Ludic Educational Game Creation Tool: Teaching Schoolers Road Safety

Nikolas Vidakis[1], Efthymios Syntychakis[1], Kostantinos Kalafatis[1], Eirini Christinaki[1], and Georgios Triantafyllidis[2(✉)]

[1] Department of Informatics Engineering, Technological Educational Institute of Crete, Heraklion, Crete, Greece
nv@ie.teicrete.gr, kalafatiskwstas@gmail.com, echrist@ics.forth.gr

[2] Medialogy Section, AD:MT, Aalborg University, A.C.Meyers Vænge 15, Copenhagen, Denmark
gt@create.aau.dk

Abstract. This paper presents initial findings and ongoing work of the game creation tool, a core component of the IOLAOS(IOLAOS in ancient Greece was a divine hero famed for helping with some of Heracles's labors.) platform, a general open authorable framework for educational and training games. The game creation tool features a web editor, where the game narrative can be manipulated, according to specific needs. Moreover, this tool is applied for creating an educational game according to a reference scenario namely teaching schoolers road safety. A ludic approach is used both in game creation and play. Helping children staying safe and preventing serious injury on the roads is crucial. In this context, this work presents an augmented version of the IOLAOS architecture including an enhanced game creation tool and a new multimodality module. In addition presents a case study for creating educational games for teaching road safety, by employing ludic interfaces for both the game creator and the game player, as well as ludic game design.

Keywords: Educational game · Road safety · Open authorable framework · Ludic game design

1 Introduction

Educational games for children have been widely used in supporting learning inside and out of school and as a result a growing interest has appeared for the potential of digital games to deliver effective and engaging learning experiences [5]. There is a variety of computer games and software that intend to assist users to achieve various educational goals. Educational gaming is a great platform that helps in motivating students to learn and is designed to teach students about a specific subject and/or skills. Prensky in [3] argues that children are naturally motivated to play games. Educational games are interactions that teach students goals, rules, adaptation, problem solving, interaction, all represented as a narrative. Such games give them the fundamental needs of learning by providing enjoyment, passionate involvement,

M. Antona and C. Stephanidis (Eds.): UAHCI 2015, Part III, LNCS 9177, pp. 565–576, 2015.
DOI: 10.1007/978-3-319-20684-4_55

structure, motivation, ego gratification, adrenaline, creativity, interaction and emotion. “Play has a deep biological, evolutionarily, important function, which has to do specifically with learning” [3].

In general, computer games and other digital technologies such as mobile phones and the Internet seem to stimulate playful goals and to facilitate the construction of playful identities. This transformation advances the ludification of today’s culture in the spirit of Johan Huizinga’s homo ludens [4]. In this context, this ludification of today’s culture can be also used in educational activities to strengthen the motivation and the engagement of the students.

In this paper, we introduce the game creation tool of the IOLAOS platform [1, 2] which is an open authorable framework for educational games for children. IOLAOS aims to employ ludic elements to provide efficient educational gaming for children.

IOLAOS suggests a fully authorable editor, with which, educational experts can create templates and teachers can shape and customize the template-based games according to specific needs for a more personalized education. It’s important that such customizations can be performed easily and without the reliance on software developers. The editor is also open. This means that new templates can be added easily for creating new games serving new educational goals.

Regarding the ludic approach, IOLAOS game creation tool features ludic elements for creating games, which support the use of natural user interface (NUI) for the playing. A NUI is a human-computer interface that allows humans to communicate with the computer using standard modes of human communication such as speech or gestures, and to manipulate virtual objects in a fashion similar to the way humans manipulate physical objects. During the last few years, technology has been improved rapidly and allowed the creation of efficient and low-cost applications featuring NUIs. One of the characteristics of a successful NUI is thus the reduction of cognitive load on people interacting with it. This is an important feature that makes NUI a suitable interface in developing successful learning applications. In our approach NUI focuses on the kinesthetic factor (gestures, movements, etc.), which is an important element in achieving the required playfulness of a ludic interface. For example, it is much more “fun” in a game to drive a car with your hands naturally, compared to pressing some keyboard keys. And this is even more important and critical when the target group is children.

