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in training settings

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Abstract. Nowadays, serious games are present in almost every educational context. The current work deals with the design of serious games oriented towards getting transferable skills in different kinds of training settings. These games can be a valuable way of engaging citizens and workers in the learning process by means of metaphors or similar mechanisms close to their user experience. They also contain an encouragement factor to uptake generic job competencies. An approach is proposed to develop this type of game by mixing traditional design steps with an instructional strategy to provide structured *learning bites* in training settings. Several game prototypes have been developed to test this approach in the context of courses for public employees. The obtained outcomes reveal the wider possibilities of serious games as educational resources, as well as the use of game achievements to evaluate the acquisition of transferable skills.

Keywords: Serious games, Training settings, Instructional design, Game design approach.

1 Introduction

The *game-based learning* paradigm is now present in almost every educational context, spreading the concept of *gamification* [1] and serious games. Multiple initiatives have been launched dealing with how serious games can support formal education in schools [2] and higher education [3]. There are also examples applied to training settings although these games are usually oriented towards specific professional areas such as medical [4] or military scenarios [5]. In the case of training settings, the role of serious games has to be adapted to adult users who are not used to *playing* in this way and have tight time restraints. Traditionally, this role has been focused on simulators and other immersive techniques addressed to training for specific tasks [6]. However, the need to incorporate new social and transferable skills for lifelong learners gives serious games wider chances within a knowledge society in a state of continuous change. This paper deals with the design of serious games oriented towards getting transferable skills in different kind of training settings including public institutions and organizations. These organizations are ever more

concerned about the call for new training strategies. Serious games offer an excellent opportunity to promote active learning among people who have to cope with changes in their job assignments and social responsibilities. They also provide a way to teaching alternative skills outside their usual routines, such as inquiry, collaboration or reasoning abilities. The current work proposes serious games as a way of involving citizens and workers in their training process while taking into account their time restrictions. The aim is to produce small learning bites that get the interest of workers with tight schedules and instructional limitations in acquiring the relevant skills. This idea is linked to the principle that "in adult education small is beautiful" [7]. The games proposed are based on mechanisms close to the users' experience, using metaphors or similar elements, and are adapted to their level of expertise. They can be considered as learning resources oriented towards achieving specific goals but introducing motivating factors to uptake generic job competencies. For example, a training setting focused on risk management at the work place can also enable inquiry skills about exploring working scenarios at professional environments. In a similar way, collaboration abilities can be encouraged through the exchange of viewpoints in a learning situation to define and explain public job responsibilities.

The proposed approach is based on mixing traditional designs with an instructional strategy of structured *learning bites* in training settings. It is important to emphasize the size factor when trying to fit the game dimension with the required learning goals. In addition, these games are viewed as complementary resources that can be developed as learning objects and integrated into more general activities. There are several references that describe tools and methods to help developers in producing educational games with such requirements. De Freitas & Jarvis [8] introduced a four-dimensional framework for describing game-based learning scenarios according to learner needs. Gunter et al. [9] called for the implementation of instructional principles into the design of serious games considering the need "to meet their intended educational goals". An additional conceptual framework [10] included "learning and pedagogy theory in combination with gaming requirements". In general, there is a consensus that serious game design has to be driven by instructional issues without forgetting their intrinsic motivating and creative factors.

This instructional design has to be supported by mechanisms that facilitate rigorous and systematic game development. Several types of framework have been proposed for formally representing and developing different types of games [8], [11], [12]. Some of these proposals incorporate formal instructional issues, for example, well-established learning theories [9], or try to reduce game design complexity in higher education [13]. PIMI [14] proposes another formal framework to assist in the design and development of serious games through an iterative process. However, few of these frameworks focus on serious games for learning professional skills [15] and they usually need to be adapted to teach transferable skills. Training settings have traditionally been supported by simulations and immersive worlds as basic techniques to meet learning requirements in these settings [6]. These techniques have succeeded when specific goals or skills are required, for example, in adaptive training systems [16]. In the case of more generic or transversal skills, the use of metaphors can provide an appropriate mechanism to acquire these skills. These metaphors can be linked to users' seamless experiences during their formal education such as reading books or answering quizzes, but also in their professional and daily activities. The

selected metaphors should not interfere with the training activities and should become a transparent item in the process, in order to encourage the acquisition of skills that could be transferred to other learning scenarios. In many ways, the use of serious games in training settings could be compared with commercial advertisements with subliminal purposes. In the context of the current work, several game samples have been designed with the purpose of checking the adequacy of the proposed approach in lifelong learning areas and addressing the generic skills considered useful for public employees. These samples are mainly concerned with learning experiences in a government organization known as *DiVal* (Diputación de Valencia) but they can easily be transferred to other professional settings such as universities or hospitals. This development is supported by the use of a tool called *Eadventure* [17], which allows game designers to rapidly generate small prototypes that can be rigorously tested by instructors who are not necessarily expert in game-based learning topics.

