Towards a Serious Game for Portuguese Learning

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Abstract. Language learning resources are constantly evolving along-side technology. One of such resources is REAP.PT, a system which aims to raise users proficiency in the Portuguese language in an interactive manner. Its current features include text-based exercises. This paper describes the evolution of REAP.PT aiming on locative prepositions used to describe the spatial position between objects. In this new REAP.PT, exercises take place in a 3D environment, and are complemented with gaming aspects to make them more appealing to students. The game scenario is an office, where each room contains different exercises. Completing exercises awards the student with points that unlock harder rooms. This provides the student with a challenge and a sense of progression. We believe that with these gaming aspects, students will have increased motivation to complete exercises.

Keywords: Computer Assisted Language Learning, Serious Games, Pictorial Exercises, Portuguese.

1 Introduction

Nowadays, people have come to expect more from language learning tools. The purpose of the REAP[1] [1] (REAder-specific Practice) project, is to create a tutoring system for second language learning taking advantage of CALL technologies based on Natural Language Processing [2]. The system focuses on vocabulary learning by providing the students real documents featuring target vocabulary words in context.

In order to offer an interactive and individualized experience to the students, these have the possibility to define their topics of interest, which allows the system to present the most suitable documents for a specific student. The documents are extracted from the web, and because of this, students have access to both recent and varied readings.

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[1] http://reap.cs.cmu.edu (last accessed in June 2011).

REAP has been ported into European Portuguese as REAP.PT (REAder-specific Practice PorTuguese) [3], and current development includes an automatic syntactic and semantic exercise generator. While REAP.PT has been constantly evolving since being ported, no step had yet been taken away from text-based exercises. The addition of a 3D environment opens up many possibilities both in terms of the exercises that can be made and in the ways that they can be presented to the student.

The main contribution of the work described in this paper is to provide a 3D environment filled with objects with which the student can interact. In this environment, students perform exercises that focus on the verbs and prepositions used to describe the spatial relations between two objects. Exercises consist in asking the student – represented by an avatar on screen – to perform different actions. These include rearranging the position of objects so that certain spatial conditions are fulfilled, as described by the following example:

<div align="center">"Put object A on top of object B"</div>

In some exercises, instead of requiring the student to perform an action, the game may show an object and ask the student to provide a written description of its location. Another category of exercises requires the movement of the avatar, teaching expressions like "turn left" and "go down the stairs".

Some accessibility utilities are also available to the student. One of them is the possibility of clicking on a certain object to check its definition in a dictionary. Another is the integration with the text to speech (TTS) synthesiser already in use in REAP.PT so that the student is able to hear the instructions, as well as any words s/he selects.

This document is structured as follows: Section 2 gives an overview on the REAP.PT system; Section 3 describes the state of the art regarding Serious Gaming for language learning; in Section 4, the Pictorial REAP.PT module is described in terms of its architecture, categories of exercises and game plan; Section 5 focuses on the description of features that can still be added to Pictorial REAP.PT, as well as the evaluation method to be followed, and a few conclusions.

2   REAP.PT

REAder-specific Practice PorTuguese (REAP.PT) is the result of porting REAP – originally built for English – to Portuguese. The porting effort required the integration of new linguistic tools and resources, as well as the indispensable adaptations for this topologically different language [3]. Interaction with the system is done via a Web browser. When a student logs into the system for the first time, s/he is presented with a series of questions that allow the system to determine her/his proficiency level. Based on this level, the student will be assigned a word list that contains the words s/he is supposed to learn. This is where the individualized learning comes into play, since each student will have her/his own list of words to learn. The list of words is derived from the

Portuguese Academic Word List (P-AWL) [4], a word list inspired in the English AWL and built specifically to be used in the REAP.PT tutoring system.

Another major characteristic of the system is the use of topics of interest. The student can choose from a number of topics, such as music, sport or history, and s/he can also accord them a certain level of interest (ranging from "not interested" to "very interested"). When the system chooses which documents are to be shown to the student, priority is given to certain documents based on the manifestations of interest in those topics. After defining her/his interests, the student can start an individual reading. In the document chosen by the system, target words are highlighted in blue. The student is given a certain amount of time to read the text, during which s/he can use the dictionary or the speech synthesiser to help her/him. Having finished reading the text, the student is presented with questions focused on the target words included in the text. These questions are automatically generated by another module of the system [5]. Current developments of REAP.PT also include automatic generation of syntactic and semantic exercises, and an oral comprehension module.

