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Brian Mac Namee
Dublin Institute of Technology, bmacnamee@comp.dit.ie

Pauline Rooney
Dublin Institute of Technology, Pauline.Rooney@dit.ie

Patrick Lindstrom
Dublin Institute of Technology

Andrew Ritchie
Dublin Institute of Technology

Frances Boylan
Dublin Institute of Technology

See next page for additional authors

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Authors
Brian Mac Namee, Pauline Rooney, Patrick Lindstrom, Andrew Ritchie, Frances Boylan, and Greg Burke

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Serious Gordon: Using Serious Games To Teach Food Safety in the Kitchen

B. Mac Namee, P. Rooney, P. Lindstrom, A. Ritchie, F. Boylan & G. Burke

***Abstract*—This paper will describe the development of Serious Gordon, an interactive digital game developed to tech the basics of kitchen food safety to workers in industries dealing with food. The motivations driving the development of the game will be described as will the development process itself. An initial evaluation of the game, from both a technical and pedagogical point of view, will be presented as will conclusions on the viability of using a commercial game engine for the purpose of developing educational games.**

***Index Terms*—Serious games, education, food safety**

I. Introduction

RECENTLY there has been huge growth in interest in serious games, and in particular their use for education [17]. While it is certainly true that using games (and in this paper we refer exclusively to digital games) for education is nothing new, the relatively recent trend in which commercial game developers open up their technology for modification has brought things to a new level. Now developers of serious games can use the sophisticated technology of their mainstream counterparts to create environments which exhibit a level of realism that was previously only possible for those working with budgets that stretched into the millions.

In this paper we will describe the development of *Serious Gordon*, a prototype game developed to teach the rudiments of kitchen food safety to workers in industries dealing with food. The paper will begin with a short introduction to the areas of serious games and game-based learning. This will be followed by a brief synopsis of the key aspects of kitchen food safety that the game sets out to teach. Next, the development of the game will be described. A preliminary evaluation of the usefulness of the game has been carried out and this is described before, finally, some directions for future development both of this and other related projects are laid out.

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B. Mac Namee is with the School of Computing, Dublin Institute of Technology, Kevin St., Dublin 8, Ireland. (e-mail: Brian.MacNamee@ comp.dit.ie)

P. Rooney is with the Learning Technology Team, Dublin Institute of Technology, 14 Upper Mount St., Dublin 2, Ireland. (e-mail: Pauline.Rooney@ dit.ie)

P. Lindstrom is with the School of Computing, Dublin Institute of Technology, Kevin St., Dublin 8, Ireland.

A. Ritchie is with the School of Computing, Dublin Institute of Technology, Kevin St., Dublin 8, Ireland. (e-mail: Andrew.Ritchie@student.dit.ie).

F. Boylan is with the Learning Technology Team, Dublin Institute of Technology, 14 Upper Mount St., Dublin 2, Ireland. (e-mail: Frances.Boylan@ dit.ie)

G. Burke is with the School of Food Science and Environmental Heath, Dublin Institute of Technology, Sackville Place, Dublin 1, Ireland. (e-mail: Greg.Burke@dit.ie)

II. Serious Games & Digital Game-Based Learning

The term *serious games* [16] refers to games designed to do more than just entertain. Rather, serious games, while having many features in common with more traditional games, have ulterior motives such as teaching, training, and marketing. Although games have been used for ends apart from entertainment, in particular education, for a long time, the modern serious games movement is set apart from these by the level of sophistication of the games it creates. The current generation of serious games is comparable with main-stream games in terms of the quality of production and sophistication of their design.

The modern serious games movement can be said to have begun with the release of *America's Army* (www.americasarmy.com) in 2002 [18]. Inspired by the realism of commercial games such as the Rainbow 6 series (www.rainbow6.com), the United States military developed America's Army and released it free of charge in order to give potential recruits a flavour of army life. The game was hugely successful and is still being used today as both a recruitment tool and as an internal army training tool.