The remainder of the paper is organized as follows. The second section describes the approach used to develop game prototypes for training settings. The third section reports on the development of games that apply the approach in the context of a specific public organization. Section 4 explains some of the benefits of applying this approach and compares it with similar proposals. Finally, Section 5 provides the main conclusions and suggests future lines of research.

2. Instructional game approach

The proposal for developing small games in training settings is based on a strategy that combines traditional steps in the design of games with an instructional strategy to integrate game learning requirements. The design and development of computer games has been widely addressed to provide game designers with different perspectives for designing such products. However, the choice of the right method is cumbersome due to the diversity of game features and aims, particularly, in a learning context. In this work, an instructional game approach is presented based on the importance of a structured and systematic development process combined with the use of techniques to quickly produce versatile games. The current proposal allows an instructional designer to actively collaborate in creating the game by fitting the play elements to the required learning goals or taking advantage of game outcomes to assess the user's progress.

Fig. 1 shows a flowchart representing the stages that compose the global approach, which are close to the instructional steps proposed in the ADDIE model [18]. These stages address: i) the conceptual *definition* of the experience that arises out of the game; ii) the *design* of the game components such as the visual scenario or their main actions; iii) the *implementation* of the game prototype through authoring tools; and iv) the *evaluation* of the developed product using the game achievements or the users' points of view. Instructional issues are transversal to the game development in the sense that it is considered as an educational resource used in a specific training context to provide generic or specific skills. The approach stages are described below

showing a cyclic process where some designed game actions or game achievements produce a feedback to previous design or development steps.

2.1 Conceptual definition

The first stage is the conceptual definition, which addresses a general description of the experience associated with the target game and represents an abstract outlook of the game purpose and its main features and needs. This perspective comprises several issues, such as a title for the game, its learning goals, the potential audience or the game training focus.

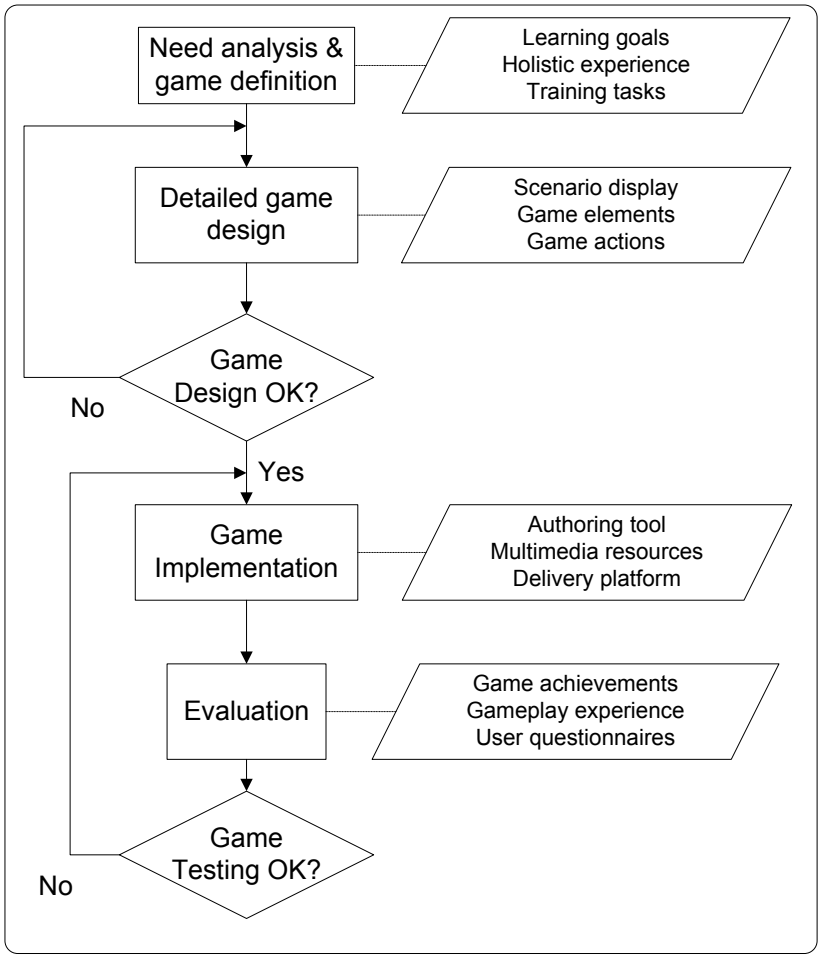


Fig. 1. Instructional game development flowchart.