As described before, the current interface and exercises available to the student are completely text-based. In this paper we propose taking advantage of serious games in order to make both the interface and the exercises more appealing to the student.

3   Serious Gaming for Language Learning

It is known that video games have an intrinsic motivation appeal that makes them a valid tool for learning [6] [7] [8]. Serious Games emerged as digital games and equipment with an agenda of educational design and beyond entertainment. As Kurt Squire said, "e-Learning designers struggle to compel users who have paid thousands of dollars to complete an online course. Yet, game players routinely spend dozens, if not hundreds and thousands of hours mastering complex skills in digital worlds that are time-consuming, challenging, and difficult to master" [9]. Video games also allow players to be placed in rich environments, otherwise inaccessible, giving them increased motivation.

A study involving 100 students showed that the right combination of both interactivity and media-richness results in an increase in knowledge acquisition, sustainability and topic interest [10], making video games a trustworthy environment for learning.

Although Serious Games can have a broad range of purposes and areas of application – such as healthcare, military and education [11] – we will focus on language learning. Recent projects show that most of the time, Serious Games are used to learn specific parts of a language, or to prepare someone for a certain situation, be it a person in a vacation trip or a soldier going to war. The next paragraphs describe some of the Serious Games recently developed for language learning.

Polyglot Cubed[2] is an educational game designed to aid in foreign language learning [12]. Its purpose it not to provide all the resources required to learn a language in full, but instead to teach a few common vocabulary words for a situation where they will be useful. The game encourages a trial and error approach, and because of that does not require any prior knowledge of the language being learned. It is currently available for Mandarin Chinese and Cape Verdean Creole.

Global Conflicts[3] is a series of educational games used for teaching history, citizenship, geography and media courses. While not directly developed to teach a second language, it is an interesting example that can be used for that purpose, even at an advanced level. In one of these games the user plays the role of a freelancing journalist that has to write an article about the Palestinian Conflict, on site, by gaining the confidence of locals — Non-playable Characters (NPC's) — and have them provide him with quotes. A research project in two Danish high schools with 51 students using a playable prototype showed that over half of the students felt they had learned more from the game course than from normal history courses, and one third of the students felt they had learned as much as they usually do from a normal course [13].

Mingoville[4], an online learning environment featuring English lessons for children, has currently more than one million users [14]. Users are represented on screen by a Flamingo (hence the name), and can move freely in a world populated by other user's Flamingos, with whom they can speak to through text. Various games and learning activities are scattered throughout the world; these include exercises in spelling, speaking, reading and writing, sing-along karaoke songs and missions for vocabulary learning, each featuring a theme with a list of words that the user must learn. The game also features an illustrated dictionary with translations for 32 languages.

Tactical Language & Culture Training Systems[5] (TLTS) are courses that use virtual-world simulations to help people acquire communicative skills in foreign languages and cultures. Several titles have already been developed. Tactical Iraqi, Tactical Pashto, and Tactical French are in widespread use by U.S. marines and soldiers, and increasingly by military service members in other countries [15]. Heavy emphasis is given to spoken vocabulary and pronunciation, while grammar and written language is covered only when required. Also with significance in these courses is the cultural education. Users can learn norms of politeness and etiquette, as well as non-verbal gestures that are critical for successful communication. TLTS has two main components that interact with the user [16]. One of them is the Mission Skill Builder (MSB), which provides learning resources in the form of lessons. Another, the Mission Practice Environment (MPE), consists in the 3D simulations of social situations. Both of these components share and use a pool of resources of a common set of services and databases. These include a Language Model, featuring a natural language parser and a speech recognizer.

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[2] `http://www.polyglotgame.com` (last accessed on June 2011).

[3] `http://www.globalconflicts.eu` (last accessed on June 2011).

[4] `http://www.mingoville.com` (last accessed on June 2011).

[5] `http://www.alelo.com/tactical_language.html` (last accessed on June 2011).

In short, the use of Serious Games for language learning has been increasing in recent years, and there are already some successful systems in widespread use. Thus, these systems served as inspiration for some of the aspects of our approach.

4   Our Approach

To create a 3D serious game for Portuguese learning we developed a new exercise module to be integrated in REAP.PT. The creation of this module was not a straightforward process. Decisions were made about which technology to chose to provide a graphical interface, as well as on the types of exercises that would best suit the student's needs. Another major decision point was on whether and how to surround these exercises with a gaming environment, so that all the advantages of the systems discussed in Section 3 could be explored. This section provides an insight on those decisions.