Spurred on by the success of America's Army the serious games movement began to grow, particularly within academia. A number of conferences sprung up and notably the Serious Games Summit became a part of the influential Game Developer's Conference (www.gdconf.com) in 2004.

Some other notable offerings in the serious games field include *Food Force* (www.food-force.com) [4], a game developed by the United Nations World Food Programme in order to promote awareness of the issues surrounding emergency food aid; *Hazmat Hotzone* [3], a game developed by the Entertainment Technology Center at Carnegie Mellon University to train fire-fighters to deal with chemical and hazardous materials emergencies and *Yourself!Fitness* (www.yourselffitness.com) [16] an interactive virtual personal trainer developed for modern games consoles.

However, education still holds the greatest potential for serious games, with proponents of their use arguing that they

hold enormous potential as learning tools [21, 23]. One argument for the use of games in education is that the multi-sensory environment offered by virtual gaming worlds caters for multiple learning styles (e.g. visual, auditory and kinaesthetic) [10].

Another argument is that in training settings where learners need to acquire a skill or competence, games provide extensive opportunities for drill and practice (where learners master skills or information through repetitive practice) thereby reinforcing information retention [17]. In particular, the micro-worlds of games allow educators to create learning activities that may be too dangerous or costly to replicate in the classroom [11]. For example, in a gaming environment, students can "blow" circuits, mix lethal chemicals or make mistakes in a surgical procedure without killing a real-life patient. Thus, gaming affords new opportunities for learning which are not available in traditional media.

In addition to facilitating the acquisition and retention of information, it is argued that games also hold considerable potential for developing higher order skills such as critical thinking, strategic thinking, problem solving, team work etc [23]. Simulation and adventure games, where students are immersed in a virtual world and assume a specific role within this world, allow this by creating a constructivist learning environment (where students construct their own knowledge and create their own meanings in a social process) [21]. For example, at the Carnegie Mellon University in Pittsburgh, a video game called *Peacemaker* (www.peacemakergame.com) allows players to assume the role of the Israeli prime minister or the Palestinian president. Within their role, the player makes various political decisions, their ultimate aim being to achieve a ceasefire [22]. In another UK study, researchers found that games such as SimCity (www.simcity.com) and RollerCoaster Tycoon (www.rollercoastertycoon.com), where players create societies or build theme parks, developed players' strategic thinking and planning skills [2].

Thus, such complex games hold considerable potential as a learning tool. On one level games can be seen as embodying behaviourist learning principles – where learners acquire and practice a range of skills and competencies while receiving regular feedback in an engaging, highly interactive and safe environment. On another level, more complex games allow learners to develop higher order skills in a constructivist learning environment by embodying various pedagogical strategies including experiential learning [12], problem-based learning [20] and situated learning [13]. In addition, many games are highly social, the clearest example being massively multiplayer online games (MMOGs). In such games, thousands of players are playing online simultaneously at any given time, interacting in virtual worlds with their own economies, cultures and political systems. Such games allow players to experiment with new identities, develop social skills and experience effective (and often ineffective) social practices in a range of political, social and cultural environments. In essence they allow players to experience and become part of a community of practice, which according to Lave and Wenger [13] is crucial for effective learning.

However, the results of using games as teaching tool are not all positive. Much of the so called *edutainment* software produced results in nothing more than boring games incorporating what is termed *drill-and-kill* learning. Arguments have been put forward that this is due to the fact that these educational games are designed by academics who do not have a true understanding of the science and art of game design. So, while the products might be educationally sound as learning tools, they do not fulfill 'gaming' criteria [19, 23]. It also stands to reason then that games for the education market that are designed solely by gamers are also destined to fail in achieving their overall objective. The answer, as summed up in [23], "*…is not to privilege one arena over the other but to find the synergy between pedagogy and engagement in digital game based learning*".