This conceptual definition agrees with the holistic view that is part of the framework proposed by Bjork & Holopainen [12] considering the game as an *undividable experience*. This view provides an important meeting point for instructors and game designers. The key issue can be centered on the question "Why should learners play?" instead of "Why do players play?" thus establishing the instructional focus of the game to be designed and developed in the next stages.

In the current context, game experiences are related to professional settings that require specific knowledge items or practice abilities, but these experiences can also be extended to more generic and transversal skills. For example, the core game conception can promote systematic inquiry abilities or encourage teamwork responsibilities. Learning goals thus have to be carefully defined and connected with well-known taxonomies [9] as well as with those game actions that enable the required goals to be achieved and with the associated training skills. Table 1 shows a list of Bloom competencies (displayed as *Goals*) which can be related to transferable skills in a training context. For example, a knowledge-based goal can be associated with recalling information on safety protocols in a *Risk Management* course. The skills represented can be linked to game actions such as "identify critical objects" in a safety scenario or "explore systematically" this scenario. This basic definition enables a game conception that can be adapted to fit specific learning contents and activities in further steps.

Table 1. Learning goals and their relationships with game actions.

Goals	*Skills*	*Game actions*
Knowledge	Learners can recall information about safety protocols and public hiring procedures	Identify or collect critical game objects
Comprehension	Learner can explain legal topics and understand organizational conditions and conflicts	Select game descriptions or follow narrative paths
Application	Learners can solve problems, assign public job responsibilities, apply technical specifications and assist citizens	Choose game options or launch character conversations
Analysis	Learners can determine public or social responsibilities, explore roles and assign tasks to team members	Assign role functions or configure game activities
Synthesis	Learners can build or prepare a plan/project	Review game outcomes
Evaluation	Learners can make judgments about managing a project or a plan scheduling	Answer relevant questions or select game options

2.2 Game design

The game design deals with the different views that complement the description of the game from its core conception in the previous stage. In the framework proposed by Bjork & Holopainen [12] the structural view describes "the basic parts of the game manipulated by the players and the system" while the dynamic view allows the designer to specify "the flow of the game" through player actions, character conversations or state changes. Schell [19] divides game elements into four basic categories: mechanics, story, aesthetics and technology and other categories can be proposed to classify these elements such as characters, items, objects or mechanisms [20]. Whatever the model selected, the main question is how to match these structural and dynamic components to the instructional issues required by the game.

In this context, it is important to choose an appropriate visual scenario that involves the user in the learning process, for example, using a metaphor close to his or her experience. It is also crucial to describe game actions that promote certain training objectives, e.g. collecting objects or assigning roles to game characters. Some of these actions are displayed in Table 1 and include their relation to Bloom competencies in a public working context. All these steps are present in the design of other instructional products. For example, a lesson presentation or a screencast recording are designed according certain aesthetic criteria and different roles and functions can be assigned to project activities in a course. Games introduce a leisure factor, which adds an extra motivation in the learning or training process [21] but they can be considered as a complementary resource within the overall system. This accumulation of game components leads designers to deploy methods and techniques that help them to elaborate a game model before implementing it. Such modeling processes can take advantage of elements and notations that represent the game in a systematic and formal way. The visual game components can be represented by sketches or storyboards, and, scripts or state charts can be used to model the dynamic game behavior [20]. The dynamic component is perhaps the most difficult part to model in an educational product. Some notations that combine the modeling of both technical and instructional issues can be useful in this context [22]. Burgos et al [23] address the use of e-learning standards such as IMS LD to represent educational games and Marfisi-Schottman et al [15] propose engineering methods for designing serious games. Other frameworks proposed by *Emergo* [24] and Yusoff et al [10] are based on UML diagrams to describe and represent game components.

In the current work, UML notations have been selected to represent a game structural and dynamic view. Class diagrams are an effective way of modeling structural elements such as the characters who participate in the game and the objects that form part of the game scenario. Several UML artifacts, such as activity or state diagrams, can help to represent how the game characters perform specific actions over certain objects. Fig. 2 shows a UML class diagram that adapts the conceptual framework proposed by Yusoff et al [10] incorporating entities (shown as darker boxes) to add instructional issues into the game design. For example, to differentiate certain generic capabilities, such as "solving problems" or "supervising teamwork" from instructional contents attached to a specific training area such as a safety protocol or a public administration procedure. An entity that represents the "collection of items" can be used as a learning outcome and "conversations" can be part of the

activities or tasks promoted during the course. To sum up, these entities link learning goals or instructional resources with game mechanics by means of items such as character *scripts*, object *actions* or player *roles*.