4.1   Game Plan

Much care has to be taken when developing a game in order for it to be successful regarding the user's enjoyment. Even more so when that game is intended for learning purposes. [17] discusses some heuristics that make things fun to learn, in particular when applied to instructional games. Those heuristics, along with the Serious Games review, were used as a base during the creation of this game plan and helped define many of its aspects, such as the importance of goals and of progression in keeping the user engaged; the need for appropriate performance and informative feedback; among others that are discussed in detail throughout this section.

Progression and Point System. The game's main scenario is the office. When starting a new game, only a small room is available to the player (See Figure 1 for an example of one of the available rooms). This location has exercises the student has to complete. For each correctly finished exercise, the student receives points, and when enough points have been gathered, another area of the office is unlocked for exploration, where more exercises are available. This structure of progression was chosen in order to keep the student curious about what is coming next, giving him the motivation to finish the exercises.

Points earned for completing exercises serve two purposes. The first is to unlock new areas. The second is to compare scores with other players. For each room, students are able to check how they graded against the other students, both in terms of points and speed. This second aspect of the point system contributes as a second layer goal. If there was no higher score to achieve, students would have no desire to repeat exercises, yet repetition can play an important role in language learning. It also provides the student with a sense of accomplishment, which, once again, keeps him motivated. Point attribution takes into consideration the exercise base point value, the number of errors made during its execution and the time taken to finish it.

Fig. 1. One of the rooms available

Challenge. Each division has a fixed number of exercises, which become increasingly more difficult as new areas are unlocked, but it is not required that all of them be finished before access is given to a new room. Since points are dependent on the student's efficiency, students that score higher need to complete fewer exercises, and students that score lower must complete almost every exercise. Low scoring students can proceed without completing all the exercises so that frustration does not build up from being unable to finish an exercise, causing her/him to quit. Hints are also available, which can help in a number of ways. One of them is in finding objects whose name the student still has not learned during a certain exercise. It is important to note that some of the hints are already given "for free" depending on the difficulty setting chosen by the student.

One of the essential characteristics of a good game, as discussed by [17], is the existence of a challenge. Winning can not be a certainty. Otherwise, the student would have less reason to give her/his full attention to the exercise. Because of this, it was decided that when an exercise is failed the student loses some of his score and may have to repeat a previous exercise.

Feedback. Feedback plays an important role in any game. [17] identified feedback as being necessary to both keep the player engaged and to instruct her/him. Keeping the player engaged can be accomplished by always providing feedback on how close s/he is to her/his goal. Applied to this game plan, the feedback is

provided at different levels; the first one consists in giving the player information about how many points s/he still has to obtain in order to unlock the next division; the second one, inside exercises, is achieved by showing the student whether s/he is moving towards the exercise goal or away from it. Perhaps s/he picked the incorrect object or took the wrong turn. The student should be informed of this.

Instructing the player is done by giving constructive feedback when the exercise is not finished correctly. Instead of displaying a message such as "You have failed the exercise", it is many times more helpful to display something like "You did [A] and were supposed to do [B]". With the latter approach, students actually learn from their errors, and it was thus adopted when informing the player of her/his results.

4.2 TARGET Platform

This section provides a description of the technologies used in the development of this module. The chosen framework was the Transformative, Adaptive, Responsive and enGaging EnvironmenT (TARGET) Platform [18]. This serves as support for the TARGET Project[6], whose objective is to research, analyse and develop a new genre of Technology Enhanced Learning environment. In this environment, the learner goes through complex situations in the form of game scenarios. By completing these scenarios, knowledge is gradually acquired by the player.

The selection of the technology for the TARGET platform was made iteratively, during which two prototypes were developed in two different engines before going back to the analysis phase and finally choosing the Unity[7] game engine. This engine is one of the few that allows for the deployment of a web-based application – a crucial requirement in any REAP.PT module.

The TARGET platform was chosen based not only on its capabilities, but also on the similarities between the requirements of the work described in this paper and those in the TARGET Project. Also, [18] states that real development is necessary in order to be able to choose an appropriate platform. Since this was the case during TARGET's selection of technology, one can be confident in its capabilities based on the requirements of the project.

4.3 Architecture

Our system follows the TARGET platform's architecture, which is based on managers. It deploys a client-server application, and requires that the code running in both the client and the server side be the same. Because of this, these managers can be instantiated in both a client version and a server version. Our architecture – which can be seen on Figure 2 – makes use of some of the managers available in the TARGET platform, but adds new ones as well. All of them are are detailed below.