Research has shown that for a serious game to be successful, the overall structure of the game, and the instructions provided to play it, should be kept simple so as to minimise the time spent learning the rules of the game [17]. Such an approach also ensures a clear route through the game with constant access to information that aids navigation. The nature of the challenge, the levels of the challenges and the methods of scoring need to be varied, but effective games must provide feedback so as to encourage a focus on the process in hand as well as the performance achieved. A constant cycle of hypothesis formulation, testing and revision needs to be built in [23], as it gives the user a chance to correct and learn from errors made. And, most importantly, the structure of the game must suit the learning objectives and outcomes set out during the planning stage.

These were the considerations that drove the development of Serious Gordon. The following section will briefly touch upon the aspects of kitchen food safety which the game sets out to teach.

III. Food Safety in the Kitchen

EC Regulation 852/2004 [5] (transposed into Irish law under the Food Hygiene Regulations 1998 [8] and SI 369 2006 [9]) reinforces the requirement "*that food handlers are supervised and instructed and or trained in food hygiene matters commensurate with their work activity*". Therefore, food safety is an essential component of the training undertaken by anyone embarking on a career in the food industry.

The Food Safety Authority of Ireland has devised training guides [6, **7]** which cover the principles of food safety at three levels:

- Guide to Food Safety Training: Induction Skills (food service, retailers and manufacturing sectors) [6]
- Guide to Food Safety Training: Additional Skills (food service, retailers and manufacturing sectors) [6]
- Food Safety Skills for Management (food service, retailers and manufacturing sectors) [7]

The first of these guides - Guide to Food Safety Training:

Induction Skills [6] – was used as the content basis for Serious Gordon. The guide lists a set nine competencies which workers must demonstrate in order to safely handle food. These are as follows:

1. Wear and maintain uniform/protective clothing hygienically.
2. Maintain a high standard of hand-washing.
3. Maintain a high standard of personal hygiene.
4. Demonstrate correct hygiene practice if suffering from ailments/illnesses that may affect the safety of food.
5. Avoid unhygienic practices in a food operation.
6. Demonstrate safe food handling practices.
7. Maintain staff facilities in a hygienic condition.
8. Obey food safety signs
9. Keep work areas clean.

Serious Gordon sets out to teach the importance of these skills. The following section will describe the development of the game, the starting point of which was this list of competencies.

IV. Development of Serious Gordon

This section will describe the development of Serious Gordon, which was undertaken by a multi-disciplinary team at the Dublin Institute of Technology (DIT) in Dublin, Ireland over the Summer of 2006. The discussion will begin by outlining the learning objectives which were the genesis of the project, followed by the development of the script and game scenario and finishing with a short description of the development of the game itself.

A. Learning Objectives for Serious Gordon

The overall aim of the Serious Gordon project was to teach the basics of kitchen food safety required of both food and non-food handlers in the food service, retail and manufacturing sectors, as set out in [6]. This document centres around the nine *induction skills* given in the previous section. In order to demonstrate that they understand how to handle food properly an employee must be able to display each of these skills.

The guide provides further details of each skill by outlining how the employer should demonstrate each one to their employees, as well as listing the resources or supports that employees may need to help them demonstrate good food practices. These nine skills steered the design of Serious Gordon, inspiring all of the tasks the player must undertake during the game. Essentially, demonstration of these nine skills are the learning objectives expected of a player after playing the game to completion.

B. Script and Level Design

So that this game achieved each of its learning outcomes in a concise and effective manner, it was vital that a structure for the game, in the form of a very detailed storyboard, was set out quite early in the project and agreed between both the game designers and developers. Furthermore, it was extremely important that the factors in the design of serious games, as outlined in section 2, were kept in mind at all times. Briefly, these are that the controls and rules of the game are kept simple, that a clear route through the game is presented to the player at all times and that useful feedback is presented to the player after all challenges have been completed (either passed or failed).

