

eBug – teaching children hygiene principles using educational games

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Abstract

Technology enhanced education has been recently established as a new approach for all stages of education. However, among these new IT media it is computer games playing the central role in delivering education in particular to children and teenagers, however, real world sound evaluation is often given little attention. The EU funded e-Bug project developed web games aimed at children to teach basic principles of prudent antibiotics use, hand and respiratory hygiene and aims to reinforce an awareness of microbes, hand and respiratory hygiene among junior and senior school children in 10 countries in Europe. An educational pack implemented in schools across Europe is complemented by Internet web games for two age groups teaching a set of learning objectives (LOs) using a fast and interactive platform game design for junior children and investigate detective games based on PBL principles for senior children. In this paper, we present the design of e-Bug junior and senior games and evaluation results.

Keywords:

Infectious disease, Educational games, Platform game, Detective game, Antibiotic resistance, Microbes, Hand and respiratory hygiene

Introduction

E-learning has been widely established as the use of Internet technologies to enhance knowledge and educational performance [1]. The value of e-learning tools and packages in supporting medical education is now well-documented [1,2], however little attention has been given to the use of web games that are particularly suitable teaching media for the e-native generation of children.

There are a few health education programmes targeting children (e.g. Do Bugs Need Drugs [3], Bugs Investigators [4]), however, this target group is often omitted in public campaigns. Raising the awareness of antibiotic resistance and improving hand and respiratory hygiene among children has proven to have strong impact on children health and school absences [5, 6].

In this paper, we describe e-Bug games developed in a DG SANCO-funded Europe wide project aiming to fill this gap by developing web games to teach children basic principles of microbes, hygiene and antibiotic resistance and translate into 10 EU languages and implement across Europe.

e-Bug Project

The reason EC branch DG SANCO funded this large EU educational project was that antimicrobial resistance remains one of the key problems within community and hospital settings within Europe. Increasing antibiotic resistance is related to increasing antibiotic use and lack of awareness of this phenomenon among parents and children is contributing to the problem [5].

Many EU countries have public educational campaigns to encourage prudent antibiotic use, however, children are not the typical target group. Research has shown that respiratory and gastrointestinal infections have been identified as a major cause of childhood illness in schools and that the implementation of proper hand hygiene practices has reduced absenteeism within the school environment.

e-Bug (www.e-bug.eu) is a DG SANCO funded antibiotic and hygiene teaching resource aiming to reinforce an awareness of basic knowledge of microbes, hand and respiratory hygiene and the benefits of prudent antibiotics use among junior and senior school children across Europe. There are 17 countries involved in e-Bug covering 62% of European population.

There are two complementary products for both age groups – an educational pack taught at school science lessons and online games, currently launched in 10 EU countries. Education packs, covering the appropriate part of the learning curriculum, are complemented by web-based interactive games teaching the same e-Bug learning outcomes (LOs). Therefore, e-Bug combines traditional methods of classroom delivery with online, web-based games to teach a set of agreed Learning Outcomes. Education games teaching through the mechanics of the game have been successfully evaluated as effective educational intervention [7].

e-Bug Project Aims

The set of LOs were derived, implemented through the games, from the e-Bug project aims:

- To compliment national antibiotic and hygiene educational campaigns
- Develop an antibiotic and hygiene teaching pack & website with online games for both junior and senior schools
- Translate and implement the pack across associated countries in close collaboration with local Ministries of Health and Education
- Evaluation of use and impact of pack and website
- Disseminate and market the e-Bug resource to collaborating partner countries

The project is aimed at two age groups, for each a different style of games was developed to better suite the playing needs and cognitive abilities of children. Therefore, the first game style, aimed at junior children, is a fast engaging platform game while the senior children game design is rather a cognitive detective game. In each of the game the learning outcomes were taught through games mechanics and seamlessly tested.

The e-Bug Junior Game

The junior platform games (designed for the age group of 9-12 year olds) consists of a number of “levels” each teaching a set of learning outcomes. Player, shrunken inside human body, interacts with useful and harmful cartoon microbes and antibiotics and viruses. Teaching the LOs is implemented through the way the player interacts with microbes. Children knowledge is tested seamlessly before and after each level in a Game Show style similar to the popular TV game “Do you want to be a Millionaire?”

The game was designed to incorporate elements of platform games (similar to the Mario series), fast-reaction games (similar to Whackamole) and quiz games. These types were identified through focus groups and market research as being popular with this age group.

In the platform game elements, the player is shrunken to the size of a bacterium and uses a hoverboard to navigate environments that microbes inhabit. Learning outcomes are implemented through the way the player interacts with microbes. For example, the player throws soap at bad microbes to wash them off skin.

The quiz elements are used to assess player knowledge gain in a seamless fashion. For evaluation purposes, we use a pre and post questionnaires which will be changed to post-questionnaires for the real version. Immediately prior to each section of the game, the player is asked a series of questions in the quiz that assess their knowledge of the content of the coming section. The same questions are asked immediately following the section. By comparing the player's response before and after each section, we are able to determine the effectiveness of the game mechanics used to teach each learning outcome.

