of the game story allows players to explore different options during the investigation. Not all the paths lead to an answer and they are not all mandatory for solving the mystery.

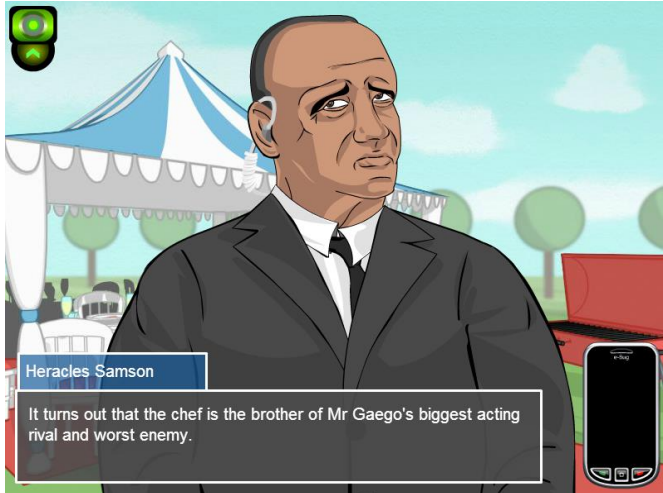


Fig. 2. The player gathering evidence by talking with the witnesses

#### IV. TRAINING MISSION

The *training mission* [18], [29] was introduced after the first three games (Bad Bacteria at BBQ, When Bugs go Wild and Gambling Never Pays) were already developed, mainly because of the difficulties players encountered while playing. It introduces in a fun way the concepts some non-game savvy children were missing by having the game characters explicitly describe how certain features of the games have to be used (see Fig. 3). To keep players engaged, a case that was easy to solve was also presented. The player is first introduced to his game partner, Alyx, who explains the game mechanics and explicitly guides the player through the game. The player is shown how to travel between different locations, how to collect and analyse evidence, and the usage of the *microvision* (see Fig. 1),

elements pertinent to solving the mystery in the rest of the missions.



Fig. 3. The player's partner explaining how to use the e-Phone.

In the *training mission* the player needs to prove that Nathan, one of the non-player characters the player interacts with, hasn't completed the task he was assigned (see Fig. 4): to clean up the locker room. The first thing the players sees when looking for evidence in the locker room is a football ball lying on the floor. Next, while exploring the locker room, more evidence can be found: socks lying around (Fig. 5). When confronting Nathan, he claims that these socks are clean but smell funny because of the washing detergent used. At this point, Alyx, the player's partner, points out that the agency has more scientific methods to determine if Nathan is still lying. *Microvision* (Fig. 1) is introduced to the player, and the player then tests the socks (acquired as evidence with *microbe vision* turned on – Fig. 1). In this manner the player finds out that the socks are full of fungal microbes and Nathan admits defeat. He then promises to sort out the locker room, and the player returns to the agency.



Fig. 4. The player is introduced to his mission.



Fig. 5. Searching for evidence

## V. USABILITY EVALUATION

We evaluated in the first study the usability of the *training mission* and afterwards we address children suggestion on what is to be improved. In the second evaluation we looked at the impact the *training mission* on the usability of the game. This is presented in the next section and this section presents the game usability.

### A. Set-Up

The *training mission* was previously evaluated [18] with 49 10 to 13 year old students (average age was 11.8) attending “Technology Camp,” a summer school held at Elstree School, near Reading, Berkshire in 2010. The students were asked to play the *training mission* and fill the questionnaire containing demographic information questions, usability questions and questions about learning outcomes. This took approximately 10 minutes. Related to the *training mission* usability, the students had to answer five open questions focusing on the training graphics, easiness to follow the training, willingness to continue playing, and improvements to be made.

### B. Results

#### *Easiness to Follow the Training*

One of the concerns of the study was whether the training was easy to follow; otherwise it would only confuse the children even more. The question asked: Was it easy to follow the training instructions?. Approximately 92% of the participants find it easy: “Yes, it’s a nice simple, effective game.”, “yes, very easy”. Another 4% found it usually easy but it could be also confusing: “Mostly yes, a bit confusing sometimes.”. The rest of them (4%) reported that it was not easy to follow but they did not provide any feedback on why.

#### *Having Difficulties Advancing in the Training Mission*

The next question addressed whether they had difficulties advancing in the training: Did you get stuck at some point during the mission?) Half of the participants reported not having any problems and the other half getting stuck during the mission. There were two points in the game that were problematic: “right at the end!” and when they have to go to the e-Copter “Yes, when I had to go to the e-Copter.”.

### *Willingness to Continue Playing*

Another concern was whether the children were willing to continue playing after the training mission: After the tutorial, were you excited to continue playing?. Most of the participants (76%) reported being excited to continue playing. An indecisive response was obtained from 8% of the children: “medium (yes and no)”. The remaining participants (16%) did not want to play after finishing the mission: “I was really excited, but I did not want to carry on.”