Besides the ludic interface, ludic design for the game has been also employed in the game creation tool in order to improve playfulness, make the educational games more attractive for the children and aim to improve the learning procedure.

As a proof of concept for the IOLAOS game creation tool, a work scenario is presented in this paper, for creating an education game for teaching schoolers about road safety.

The rest of the paper is organized as follows. In Sect. 2, a brief presentation of similar existing work and the context of relevant educational games in road safety is presented. Section 3 focuses on the proposed architecture of the IOLAOS game creation tool. To illustrate the concepts of the proposed architecture, Sect. 4 presents the scenario for teaching schoolers road safety and how is this possible by using the IOLAOS framework. Finally, Sect. 5 describes conclusions and discusses future work.

2 Background Work in Road Safety Education

The pedestrian accidents are considered as one of the most serious of all health risks facing children in developed countries with United Kingdom (U.K.) leading Europe in the rate of child pedestrian fatalities [6]. In United States (U.S.), the fifth leading cause of unintentional injury death to children aged 1–14 years is also the pedestrian injury [7]. In 2012, more than one in every five children between the ages of 5 and 15 who were killed in traffic crashes were pedestrians [8].

Young children are most susceptible to pedestrian injury as they are not capable of making decisions concerning their safety. The perception of road danger depends on cognitive development, which may impose limitations on the children's ability to make decisions when negotiate crossing traffic-filled roads. Crossing a street safely is a cognitively difficult task for them as it requires planning and multiple steps. The several functions required for safe pedestrian ability are developed through early and middle childhood [9].

For safe street-crossing, children must develop a wide range of abilities such as cognitive, perceptual and decision making skills. They must be able to choose the appropriate location to judge the traffic, to accurately perceive the speed and the distance of oncoming traffic and finally to determine the safest root to cross the road. Oxley et al. [10] conducted a research to evaluate the effectiveness of a targeted and practical training program for primary school children aged between 6 and 10 years using a simulated road environment. In this study, the children had to make road-crossing decisions in a simulated road environment in which time gap and speed of approaching vehicles were manipulated. Their results suggested that children predominantly made decisions based on distance gap and that younger children (6–7 year olds) were 12 times more likely than older children (8–10 year olds) to make critically incorrect (or unsafe) crossing decisions. Factors found to be associated with incorrect crossing decisions included lower perceptual, attentional, cognitive and executive performance, and independent travel.

Several scholars have previously considered ways to teach children relevant skills for pedestrian road safety. Different type of interventions have been proposed such as interactive classroom training, computer-based training, virtual reality training, film or video training and verbal instruction training. Many school-based training programs have been implemented in order to increase children's knowledge of road safety. These initially training programs revealed that there are many variables that can affect the judgments of children and have been considered broadly ineffective because they often do not include behavioral training techniques and rely on parents to implement practice outside of the classroom [11]. Classroom approaches are also criticized for focusing on increasing children's knowledge about road safety rather than providing practical skills to use in real situations in order to improve traffic behavior. Zeedyk et al. [12] conducted a classroom-based study that employed commercially marketed products, a three-dimensional model of the traffic environment, a road safety board game and illustrated posters and flip-chart materials for teaching children about road safety. They showed that although classroom training succeed in increasing children's knowledge, children who received such training failed to automatically transfer these knowledge to behavior and performed no better in a real-traffic environment than children in their control group.