The game is split into 5 sections, each of which is designed to teach one set of learning outcomes. Figure 1 illustrates the process of the junior game.

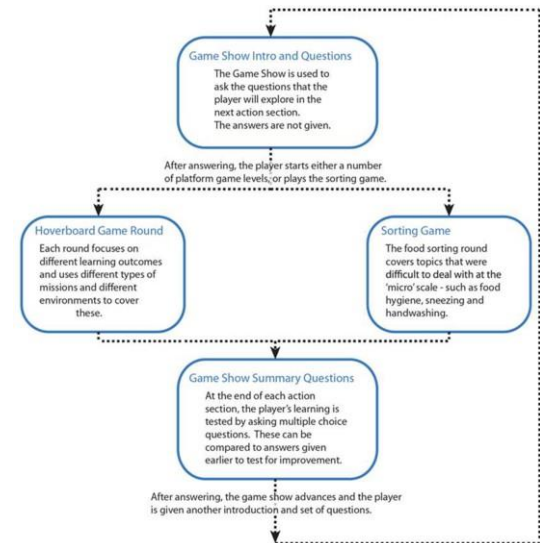


Figure 1 - Junior games process

Implementation of Levels

The first section of the game covers basic information about microbes. To teach the difference between the three main types of microbes (bacteria, viruses and fungi), the player is tasked with using a camera phone to take photographs of one type at a time. In the game, the three types of microbe are visually designed to show the differences in size and shape, as illustrated in Figure 2.

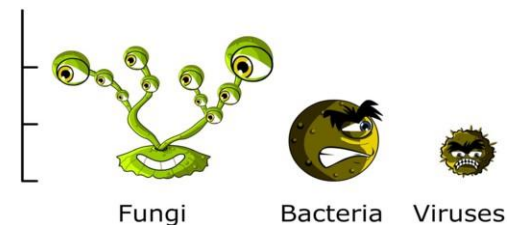


Figure 2 - LO: Bugs are different sizes

The second section of the game introduces the idea that some microbes can be harmful. The player is damaged through contact with bad microbes. Additionally, the player uses soap to wash harmful microbes off skin and uses white blood cells to destroy microbes that have infected a body (see Figure 3).



Figure 3 - Bugs are shown in different locations – on the skin and in the kitchen

The third section of the game seeks to demonstrate the usefulness of some microbes. The player has to push lactobacillus microbes into glasses of milk in order to turn the milk into yoghurt; as illustrated in Figure 4.



Figure 4 - Player transports lactobacillus to make yogurt

The fourth section of the game covers appropriate food storage guidelines. The player aims to put shopping away in a fridge and cupboards, making sure to wash hands after handling meat and to put each item in an appropriate place to prevent contamination and use a tissue when sneezing to test appropriate respiratory hygiene skills. This is illustrated in Figure 5.



Figure 5 - The food sorting game is used to show hand and respiratory hygiene.

The final section tackles appropriate antibiotic use. Seeking to show that antibiotics kill good and bad bacteria but no viruses, we implemented a ‘smart bomb’ effect for antibiotics. To show the importance of finishing a full course of antibiotics, the player is shown an infection grow back after initially appearing dead following a partial antibiotic course. By using the remainder of the course, the infection is fully eliminated. This level is illustrated in Figure 6.



Figure 6 - Player delivers full course of antibiotics to infection

The player pre and post knowledge responses gathered during the quiz show elements are used to assess the effectiveness of each of the above game mechanics.

Evaluation and Results

In addition to the pre and post knowledge gain evaluation, from February until March 2009, a beta-version of the game [8] was evaluated for playability and user-friendliness using a questionnaire to assess user satisfaction and focus groups with a number of primary schools in the UK.

29 pupils took part in the focus groups (and fully completed the pre and post questionnaire) from three schools. Whilst this is a small number of participants, the results were promising. Before playing the game, only 4 pupils “agreed” that fungi were microbes. After playing, 18 agreed. Smaller improvements were seen in other questions including: “We use microbes to make things like bread and yogurt” (11 correct before, 23 correct after playing), “Soap can be used to wash away bad bugs” (20 before vs 24 after) and “Bacteria and Vi-

bugs” (20 before vs 24 after) and “Bacteria and Viruses are the same” (19 correct before vs 23 after playing).

The main evaluation of the games took place in the period of May – August 2009. Each of the completed level (many users dropped out during the game) was evaluated for statistical significance of knowledge change of the LOs. As many questions were correct before and after the game, the statistically significant improved responses were measured (using McNemar’s test), for the following questions: “if you cannot see a microbe it is not there”, “most coughs and colds get better without medicine” and in particular “we use good microbes to make things like bread and yogurt”. There was a trend towards improved knowledge however in other questions did not reach statistic significance. The full report of this study can be found in [9]. Therefore those particular game mechanics seem to teach the LOs very well. Further study would need to be conducted to evaluate an impact on behaviour change.