2.3 Game implementation and evaluation

Once the main aspects of the instructional game have been designed, these can be implemented by means of prototypes that show how they work in specific training scenarios. There are several companies that specialize in developing this type of serious games such as DDigitally[1] or PIXELearning[2] that produce simulators or immersive worlds. These products are usually oriented towards 3D complex graphical developments, which are expensive and normally out of reach of public organizations or private companies. An alternative way of obtaining affordable products consists of using creative tools either commercial or free software products adapted to different types of serious games.

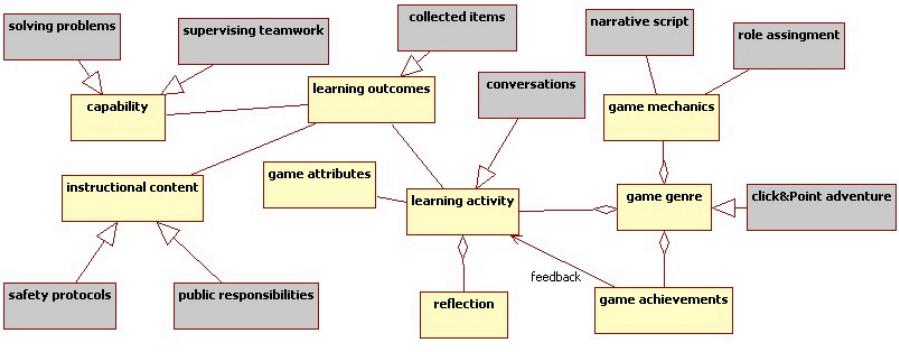


Fig. 2. Conceptual design framework.

In the current work, the main purpose is to implement game prototypes that can be easily tested by instructors to determine their feasibility. After this initial testing and evaluation, a decision can be made on whether to take the game development a step further. Several authoring tools have been assessed considering these premises for the purpose of creating adventure-based games easily and quickly. In this category there is also a wide range of tools able to generate this type of game. For example, Adventure Maker [3] helps to create *point&click* games for web-based environments for users with no programming skills. WME[4] and AGS[5] are similar tools and both require a .NET platform for developing games. The multiplatform facility is considered an important factor in this stage, and so other tools were examined. There are some Java-

[1] http://www. designingdigitally. com/
[2] http://www.pixelearning.com/
[3] http://www.adventuremaker.com/
[4] http://dead-code.org/home/
[5] http://www.adventuregamestudio.co.uk/ac.shtml

based products such as or Hephaestus[6] or GTGE[7], but they do require knowledge of programming. *Eadventure* [17] has been finally selected as it provides an easy development process using a graphical friendly interface with the option of incorporating didactic objects (e.g., book documents, web pages or video records) and debugging products during the implementation stage. It also provides for the integration of accessible elements that allow disabled players to control the game using a keyboard or enabling audio descriptions of game actions. *Eadventure* can also generate standard specifications, such as SCORM or IMS CP, which can be integrated in several e-learning platforms.

The final approach stage deals with the evaluation of developed games and they can be viewed from different perspectives, based on either instructional issues or experience features. The *Game Object Model* [25] provides a global view of the integration of educational theory and game design complemented by a model of the game's achievements, which can be the link between learning goals and activities formulated in the conceptual game definition and the game actions that are part of its design and development. Table 1 shows a set of game actions linked to learning goals and associated skills in a public training context. For example, the collection of objects addressed to promote a kind of inquiry ability can be used as a game achievement and it becomes a useful instrument for assessing the player's performance. Another example of game achievement can be the number or kinds of conversations started in a game as a way of measuring the player's communication skills. This type of achievement can be processed to obtain a quantitative measure of the user participatory level in a collaborative environment or to get a qualitative view about the proficiency when discussing an administrative protocol in a public forum.

Event tracking also helps instructors to understand how players deal with the game mechanics by obtaining a learner profile describing his game achievements. Serrano et al [26] proposed a framework "to improve evaluation in educational games" by applying *Learning Analytics* techniques based on the logs produced by the *eAdventure* engine. There are several possibilities for checking relationships between instructional issues and game items to detect if the developed games meet the required training goals [9]. Some studies have also found that games are especially effective for students with poor performance in the domain taught [27], but not all game features improve their learning effectiveness. Wouters et al [28] propose the alignment of learning outcomes and game types. Games should be carefully designed and evaluated as to their instructional potential in order to have a real impact on learning or training activities [29].