### *Improvements to the Training Mission*

One of the aims of this study was also to obtain feedback on what can be improved in the game. The participants were asked: What would you change about this training? Anything?. A bit more than half of the children (63%) would not change anything to the game. Some of them (16%) mentioned having less dialogue (all the dialogue in the game is done through reading which sometimes possess problems for younger children): “Maybe cut down on the talk.”. Four percent mentioned difficulties in using the lab, e-Copter: “More simple use of the e-Copter.” and another 4% mentioned difficulties in noticing that the game ended: “Make what you have to do at the end clearer.” problems which appeared also when the participants were asked whether they got stuck. An equal number of participants (4%) mentioned the need of extra help from the non-player characters in the game: “With just ‘that doesn’t prove anything,’ Alyx should give you a tip.” and the fact that the training is too simple: “It was a bit boring and simple.”. Other issues mentioned concerned text: “Yes, stop calling it a game using the character, it’s unrealistic.” and the ability to return and read previous conversations “When people talk a lot, have arrows at the top and bottom of the text box so you can go back to what people were saying before.”.

### *Conclusions*

Most of the participants commented positively about the training graphics, found the training easy to follow and they were excited to continue training. The children also provided suggestions on how to improve the training which was addressed before the study presented below. The researchers that were observing the students both when playing the game with and without the *training mission*, mentioned that more students finalised playing the game and students asked fewer questions when they played the tutorial [18]. These results were confirmed by a following study performed in 2012 during which a group of students were asked to play the game without the *training mission* and the second playing the *training mission* beforehand. After this study the researcher observing the students confirmed the above results.

## VI. TRAINING MISSION EFFECT ON GAME USABILITY

A second evaluation took place at a later stage to assess the effects of the training mission on the children’s perceived usability of the game (i.e. whether by playing the *training mission* before playing the game the children perceived the game as being more usable than when they did not).

### A. Set-Up

15 children from a school in the UK took part in the evaluation. Eight children played one of the game missions. Global Handwashing Day Game, after playing the *training*

*mission* first and seven children played one of the missions without having played the *training mission* first. Children in both groups were between 12 and 13 years old, evenly distributed in terms of sex and gender. The children in the first group were first asked to play the *training mission*, then the mission: Global Handwashing Day Game, and afterwards they were asked to fill in a questionnaire concerning the game usability. The second group has played the game and filled in the questionnaire. Both groups had one hour to finish the game and the questionnaire (the first group played the *training mission* at an earlier point during the day and a separate session was done in which they have to play the game and answer the questionnaire). The questionnaire consists of demographic data, usability questions. The usability was assessed using the SUS [30] questionnaire.

### B. Usability

The usability evaluation was performed using the System Usability Scale (SUS) questionnaire [30]. SUS is a questionnaire that has been extensively used in testing usability, including in testing game usability [31], [32]. It is short, consisting of only 10 questions. It indicates the usability of a system in general, and a game, in this particular case, on a scale from 0 to 100, where 100 is the best score that can be obtained. For each question the subject has to choose an option on a 5 point Likert scale to indicate the degree of agreement or disagreement with the statement in the question. In this case where 1 stands for Strongly Disagreeing with the affirmation and 5 stands to Strongly Agree.

To compute the SUS score, the following steps are required. For the odd questions one has to subtract 1 from the option the subject chooses on the Likert scale, while for the even questions the chosen scale position is subtracted from 5. In this way, each of the questions contributed with a value from 0 to 4 to the final score. The sum of the results computed in this way is multiplied by 2.5 and divided by the number of subjects. The number obtained in this way is the SUS score.

The SUS questionnaire has been designed for analysing systems in general. The questionnaire was adapted to our situation by changing the word “system” to “game” and “use” with “play”. For example the first question: “I think I would like to use this system frequently” has been changed with “I think I would like to play this game frequently”. The questions as they were asked are presented in Table 1.

The average SUS score for the group who played the tutorial was 61.25 and standard deviation 8.95. The average SUS score for the group who did not play the tutorial was 60 and standard deviation 19.94. Although the group who initially played the tutorial mission had an average a better usability score than the one who did not the difference was not statistically significant ( $p=0.83$ ) considering a confidence interval of 90%. The statistical significance was measured using the Welch t test [33]. Welch t test can be used when the assumption of equal variances cannot necessarily be made. The Welch’s t-test works also well with samples of unequal sizes, as those involved in this research are.