During an initial meeting between all of the parties involved in the design of the game (including persons with expertise in the areas of education, game design and food safety) the different possible scenarios for the game were considered. After much discussion a broad outline of the game was agreed upon. It was decided that the game would be a realistic simulation of a restaurant environment in which the player, playing from a first-person perspective, would take the role of a kitchen porter arriving for their first day at work. Over the course of the game the player would be given a number of different tasks to complete, each of which would relate back to the aforementioned list of nine induction skills. Some of the tasks discussed in the initial design stages included choosing the correct uniform for a particular job from a selection of different options, correctly moving deliveries from a truck outside the restaurant to the kitchen's various store rooms and dealing with workplace disasters such as injury and sickness.

As a means to provide a clear route through the game and provide useful feedback to the player at all times, a chef character was introduced whose part would be to welcome the player to work, give guidance on what tasks the player had to carry out and offer feedback on the player's success or failure in these tasks. Throughout the game the chef character would also drop nuggets of information relating to the nine induction skills into their conversations with the player.

To begin with, a specification was written for each of the characters in the game outlining their name, their personality and their general appearance, given their role in the kitchen environment. The characters included the player, the chef and two commis-chefs who also worked in the restaurant. The game's storyboard was then built around these characters outlining, in great depth, the learning outcomes to be achieved in each individual scene of the game, the tasks that the player needed to undertake in each scene so as to achieve the specific learning outcomes in question, a detailed description of the exact environment in which each scene would take place and finally the characters involved in each scene and the appropriate interactions and dialogue that needed to occur between them. During the group's weekly meetings, the storyboard was constantly referred to and often updated as the first draft of each scene of the game was reviewed and edited so as to ensure that the learning outcomes were achieved as effectively as possible.

As each scene was finalised, so was the associated dialogue. The dialogue for serious games is always functional with its sole purpose being to pass on vital information in a concise and natural manner, and is used primarily as either a bridge from one part of the game to the next or to explain to

the player what the next part of the game involves.

Serious Gordon is set predominantly in the kitchen of a small restaurant. In order to make the game environment as true to life as possible the design of this fictional kitchen was based on a set of real kitchen plans, which are shown in figure 1.

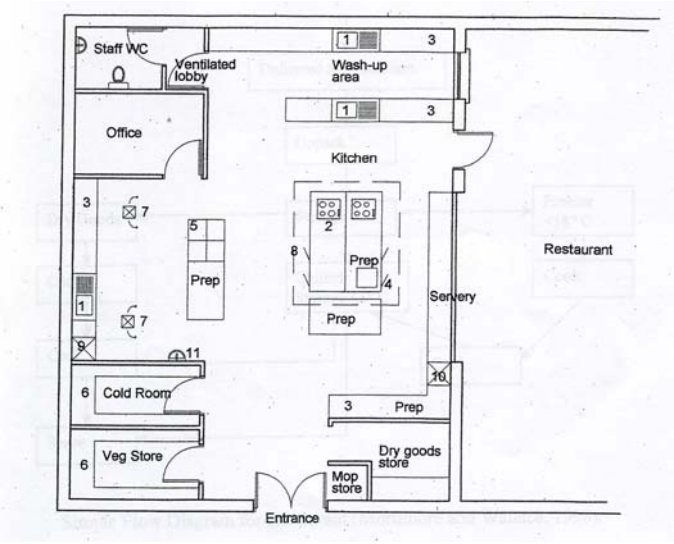

Figure 1: The floor-plan on which the kitchen in Serious Gordon was based

However, with the notion of *virtual fidelity* in mind [1], the design of the game environment did not rigidly stick to the real world version of the kitchen. Virtual fidelity suggests that simulations need only remain true to the real world in so much as this enhances the experience of the users of a the simulation. A good example of this is that virtual environments need to be designed with a much larger amount of empty space than real world locations so as to avoid users feeling claustrophobic [15].

Similarly, in designing the game environment great lengths were gone to in order to make the game environment appear to stretch beyond the boundaries of the restaurant, and yet at the same time coral the player within this smaller space without their noticing. It has been shown that this approach to game design aids immersion in that the player believes themselves to be part of a larger world [15].