Other issues than instructional aspects can be considered when evaluating a game. Nacke et al [30] describe several methods of evaluating the gameplay experience, by assessing aspects such game system experience, individual player experience and player context experience. The current work focuses on evaluating the player perspective and how he interacts with the game. Since game prototypes are first checked by course instructors, they are considered the main actors in this evaluation process. In this case, eye tracking techniques and mouse tracking analysis can be used to evaluate the player experience from the instructors' point of view. They can then

[6] http://markdamonhughes.com/Hephaestus/index.php
[7] http://goldenstudios.or.id/products/GTGE/

decide not only whether the game mechanics fits the required learning goals, but also whether they can be understood and used by potential players.

3 Developing game samples

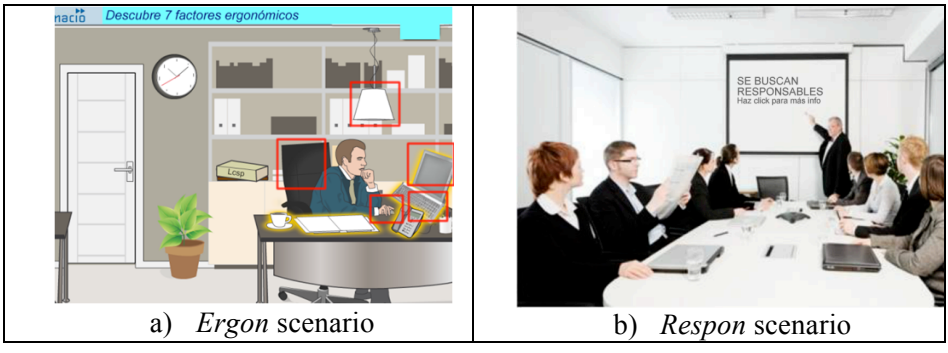
Several game prototypes have been developed in *DiVal* (Diputación de Valencia), a government organization that gives support to local councils in providing services to both the general public and workers. It offers a wide range of services, including training for public employees in several areas. For example, *DiVal* delivers more than 130 courses in life-long learning topics (e.g., help centers or information and communication technologies) and other internal programs are offered, such as risk management and job responsibilities. A special department exists to train workers in these areas and serious games have been proposed to complement the instructional resources for some of their courses. A *Moodle* platform is used to store and manage course resources, such as documents or presentations or delivering training contents and tasks. The first step has been to choose the courses to be included in the testing experience and decide how the proposed approach would later be applied to the courses themselves.

The conceptual definition of these games has been based on selecting training scenarios familiar to *DiVal* users. There were a number of candidate courses, and several issues were analyzed to determine whether educational games would be appropriate in their curricula and the transferable skills that could be transmitted by them. Because of this diversity of courses, a common template has been used to design educational resources and instructional activities following controlled learning sequences. The main idea has been to integrate the games as specific elements connected to additional educational resources such as video recordings or text documents. The principal objective is based on teaching certain knowledge items combined with practical activities, enabling the acquisition of generic transferable skills such as exploratory and inquiry routines, problem solving procedures, communication and reasoning abilities and collaboration and negotiation attitudes.

Every game application should provide specific outcomes and achievements to make it possible to assess learners' performance. Several sample games have been designed under these principles and two prototypes were finally chosen. Fig. 3 shows two screenshots of office-based scenarios for these games. The first sample displayed in Fig. 3a has been called *Ergon* (from ergonomics) and it can be considered a basic *click&point* product addressed to picking up items from a simplified office sketch. The game purpose consists in allowing users to explore this kind of scenario and detecting what office objects have an ergonomic impact in their workplace. The second sample game is called *Respon* (from responsibilities) and it draws a situation where several people are being assigned with specific tasks in a professional context. Fig. 3b shows a *roundtable* scenario of the *Respon* game in which actors interact with items on the table while they have conversations about workplace responsibilities Players have to decide the right user profile for each responsibility through questions asked by the game and the actors' answers. In the case of *Ergon*, basic abilities such

as systematic search or promoting inquisitiveness were considered, while *Respon* dealt with higher level skills such as collaboration and communication abilities.