Alternative solutions have been used for children pedestrian safety through the use of virtual reality training. Bart et al. [13] examined street crossing behavior of children in real and virtual environments. In this study, typical developed children between 7 and 12 years old were trained to cross the street safely using a virtual reality environment. The results showed that the simulation employed in this study had a positive effect on children's street crossing behavior. This intervention was effective as the children improved not only their street crossing behavior in the virtual environment but could successfully transfer this improvement into the real street crossing environment. More recently, researchers suggested the development of virtual reality programs that might be disseminated broadly over the internet such as the internet-based virtual system that was proposed as an environment to train 7–8 year old children in pedestrian safety [14]. This program was developed using Unity 3D software and runs on any internet-connected computer and could also be adapted for mobile devices. The preliminary results indicated that this program offered a feasible environment for pedestrian training, it was educational and entertaining and children remained engaged and attentive while playing the game. Another study [15] examined the efficacy of widely available videotapes and websites used as training tools that require no or minimal adult support to implement in order to teach children safe pedestrian route selection skills. They compared these interventions to alternative pedestrian safety training strategies, including one-on-one training with an experienced adult pedestrian that was focused primarily on gap selection but also addressed route selection. In this study children 7–8 years old were trained in route selection and results suggested that children improved their pedestrian route selection somewhat over time. However, children trained with videos and websites did not learn route selection more quickly or better than children who received no training, or than children in either of their active comparison groups. Furthermore, computer-based interventions can offer repeated practice but fail to address other aspects of pedestrian safety. Thus, these methods may be more effective when supplemented with other learning modes that teach basic road safety rules. A recent systematic review and meta-analysis that evaluates behavioral interventions to teach children pedestrian safety where authors discuss the importance of using theories of child development to design interventions can be found in [16]. In this review authors propose further research with attention to child development and point the importance to provide interventions according to the global needs that can be disseminated broadly at low cost. As pedestrian safety represents a significant global health issue it is important to consider the need for innovation in measurement of children's pedestrian behaviors and how to focus intervention efforts internationally.

3 The IOLAOS Platform

The design of IOLAOS platform focuses on setting up the operational model for carrying out the codification of educational theories and learning styles, the generation of ludic, narrative, and educational games according to needs, abilities and educational goals and the evaluation of an inclusive educational session. This design exhibits several novel characteristics, which differentiate an IOLAOS-based game from other forms of educational computer games and platforms. Our approach is not only concerned with educational computer games, but instead, it seeks to provide a guided learning environment for both educators and children, that is story-telling and play-based by combining narrative and ludic for harnessing knowledge. Consequently, its primary focus is to enable educators and children with the use of ludology to perform learning tasks and provide an effective and engaging learning experience.

3.1 The Architecture

The proposed architecture has been designed in order to support a game platform that fulfils the requirements of customized narratives, ludic interfaces and ludic game designing. The system architecture consists of four distinct components that collaborate together to: (a) codify all different elements of educational theories and learning styles available and to create templates which are then offered to game developers, (b) compile games through a three step process, namely *template customization*, *game creation* and *utilization definition*, (c) manage inclusive learning session and play room attributes and (d) administer all necessary elements, modalities, users and their roles, game engine parameters etc. Peripheral to the system architecture are knowledge derived from educational theories, learning styles, evaluation models, pedagogical methods and classroom practices. The main components of our architecture are the "*Template Codifier*", the "*Game Compiler*", the "*Inclusive Education Training*", the "*Multimodality Amalgamator*" and the "*System Administration*" as shown in Fig. 1.

The "*System Administration*" component of the platform is responsible for managing system attributes, template parameters, game elements, artifacts and behaviors, session attributes, input/output modalities, and user accounts and roles.

The "*Template Codifier*" component is accountable for systemize/codify the various elements of the educational theories, evaluation models, pedagogical theories and learning styles. This is achieved by imprinting the theory's elements using a tabbed stepwise process by the expert.

The "*Inclusive Education Training*" component of the system is responsible for setting up the appropriate space for playing and evaluating games. It consists of the "Learning Session Compilation", the "Class-Play Room Compilation", the "Evaluation Compilation", the "Observation Center Compilation" and the "Play Area(s)".