TABLE I. SUS QUESTIONNAIRE AND P-VALUES

#	Question	p
1	I think I would like to play this game frequently.	0.78
2	I found the game unnecessarily complex.	0.37
3	I thought the game was easy to play.	0.22
4	I think I would need the support of a teacher or other expert to be able to play this game.	0.94
5	I found various functions in this game were well integrated.	0.26
6	I thought there was too much inconsistency in this game.	0.75
7	I would imagine that most people would learn to play this game very quickly.	0.90
8	I found the game very awkward to use.	0.08
9	I felt very confident playing the game.	0.27
10	I needed a lot of help before I could get to play this game.	0.22

Although the SUS score was not necessarily designed to look to particular questions in our case as we are not only looking at usability in general but also at the effects the *training mission* has on the game. We decided to look closely at each of the questions presented. Although there are differences between the group that played the *training mission* beforehand and the group who did not as they perceived the game as easier to play and not needing help (see Fig. 6) these differences are not statistically significant (see Table 1 the third column for the p-values between the two groups). The only statistically significant difference is for question eight – *I found the game awkward to use* ( $p=0.08$ ) for a confidence interval of 90%. In this case the group who did not play the *training mission* before playing a mission in the game, found the game more awkward to use than the ones who were exposed to the *training mission* beforehand.

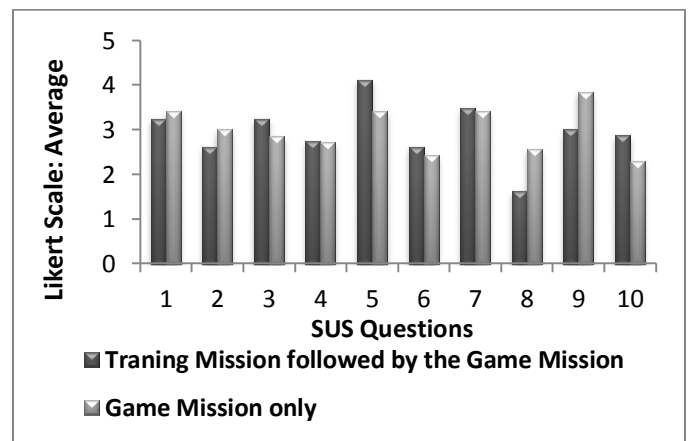


Fig. 6. Questions Results Detailed.

## VII. FUTURE WORK

We are currently analysing the results of the preliminary evaluation on whether playing the *training mission* before playing the actual game missions has any effect on student learning (i.e. whether the students will focus on the educational content and learn more, without being distracted in getting familiar with the game mechanics). We are planning to extend

the study to a larger sample and based on the results we will decide on whether the *training mission* is the best approach or we should consider other means to familiarise students with the game.

We will also give attention to the in-game improvement of tutoring, hints or help allowing the player to continue and advising on next strategies. We are investigating the idea of automatic assessment of the user likelihood of being stuck or confused at any given point of the game and providing customized help.

As typical for the iterative development, the games are always updated and improved based on the children's feedback. The results of the game evaluation showed that the children learn when using the game and that the results are statistically significant [10]. We are currently assessing the results of seamlessly evaluating the students' knowledge on the game play on the students learning outcome, engagement and enjoying. We are also planning to perform a study at a later stage to determine the effects of the game on long term retention, and the next steps are to determine attitude and behaviour change as a result of the game play.

#### VIII. DISCUSSIONS AND CONCLUSIONS

When games are introduced in the classroom, not all children know how to play them [15], [18] and some find them to be too complicated to play them first round. This is because the children either did not play or are interested in the games or they did not play a similar game beforehand. This leads to frustration and giving up on playing the game, as children did not do as well as their peers. One solution could be to help these children learn the game mechanics before the game play [15][18]. In the context of the edugames4all project this involved having a *training mission* as a way of teaching the children who did not play a similar game before the mechanics while being able to have the others who have played before continue with the game. The previous evaluations of the *training missions* showed that it was well designed and it helped children play the game [18]. In this paper, we took the evaluation one step further to gain more in-depth results around the usability of the training mission used as an intervention and we presented the results of the evaluation of the *training mission* in experimental settings in which two groups of children played one of the game missions. One group played the *training mission* before playing a game mission while the others played just the game mission. We assessed whether the usability of the group who played the *training mission* beforehand is different from the ones who did not play the *training mission* beforehand. The results showed no statistically significant difference between the two groups, in terms of the SUS score, although the group who played the *training mission* obtained a higher SUS score than the group that did not play. The students who did not play the *training mission* beforehand found the game more "awkward" to use than the ones who played the *training mission* and the difference was found to be statistically significant. One of the reasons could be that the students who were exposed to the *training mission* were probably already used with the mechanics of the game, and hence found it comfortable to play. However no significant statistical difference was obtained in

terms of the other constructs (i.e. easiness to play). Future work is necessary to determine if with a larger sample size these results are confirmed and whether the benefits of having a *training mission* outweigh the cost of development.

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