Ergon has been developed for a course in *Risk Management*, whose main goal is to provide information on risk prevention in the workplace and to practice basic safety skills. The *Ergon* prototype concerned teaching ergonomics topics to public employees, among other skills. Fig. 3a shows a synthetic view of an office area that contains typical office equipment. For example, the player can examine objects such as lights, chairs or computer devices, and then decide on their ergonomic impact (signalled as red square hot spots in Fig. 3a). It is important to emphasize the use of a *quiz* metaphor, based on identifying objects with a special meaning, similar to the quizzes for finding the differences between two images. In this way, the *Ergon* game can encourage users to systematically explore elements that are critical to their health thus teaching an additional skill.



a) *Ergon* scenario b) *Respon* scenario

Fig. 3. Game display for *Ergon* and *Respon* prototypes.

In the case of the *Ergon* prototype, the game mechanics is rather simplistic since it only requires players to collect objects from an office scenario. Some of these objects have an ergonomic impact but others only provide guidance in the game (e.g. a map for instructions) or refer non-ergonomic issues that should be detected. The game narrative starts with instructions provided in the map, which describe the actions that can be performed or how to finish the game (no time limit or deadline was imposed). Even in a simple game as *Ergon*, its design helps definitively to its further implementation. For example, it enables game elements and their states to be defined, the operations or actions that can be carried out on the defined elements, or when transitions can be triggered. This design is organized into two main parts: i) a structural model that represents the main game entities through a UML class diagram and ii) a dynamic model of the game behavior. The diagrammatic representation of the game elements allows instructors to detect the objects that would be useful in the game and their relationships with its purpose, e.g. a map for instructions or an inventory box for visited objects to track the game progress. The dynamic model is a key issue to represent possible game actions, including when the player decides to examine an object obtaining their description, selecting this object as he understands it represents an ergonomic factor, or eventually, in the case the player quits the game. Fig. 4 shows a UML activity diagram displaying some of these actions and

highlighting the options that the player can perform. For example, it displays the possibility of *examining* or retrieving information from a scenario item or the *take* action of picking up a given element and storing it in the *inventory box* of ergonomic objects. The inventory box has additional operations that allow players to list the selected objects or detect if its storage capacity has been reached ending the game.

The structural design has been also crucial in the *Respon* prototype because certain items (e.g., a microphone to allow actors to speak or a calendar to schedule job tasks) can appear or disappear from the scenario depending on the game state. *Respon* is a more complex game since it has several actors that play specific roles (e.g. administrative tasks) asking questions to the player who has to select among answer options from a list. Depending on the selected answer, the game leads the user through different paths that represent those conversations in which the player has to practice with the assigned responsibilities. This concept of conversation is used to guide the functional design for the *Respon* game also enabling the learning of those relevant collaborative and communications abilities in a public workplace.

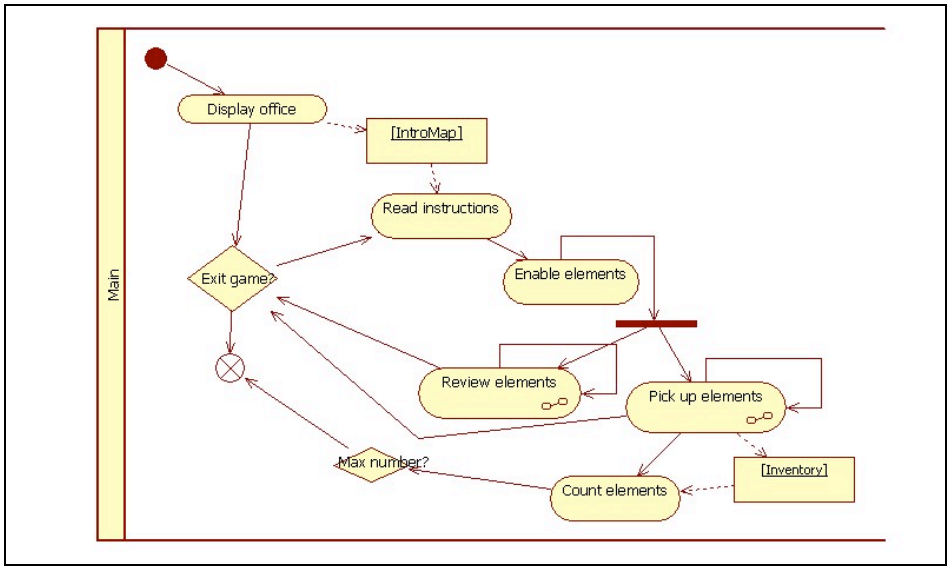
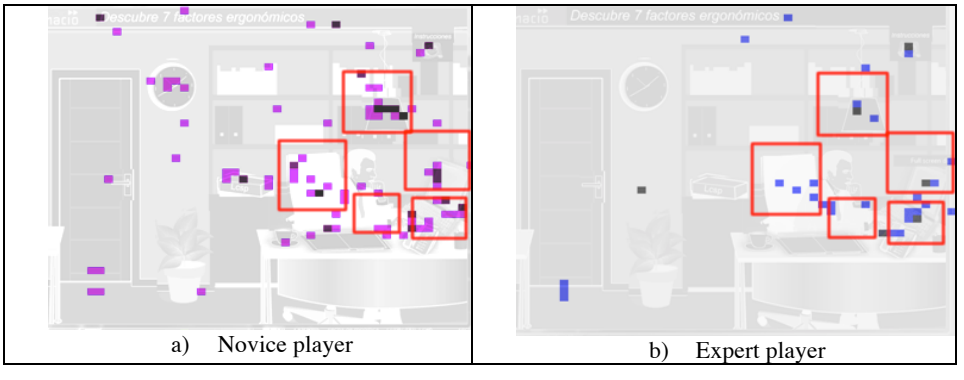