More details about the "*System Administration*", the "*Template Codifier*" and the "*Inclusive Education Training*" components can be found in [1, 2].

3.2 The Game Compiler Tool

The "Game Compiler" component (see and Fig. 2) of the system consists of the "Template Customization" the "Game Creation" and the "Utilization Management". It is responsible for providing the "Educator" with the necessary tools to set up a ludic educational game. In other words, it gives the "Educator" the possibility to (a) customize the generic template set up by the "Expert" at the "Template Codification" component in such a way that suits the specific game requirements according to target

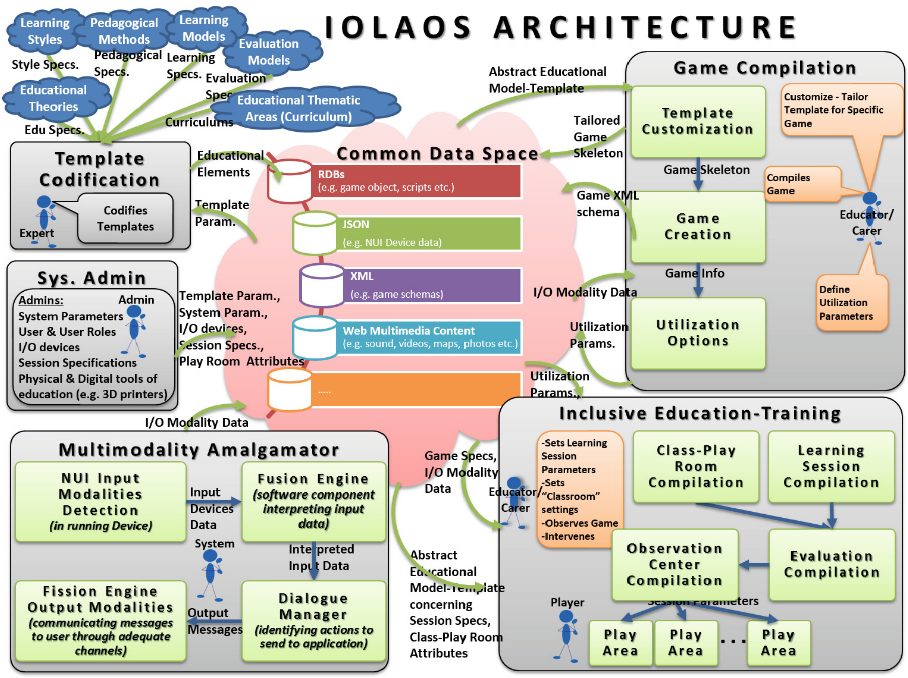


Fig. 1. System architecture

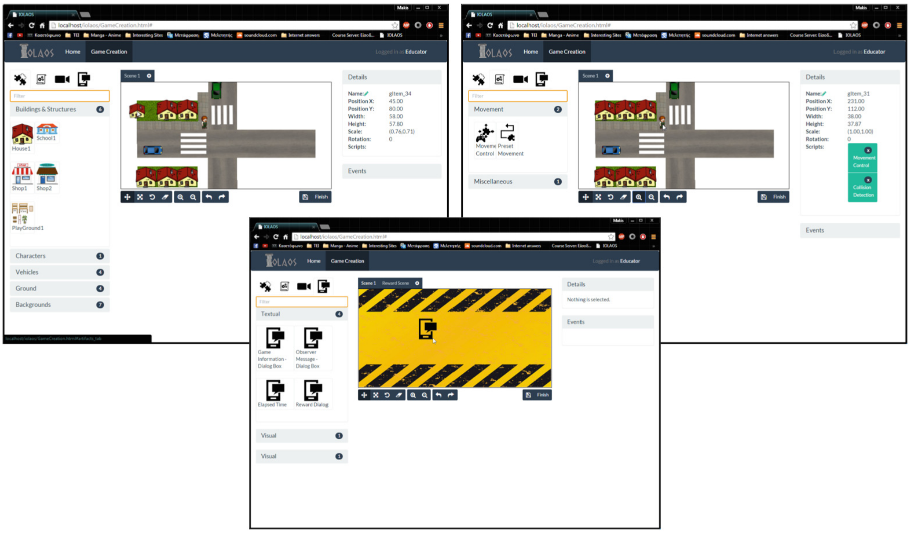


Fig. 2. IOLAOS game compiler component

user group abilities and educational goals to be achieved, (b) create a ludic game with the use of the tools provided by IOLAOS platform (see Fig. 2) and (c) to define game utilization parameters such as: Free Use, Registered User Only, etc.

Figure 2 exhibits selected elements of the game creation component based on our representative scenario described in Sect. 4. In more details, the top left screenshot of the tool demonstrates the construction of the game from predefined and filtered game objects (see the left area from the game canvas) according to our representative scenario game template, namely the "Minimum body movement template". Furthermore, the placement of the game object is performed by drag and drop user actions using a mouse pointing device or a touch screen device. At the bottom of the game area there is a tool bar with appropriate tools for the manipulation of the game objects in respect to their attributes i.e. position, size, rotation, etc. The top right screenshot illustrates game object details in respect to object attributes and containing scripts. Finally the bottom screenshot describes the rewarding scene(s) of the game and their content. A rewarding scene encompass game objects such as (a) textual, visual and sound feedback, (b) game artefacts and scripts and (c) evaluation object i.e. score, time etc. The rewarding scene canvas is activated by game creation completion according to the chosen educational game template.