C. *Implementing Serious Gordon*

The full-time development team on Serious Gordon consisted of two developers who worked on the game over a period of approximately 10 weeks in the summer of 2006. This small team was augmented by experts in the areas of food safety, education and games. Shortly after agreeing upon the initial storyboard for the game it was decided that the best approach would be to set it in a realistic 3D environment played from a first-person perspective. It was felt by the team the sense of immersion for players achieved by this sort of game would best aid the learning process [21].

Due to the scale of the project, and the time limits involved, it was established early on that the development of a complete game engine would not be feasible. Rather, the best option was to use an existing game engine to create the game. After investigating a number of options Valve Software's Source Engine (www.valvesoftware.com), developed to create Valve's Half Life 2 (www.halflife2.com) was selected for the project. The Source engine has a number of compelling features which include highly realistic physics modeling, the capacity for sophisticated scripting and the existence of an active and helpful community of professional and amateur developers. The challenge in using the Source Engine was that it was designed for developing a game so different to Serious Gordon and it was unclear whether it could be successfully turned to this new purpose. A screenshot of Half-Life 2 is shown in figure 2 to illustrate this point!

Figure 2: A screenshot of Half-Life 2 for which the Source Engine was developed

With the engine agreed upon the team's developers set about creating a series of proof-of-concept scenarios in order to experiment with the requirements of each learning task set out in the storyboard. This was an extremely useful stage in the development as it highlighted aspects of the Source Engine which would need work in order to turn it to the task of developing an educational game. As each proof-of-concept scenario was developed the entire team was brought together to determine how well this scenario matched the learning outcomes it set out to achieve. In this way the cycle of repeated hypothesis formulation, testing and revision outlined in [23] was adhered to.

After the proof of concept development phase was complete, focus switched to developing the complete game. Serious Gordon is essentially script driven, with the chef character leading the player through a series of learning tasks and responding to the player's efforts to complete these tasks. Again, throughout the development of the full game the *hypothesize-test-revise* cycle was used in order to ensure that while achieving the learning outcomes set out, the game remained playable and, as much as was possible, enjoyable.

The choice of Valve's Source Engine put a range of invaluable tools in the hands of Serious Gordon's development team. The most important of these was the Hammer Editor which is the tool used to develop the game's environment and to add all of the scripting to this environment. Hammer allows developer's relatively easily

create sophisticated virtual worlds, fill these with authentic objects and populate them with characters that react to the actions of a player. A screenshot of the interface to the Hammer editor is shown in figure 3.

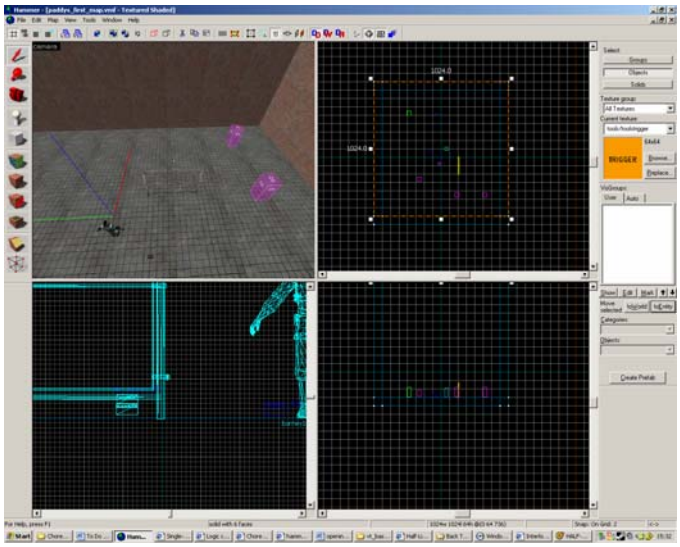

Figure 3: A screenshot of the Hammer editor used to create the world of Serious Gordon and script the behaviours of its characters

While the Hammer editor proved an extremely useful tool, it was not without its problems. The first of these was that the assets pre-packaged with the editor are those used in Half-Life 2 and so were much too grimy and industrial for use in the modern restaurant environment required in Serious Gordon. This meant a range of custom textures and objects had to be developed which put a considerable burden on the small development team. Secondly, the level of scripting required by Serious Gordon, and the free-flow nature of some of its scenarios pushed the scripting capabilities of the Hammer editor to their limits which caused some further development difficulties.