The e-Bug Senior Game

Senior games, aimed at age group 12-14 year olds, use a detective style investigating a series of infectious related cases or outbreaks in Europe where the player has to discover the source of infection or contamination to successfully solve a puzzle. The game design is similar to that of Phoenix Wright [10], a popular detective game available on the Nintendo DS. In order to avoid what Habgood calls “Chocolate Covered Broccoli” [11] where the game offers no educational benefit beyond extrinsic motivation, it is necessary to integrate learning through game mechanics. Problem Based Learning (PBL), “any learning environment in which the problem drives the Learning”, is a natural approach to games based learning [12]. That is, before students learn some knowledge they are given a problem.” [13]. The stages of PBL vary between implementations. For e-Bug, the Queens University definition of 5 stages of learning was used [14]. The full description of the 5 stages implementation on eBug could be found in [15]. The player explores a crime scene narrative, interviewing characters and finding evidence that illuminates their understanding of microbes, hygiene and antibiotics and learning the given set of LOs. The player is presented with a scene, talks to characters, collects evidence, investigates evidence in a laboratory and presents an answer to “puzzle” – the cause of infection or reason for an illness to the boss of e-Bug (“Big C” character).



Figure 7 - Big C character

There are three puzzles to solve, each testing several LOs. First puzzle is based around hand hygiene LOs, 2nd and 3rd teach appropriate use of antibiotics and the issue of antibiotic

resistance. For better illustration of the PBL concept we present an example from the first puzzle. A famous actor gets sick by infection transmitted as a result of poor hygiene at a bathroom but poisoning food and insufficient hygiene in the kitchen must be eliminated by collecting and testing evidence samples. Figure 8 illustrates so called “micro-vision” feature allowing users to see microbes on the scene, collect samples and test them.



Figure 8 - Microvision of the barbecue scene – microbes visible in the salad bowl

The evidence is being collected into a PDA-like device, tested and hypothesis about the cause of the infection either proved or disproved. These are testing the learning objectives in a seamless way throughout the game while at the end of the game user reports to the Big C summarizing the findings.

Evaluation and Results

The game is complete and an evaluation has taken place with 346 pupils. Evidence for knowledge and attitude change has been collected through an online pre and post game questionnaire. Qualitative feedback has also been collected through focus groups and an open ended questionnaire. The results demonstrated a statistically significant knowledge improvement in puzzle 2 and 3 (puzzle 1 was found too complicated by children). Over 55% children would play the game again. The full results set will be presented at the conference.

Implementation and International Dimension

E-Bug is implemented in Flash 6 and supports all common browsers (IE6, IE7 and Firefox). The multi-lingual e-Bug web site is hosted at IBM Lotus Domino 6 web server and provides full access to the complementary pack sections for both junior and senior schools. E-Bug involves 17 European countries; 10 of those are currently translating the pack and the games and will be implementing the resources in their school systems. These include, UK, Denmark, Czech Republic, France, Poland, Italy, Portugal, Spain, Belgium and Greece.

Monthly web server logs evaluation demonstrates that the user base is steadily growing¹. In particular, the importance of the resource was highlighted around the peak of the wine flu epi-

¹ http://www.e-bug.eu/ebug_secret.nsf/England-Project-General/eng_eng_p_wp_gn_stats

demics in April-May 2009 when the number of visitors quadrupled, as illustrated in Figure 9.

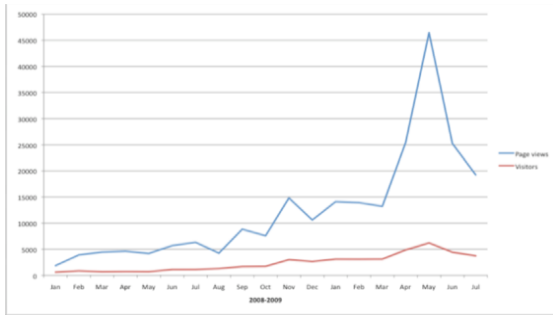


Figure 9 – Traffic on e-Bug web site

International interest in e-Bug is growing. The ease and cost-effectiveness of translation of the games to other languages and localisation to serve as education tools for children in other countries could help to bridge the financial divide and assist in effective and playful healthcare education in less-wealthy countries like Uganda where we received interest in a partnership with local NGOs. Technology transfer of e-Bug games engines can allow successful hosting of any similar kind of platform and puzzle games from any medical or other domains.

Conclusions

e-Bug project a unique example of hygiene and AMR intervention aimed at children implemented and evaluated across Europe. In this paper we described the development and evaluation of e-Bug web games complementing an educational pack aiming to teach junior and senior children basic principles of hand and respiratory hygiene and antibiotic resistance. e-Bug games were translated to 9 European languages, after being developed in the UK. Games evaluation investigating players' knowledge gain demonstrated effectiveness of teaching given LOs through the game mechanics for both age groups. International user base is steadily growing and the support to non-UK users, in particular from other EU countries, ECDC, WHO as well as from developing countries.

Acknowledgments

We acknowledge DG SANCO for providing funding for this EU project and all partners who contributed to the development of the pack and games (<http://www.e-bug.eu/ebug.nsf/Home?OpenPage>). We also acknowledge all schools taking part in evaluation and children playing first versions of the games. We also acknowledge an invaluable input from the e-Bug artists: Nancy Lai and Sandy Beveridge.

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