Multimodal interaction systems aim to use naturally occurring forms of human communication as a way for human computer interaction [17]. In our system, the "Multimodality Amalgamator" component (see Figs. 1 and 3) uses modalities with very different characteristics such as speech, hand gestures and body movement, in addition with more commonplace input methods, in order to allow the user to have a more natural interaction with the application.

The "NUI Input Modalities Detection" sub-component perceive input modalities through the appropriate input devices (e.g. microphone, web cam, etc.). Its results are then passed to the "Fusion Engine" sub-component, a software component responsible for providing a common interpretation of the input data. The various levels of which the data can be fused is beyond the scope of this paper. When "Fusion Engine" reaches an interpretation, it is communicated to the "Dialogue Manager", in charge of identifying the action to communicate to the given application, and/or the message to return through the "Fission Engine Output Modalities" sub-component. The "Fission Engine Output Modalities" is finally in charge of returning a message to the user through the most adequate channel of communication (output modality), depending on the user profile.

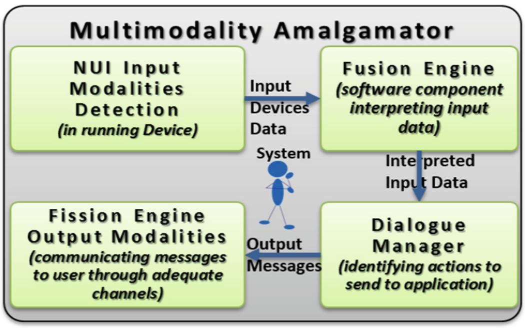


Fig. 3. Multimodal system component

4 Representative Scenario

To illustrate some of the concepts described so far and to provide insight into the Ludic Educational Game Creation Tool, we will briefly describe a representative scenario emphasizing on ludic, multimodal, narrative and authorable game creation for educating children. Our reference scenario is summarized in Exhibit 1.