The second tool used heavily in the development of Serious Gordon was Valve's FacePoser, a tool used to choreograph game sequences that controls facial expressions, lip synching and body gestures. A screenshot of Faceposer being used is shown in figure 4. Although Faceposer proved a somewhat unreliable tool to work with, the results possible with it lend a great deal of realism to a game's characters.

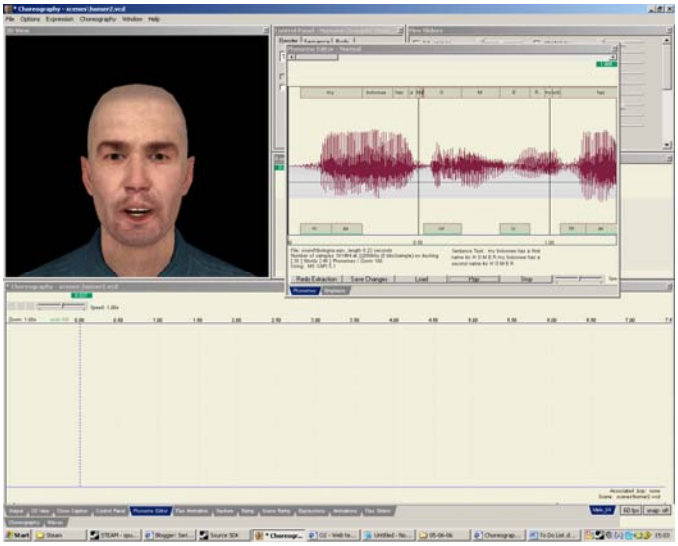

Figure 4: A screenshot of the Faceposer tool

As well as using the Source Engine development tools in developing Serious Gordon, a number of major additions were also made to the functionality of the engine itself, which involved making changes to the engine's code-base. The first of these was the addition of an inventory system. The Source Engine does not have the capacity for players to pick up objects and give them to other characters in the manner that was required by the Serious Gordon story board, so this had to be built into the engine. The functionality developed was used in scenarios where the player had to retrieve specific objects for the chef and also by a clothing system introduced through which the player could choose to wear clothes appropriate to their current tasks.

The second major addition to the Source Engine was a change to the interface system in order to allow players perform puzzle based interactions. A good example of this is a game sequence in which the player have to wash their hands correctly before entering the kitchen. In this scenario, after choosing to interact with a sink object, players are shown a dialogue box indicating that the available actions (shown on buttons) are to wet their hands, use the soap and dry their hands. Only by indicating the correct sequence of tasks (wet hands – use soap – wet hands – dry hands) can the player successfully complete the task. A screenshot of this simple scenario is shown in figure 5.

This addition to the Source Engine was developed in such a way that the available set of options and the consequences of certain sequences of choices by a player could all be defined in a simple data file making the technique easily extensible. The addition of simple puzzles made some learning scenarios extremely easy to implement in a way that players, particularly those unfamiliar with games, could easily understand.

Figure 5: The customisable puzzle capacity added to the Source Engine

In spite of the difficulties in turning the Source Engine to a purpose leagues apart from that for which it was designed, the development of Serious Gordon is considered by the team to be an overall success. A series of screenshots of the game are shown in figures 6 (a) – (c). All of the learning scenarios set out in the original storyboard have been implemented, for the most part as originally intended. Taken together they constitute an engaging learning experience which holds the learner's attention long enough to teach the basics of food safety in the kitchen in a novel fashion. The following section will discuss some basic evaluation experiments undertaken in order to quantify how successful the game is as a learning tool.