Fig. 4. *Ergon* Activity UML diagram.

The *implementation* of both games has been based on the use of *Eadventure* v1.5, which allows game designers to quickly develop prototypes to be tested by volunteer instructors. *Eadventure* mechanics is rather flexible and enables *point&click* games to be developed from products using simple object actions to complex interactions among game elements, such as scenario items and characters through conversations and other events. The *Ergon* implementation has been also oriented towards accessible features that included voice recordings for every instruction message or object interaction. An additional advantage is the ability to run and test the games inside the authoring environment avoiding the generation of final products every time a change is introduced into the prototype. This feature allowed the fast debugging of

the game and enabled to track, e.g. the correct increment in the number of collected objects, or to verify the flag values corresponding to certain game states.

The *evaluation* of game prototypes has been mainly based on usability tests of the products developed in the context of the *Dival* collaboration. Previously, a questionnaire was submitted to *DiVal* instructors in order to obtain their point of view about the use of adventure games in their training settings. Questions were focused on issues such as the instructors' confidence in game-based learning, the way they believe serious games could contribute to the learning process in training settings or their point of view estimating the prospective impact in their actual courses. Thirty-two answers were obtained from the instructors using a web polling tool. Dealing with the confidence issue, only 9% of them reported a high or very high level of confidence in serious games, although most of them had high or very high opinion of games in training courses for public administration topics (65%) or in their particular courses (59% of instructors questioned returned high or very high scores). Once, these questionnaire outcomes were analyzed, several tests were performed to check how instructors interacted with *Ergon* and *Respon* games. In the case of the *Ergon* game, a set of instructors with different level of expertise in *Risk Management* topic tried it. These tests were carried out through a Windows™ -based tablet operated by volunteer instructors who used a touch interface to interact with the game components. A tracking tool called *Odoplus*[8] was deployed to gather visual images (*heatmaps*) of instructors' interactions on the main game scenario. *Odoplus* tracks the mouse or touch clicks while an application is running and counts the pixels covered by the player. Fig. 5 shows two images that represent the *heatmaps* obtained from two different user profiles. The image on Fig. 5a displays a novice player interaction with wide dispersion of clicks (represented by small little colour squares) while the one on Fig. 5b focuses the player clicks on ergonomic hot spots (red square shapes) showing an expert use of the game.



a) Novice player b) Expert player

Fig. 5. Analysis of player actions in the *Ergon* game.

An additional test was performed to assess the usability of the *Ergon* prototype by checking the data logs obtained by a set of instructors trying this game. Besides

[8] http://www.fridgesoft.de/odoplus.php

heatmaps obtained by the *Odoplus* tool during the game running, other data were collected such as the time spent by players, the number of visited objects or the success rate in the selection of the ergonomic objects required by the game. Table 2 displays some statistics about these interactions that show for example, a measure of the time spent by users discovering ergonomic factors over a simulated office scenario what computed about three minutes on average. This result revealed a short duration that matched with the idea of "small learning bites" previously presented. Other interesting data were an average number of 2.3 objects whose information was retrieved during this time (most objects were directly taken by players) and a high success rate in the selected objects with an average value higher than 4 in a maximum of six objects assigned with a relevant ergonomic impact. All these outcomes were complemented with informal questions asked to players at the end of the game to obtain their point of view about the game experience.

Table 2. Ergon statistics.

Time spent		*Number of visited objects*		*Success rate*	
Mean	Deviation	Mean	Deviation	Mean	Deviation
03:15,2	1,63	2,3	1,05	4,17	0,98

3 Discussion of the approach

This section comments some issues about the role of serious games in a training context where transferable skills are becoming more and more important and the contribution of the approach proposed in the current work within this context.