Exhibit 1: The game begins at paused and a dialogue at the bottom of the screen shows the main character talking to the player. Through this dialogue the main character passes information to the player concerning (a) the purpose and goal of the game, (b) interaction possibilities and (c) motion guidelines. Having being informed the player closes the instruction dialogue and the game begins. She/he can use any input modality that is available on her/his device and permitted by the game. In our reference scenario the permitted input modalities are “keyboard” and “microphone”. An available modality bar with appropriate icons is displayed on the top right corner of the screen. When the player uses a modality its representing icon is highlighted by background color changes (green color means modality in use and red color means modality is idle). The player must cross the road only on the zebra crossings in order to reach the end destination, in our reference scenario the “Shop”. If the main character crosses from anywhere else but the zebra crossings then either there is a car present and the character collides with it or there is no car present. In both cases the game produces an appropriate text alert as feedback, for the wrong movement, to the main character and restarts. When the player gets to the final destination successfully, the game ends and the rewarding screen comes forth, informing the player on her/his achievement and the rewards gained.

4.1 Game Compilation

According to our reference scenario the “Educator” creates the game by performing the following steps in IOLAOS platform: (a) Select appropriate template, (b) Customize template according to scenario requirements, (c) Generate game framework upon which, the “Educator”, will construct/fabricate the game, by defining artifacts and behaviors. The outcome of the above process is an educational game for teaching schoolers road safety.

In more details, as presented in Fig. 4, initially the “Educator” selects “Game Create” and chooses the appropriate template provided, in our case the “Minimum body movement template”. At step 2 “Template Parameterization”, the “Educator” applies our representative scenario requirements which in our case are: a) the number of game scenes-levels are limited to 1 excluding welcome screen and final rewarding screen(s), b) the color scheme option is “Normal Coloring”, c) the Peripherals-Modalities for game navigation is performed via voice commands with the use of a microphone and keyboard strokes.

Feedback is passed to player (a) through light coloring for the modality used (see top right corner of Fig. 5) (b) through text alerts during game execution according to player moves and (c) as concluding feedback-rewarding at the end of the game.

At step 3 "Game Basic Info", the platform allows the "Educator" to provide game info such as "game name", "game visibility" and "game type" according to her/his desires and boundaries set up at step 2. In our reference scenario game name is "Road Safety", game visibility is "In Session" and game type is "Multidirectional".

4.2 Play Game

The game begins paused and a dialogue at the bottom of the screen shows the main character "Gary" talking to the player. Through this dialogue the main character passes information to the player concerning (a) the purpose and goal of the game, (b) interaction possibilities and (c) motion guidelines (see Fig. 5). When the child feels ready, she/he can choose to start the game.

To enlighten the different aspect of the game we describe three different playing scenarios namely the "Wrong Crossing" scenario (see Fig. 6), the "Collision with Car" scenario (see Fig. 7) and the "Successful Crossing" scenario (see Fig. 8). The goal of the main character "Gary" is to go to a shop safely.

In more detail at the "Wrong Crossing" scenario the player navigates Gary", with the use of voice commands to cross the road from the wrong place outside the zebra crossing. The active modality (voice command) is highlighted at the top right corner of the scene where the microphone device icon is turned to light green color (see Fig. 6 a, b). As a result of the wrong actions of "Gary" the game (a) provides the appropriate feedback, and (b) resets and urges "Gary" to use one of the zebra crossings (see Fig. 6 c).

At the "Collision with Car" scenario the player navigates "Gary", with the use of voice commands to cross the road from the zebra crossing but without checking if there is a vehicle passing. The active modality (voice command) is highlighted at the top right corner of the scene where the microphone device icon is turned to light green color (see Fig. 7, left screenshots). As a result of the negligent action of "Gary" the