(a)

(b)

(c)

Figure 6: (a) Serious Gordon's chef. (b) The wash room environment. (c) The kitchen environment

V. Evaluation

Initial evaluations of Serious Gordon have been carried out which aimed to evaluate the game from a technical and pedagogical perspective. To this end, a small focus group of ten participants was selected, each with varying levels of experience using serious games. Before playing the game, participants were asked to complete a questionnaire which aimed to determine (a) their previous experience of using games/serious games and (b) their prior knowledge of food safety and the nine induction skills listed in [6].

After an initial brief orientation session, participants were then asked to play the game from start to finish. On completion of the game, participants were asked to complete a final questionnaire/test which aimed to evaluate (a) the participant's experience of using the game – e.g. did they find it difficult to navigate or confusing? – and (b) how many of the learning outcomes had been achieved by the participant as a result of playing the game.

These initial evaluations of the game proved highly positive. Technically, users found the game easy to navigate and control – orientation information provided alongside the game proved very helpful in this regard.

Pedagogically, the game proved successful in its aim of teaching learners induction skills required as part of food safety training [6]. Participants' responses showed that they had acquired much of the knowledge and skills as listed in the learning outcomes for the game. In addition, participants found the game a much more stimulating and motivating environment in which to learn skills which were normally taught through the use of text books. This correlates with the experiences of other educators using serious games as part of the education process [14].

Plans for further, more comprehensive, evaluations are still in progress. It is intended that the game will be used initially by first year students in culinary arts programmes at DIT, with the game being offered in the future to other students, including part-time students working as full-time employees in the food and hospitality industry. It is hoped that through

these evaluations, significant feedback will be obtained which will allow the development team to further develop and refine the learning environment of Serious Gordon.

VI. Conclusions & Future work

This paper has described the development of Serious Gordon, an educational game created to teach kitchen food safety to workers in industries dealing with food. The game was built upon Valve Software's Source Engine and showed that, in spite of some difficulties, the engine could be successfully turned to the purpose of creating serious games.

The game was developed in a manner to conform with the best practices outlined in the literature dealing with serious games, and in particular educational games. The major challenge in this regard was to achieve a successful balance between the competing goals to teach and to entertain. An initial evaluation has shown that this goal has been largely achieved.

There are two major strands planned through which to build on the work described here. The first of these is to perform a much more extensive series of evaluation experiments, and in this way fine tune the Serious Gordon experience. The second is to develop further projects which tackle the other levels of food safety as set out by the Food Safety Authority of Ireland [6].

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Dr. Brian Mac Namee is a lecturer in computer science at the School of Computing in the Dublin Institute of Technology in Dublin, Ireland. Brian received a PhD from Trinity College, Dublin in 2004 and worked in industry as a research and development engineer before joining DIT. Brian has a significant research interest in digital games.

Pauline Rooney currently works as an eLearning Development Officer with the Learning Technology Team at the Dublin Institute of Technology. She is currently in the latter stages of a Doctorate of Education (EdD) specialising in serious games and learning.

Patrick Lindstrom graduated with a first class honours in computer science from the Dublin Institute of Technology in 2006 and is currently perusing a career in software architecture at Datalex Ltd., Ireland.

Andrew Ritchie is a 3rd year student in computer science at the Dublin Institute of Technology, Ireland and has a passion for games.

Frances Boylan works as an eLearning Development Officer with the Learning Technology Team, Dublin Institute of Technology. After working as a primary school teacher for a number of years she returned to Trinity College Dublin to undertake the Masters in Education programme, specialising in Educational Management. She followed this with a Masters in Science (IT in Education), researching online learning and the implications of Learning Style Theory on the design and development of online distance education courses. She is currently pursuing her Doctorate (EdD) with the University of Sheffield.

Greg Burke is a lecturer at the Dublin Institute of Technology School of food science and environmental health.