First of all, it is worthy to note that such approach is the result of collaboration between a research group in e-learning technologies and a local company specialized in developing educational resources and adapting e-learning platforms for public institutions. Public administration institutions are increasingly concerned about the need for new training strategies, particularly addressed to promote skills and ability-based competencies. This kind of innnovative strategies is well known in higher education, in which there is a wide experience and strong support regarding instructional issues that deal with these competencies. However, in many sectors of the administration training this instructional support is still seldom used and the proposed approach can represent a priceless tool to teach this type of skills and abilities. In this way, an important point remarked in the approach is its capability to support the design of serious games oriented towards achieving transferable skills by modeling situations close to users' experiences. The proposal has been complemented by the use of a game development framework such as *eAdventure* whose products can be quickly adapted to changing learning scenarios required to train this kind of skills.

The second issue concerns the elaboration of serious games in a context in which instructors are often reluctant to use games, mainly due to their high development cost and low effectiveness in some cases. Again, the use of *eAdventure* has contributed to easily produce small game prototypes by the same instructors who are engaged in the

training process to teach transferable skills. Such prototypes have been tested by other instructors in order to detect those weak and strong points before implementing new game versions. In our case, these prototypes were assessed by means of techniques such as heatmaps and data logs that tracked player interactions in a systematic way. These assessment outcomes allowed developers to identify if some game components were poorly displayed (e.g. small elements not touched) or specific actions were misunderstood (e.g. scene transitions never triggered). Regarding the evaluation of effectiveness, informal questions asked to players at the end of each test provided interesting opinions about how to improve not only the game mechanics but also to include or modify scenarios that could contribute to achieve new types of transferable skills. For example, inquiry abilities in the *Ergon* prototype could be also complemented with the development of self-organization skills. Other factors that were highly valuated by testers consisted in the short duration of games and the display of reports that summarized the game achievements. The fact that instructors were adults of around the age of potential players in public administration scenarios supported the adequacy of these small "learning bites" to be integrated in the training program of these types of organizations. Moreover, the availability of final reports at the end of the game displaying the time spent by users or the collected elements enabled a further qualitative interpretation about those achievements.

Finally, the presented approach has been compared to other similar proposals. It was particularly useful the review provided by Westera et al [13] pointing the lack of a "dedicated framework for educational games" already reported by De Freitas and Jarvis [8]. Certain proposals such as the conceptual framework of Yusoff et al [10], methods and tools proposed by Marfisi-Schottman et al [15] or the PIMI framework [14] have provided meaningful advances in the development of serious games. For example, Yusoff et al [10] and Emergo [24] also considered UML artifacts as a mechanism to support the game design process. However, a better fitness between learning theories and game development frameworks is still required and this is one of the contributions considered in the proposed approach. A central point consists in offering an improved matching between training requirements such as learning goals, required instructional activities, or assessment procedures and the specific game actions that can lead to meet such requirements. Table 1 shows a sample of this matching effort that tries to connect some types of learning goals using a well-known educational taxonomy with game actions that could be triggered in a specific training context. Another example is the approach peculiarity to take advantage of game achievements that can be used to measure or estimate to which level training objectives can be accomplished. This premise is especially difficult to achieve when dealing with the acquisition of transferable skills due to their generic nature and it supposes an interesting research challenge.

4 Conclusions

This paper has presented an approach that supports the design and development of small-size games for training courses in a public working context. It combines an ADDIE-based instructional strategy with the use of the *Eadventure* framework for

rapid game development and testing. The approach has been applied in a government organization in the form of several game prototypes, which enabled the acquisition of transferable skills such as exploratory and communication abilities. A questionnaire was completed by the *DiVal* instructors to obtain their opinions of the value of serious games in their training courses. Testing of the game prototypes confirmed the usefulness of *heatmap* and mouse tracking analysis to check patterns of player behavior. Moreover, collected test data provided valuable information about how to interpret the game achievements and their relationships with the acquisition of several examples of transferable skills. In summary, the work with these prototypes has shown the approach contribution dealing with the design and development of serious games addressed to adult users who require specific training in certain areas but also achieving generic abilities and broad competencies. Other issues observed in this research work reveal the need to formalize the analysis of game achievements and their relationship with training goals as well as the call for more effective collaboration among practitioners, instructional designers and game developers. The overall experience has shown that much more research is necessary in this field and it has also highlighted the difficulties involved in determining how games can support the acquisition of transferable skills in this kind of settings. Further research will be necessary into the use of educational standards and the application of agile engineering techniques in the game design process.

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