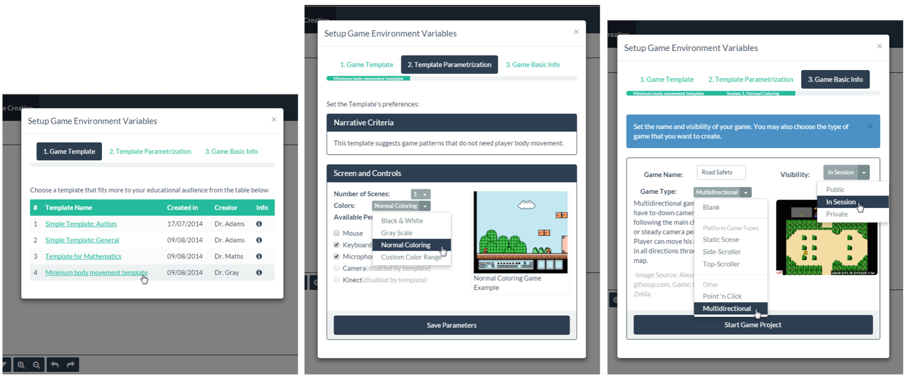
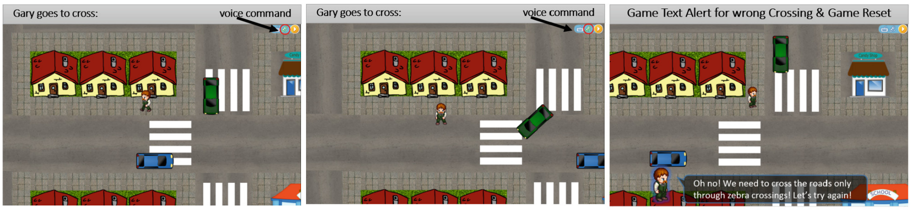


Fig. 4. Game template customization

Fig. 5. Game instruction start screen



a b c

Fig. 6. Play scenario: wrong crossing (Color figure online)

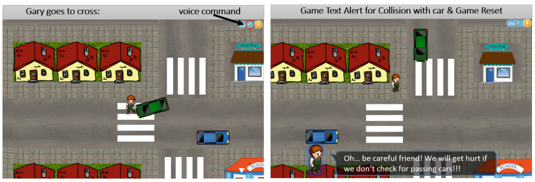


Fig. 7. Play scenario: collision with Car (Color figure online)

game (a) ends and the player lose, and (b) resets and urges "Gary" to be more careful with passing cars (see right screenshot of Fig. 7).

Moving on with our play time scenarios, at the "Successful Crossing" scenario the player navigates "Gary", with a different modality from the other two scenarios namely keyboard strokes to cross the road from the zebra crossing after checking for passing vehicles. The active modality (keyboard strokes) is highlighted at the top right corner of the scene where the keyboard device icon is turned to light green color (see Fig. 8, left screenshots). As a result of the correct road crossing attribute of "Gary" the game

Fig. 8. Play scenario: successful crossing (Color figure online)

(a) ends successfully with “Gary” reaching his destination, and (b) informs “Gary” about his achievement (see right screenshot of Fig. 8). The game concludes with the appropriate rewarding scene.

5 Conclusion and Future Work

In this paper we have attempted to sketch the organizational underpinnings of the IOLAOS platform, a pilot effort aiming to build an open authorable framework for educational games for children by combining ludology and narratology. Our primary design target is to set up an operational model for carrying out the codification of learning styles, educational theories, pedagogical methods and evaluation models as well as the generation of ludic, narrative, and educational games according to needs, abilities and educational goals and to support this model with appropriate software platform and tools.

Ongoing work covers a variety of issues of both technological and educational engineering character. Some of the issues to be addressed in the immediate future include: (a) Elaborate on the Inclusive Educational-Training module, (b) Further exploration of learning styles, educational theories, pedagogical methods and evaluation models in collaboration with expert and educator professional associations, (c) Run various use cases in vivo with the guidance and involvement of expert and educator professional associations (d) Enhance ludology aiming not only to children experience, but also to experts and teachers, and (e) Elaborate further on the Multimodality Amalgamator module to involve more input and output modalities so that the roles between game player and machine are reversed and the player performs gestures, sounds, grimaces etc. and the machine responds.

References

1. Vidakis, N., Christinaki, E., Serafimidis, I., Triantafyllidis, G.: Combining ludology and narratology in an open authorable framework for educational games for children: the scenario of teaching preschoolers with autism diagnosis. In: Stephanidis, C., Antona, M. (eds.) UAHCI 2014, Part II. LNCS, vol. 8514, pp. 626–636. Springer, Heidelberg (2014)
2. Christinaki, E., Vidakis, N., Triantafyllidis, G.: A novel educational game for teaching emotion identification skills to preschoolers with autism diagnosis. Comput. Sci. Inf. Syst. J. **11**, 723–743 (2014)

3. Prensky, M.: Fun, play and games: What makes games engaging. In: Prensky, M. (ed.) Digital Game-Based Learning, pp. 1–31. McGraw-Hill, New York (2001)
4. Huizinga, J.: Homo Ludens: A Study of the Play-elements in Culture. Routledge & K. Paul, London (1949)
5. Hwang, G.-J., Po-Han, W.: Advancements and trends in digital game-based learning research: a review of publications in selected journals from 2001 to 2010. Br. J. Educ. Technol. **43**, E6–E10 (2012)
6. Vaganay, M., Harvey, H., Woodside, A.R.: Child Pedestrian traffic exposure and road behaviour. In: European Transport Conference, Strasbourg (2003)
7. Centers for Disease Control (2015). WISQARS (Web-based Injury Statistics Query and Reporting System). http://www.cdc.gov/injury/wisqars/. Accessed 15 February 2015
8. Department of Transportation (US), National Highway Traffic Safety Administration (NHTSA). Traffic Safety Facts 2012: Pedestrians. Washington (DC): NHTSA. http://www-nrd.nhtsa.dot.gov/Pubs/811888.pdf. Accessed 15 February 2015
9. Barton, B.K., Morrongiello, B.A.: Examining the impact of traffic environment and executive functioning on children's pedestrian behaviors. Dev. Psychol. **47**(1), 182 (2011)
10. Oxley, J.A., Congiu, M., Whelan, M., D'Elia, A., Charlton, J.: The impacts of functional performance, behaviour and traffic exposure on road-crossing judgements of young children. In: Annual Proceedings/Association for the Advancement of Automotive Medicine, vol. 51. Association for the Advancement of Automotive Medicine, p. 81 (2007)
11. Cross, R.T., Pitkethly, A.: Concept modification approach to pedestrian safety: a strategy for modifying young children's existing conceptual framework of speed. Res. Sci. Technol. Educ. **9**(1), 93–106 (1991)
12. Zeedyk, M.S., et al.: Children and road safety: increasing knowledge does not improve behaviour. Br. J. Educ. Psychol. **71**(4), 573–594 (2001)
13. Bart, O., Katz, N., Weiss, P.L., Josman, N.: Street crossing by typically developed children in real and virtual environments. OTJR: Occup. Participation Health **28**(2), 89–96 (2008)
14. Schwebel, D.C., McClure, L.A., Severson, J.: Usability and feasibility of an internet-based virtual pedestrian environment to teach children to cross streets safely. Virtual Real. **18**(1), 5–11 (2014)
15. Schwebel, D.C., McClure, L.A.: Children's pedestrian route selection: efficacy of a video and internet training protocol. Transp. Res. Part F: Traffic Psychol. Behav. **26**, 171–179 (2014)
16. Schwebel, D.C., Barton, B.K., Shen, J., Wells, H.L., Bogar, A., Heath, G., McCullough, D.: Systematic review and meta-analysis of behavioral interventions to improve child pedestrian safety. J. Pediatr. Psychol. **39**, 826–845 (2014)
17. Dumas, B., Lalanne, D., Oviatt, S.: Multimodal interfaces: a survey of principles, models and frameworks. In: Lalanne, D., Kohlas, J. (eds.) Human Machine Interaction. LNCS, vol. 5440, pp. 3–26. Springer, Heidelberg (2009)