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[6] `http://www.reachyourtarget.org/` (last accessed on June 2011).
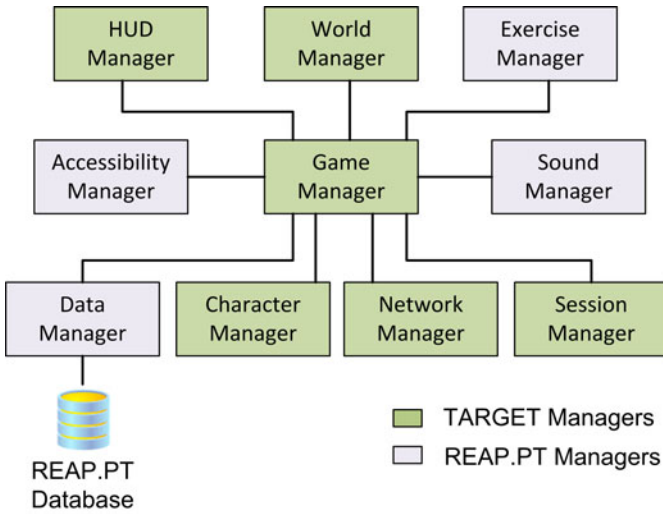[7] `http://unity3d.com` (last accessed on June 2011).

Fig. 2. Pictorial REAP.PT's Architecture

Game Manager is the main manager. It is responsible for loading the remaining managers. It also manages the game state, dealing with the progression aspect of the game and unlocking further exercises and divisions as necessary.

World Manager is responsible for defining the avatar's spawn point and moving it between different scenarios.

HUD Manager is used to provide most of the feedback given to the player, for instance, the number of exercises completed, the number of hints available, the current score and the current level. This manager also includes the menus used to navigate and configure the application.

Network and Session Manager are required to aid the communication between the client and the server application.

Sound Manager. Sound is also important to provide feedback. This is achieved with a Sound Manager, which allows different sounds to be played depending on the situation.

Exercise Manager. This manager contains the exercises in the application and it defines their different difficulty levels, as well as which hints can be used on each of them. The manager is also responsible for keeping track of the exercises completed.

Accessibility Manager provides access to the dictionary and the TTS functionality already in use on REAP.PT.

Data Manager is responsible for interacting with the REAP.PT Databases. It gets information on the student using the application, and stores her/his results. This manager also keeps the progress of the student updated, so that s/he can continue a previously started game.

Character Manager is responsible for keeping the student's score and time for every exercise completed, as well as any other information about the player, including her/his name, age, proficiency level and preferred difficulty level.

4.4   Exercise Description

Each exercise can be presented in two ways: (i) by asking the student to perform some sort of action; (ii) in a "describe the action" alternative, where the action is shown to the student, and s/he is asked to describe that particular action. This description can be provided either by choosing one of various options or by writing it. Apart from the differences between categories, each exercise also features different difficulty levels. Two categories of exercises are already implemented and described below. One more is planned to be developed in the near future.

Object Manipulation

This type of exercise consists in asking the students to change the position of various objects in the scene in order to comply with a specific spatial restriction. As an example, the avatar can be placed in an office and then be asked to put a document folder to the right of a computer monitor (see Figure 3). In order to correctly finish this exercise the student would have to move the document folder to the right of a computer monitor. The exercise is broken down in two steps, so that instructions and feedback can be given for each action.

Initially, the student has to find and click the documents. With this, we are certain that the student has found the right object, and can then fixate the camera in a new position where it will be possible to move the object. After that, the student has to pick and move the object. S/he does this by click and holding on the object and then moving the mouse until the object is placed in the intended position. To drop the object, s/he must stop holding the mouse button. The object will fall and the result will be displayed. If the answer is correct, a message appears giving information on the time taken to complete the exercise, the number of error committed and the number of points awarded. If, however, the answer is incorrect, a message appears informing the student of the position where s/he dropped the object, so that s/he can learn with the mistake.

Avatar Movement

In this category, the avatar is able of walking freely in the environment. The goal of each exercise involves performing movements with the avatar and go from one place to another. Directions appear on screen, such as "turn right", or "go down

Fig. 3. Exercise where the student has to move the documents to the right of the monitor

the stairs to the left", which the student must follow in order to reach her/his destination and complete the exercise. Similar attention to feedback has been given in this category, and the student is informed of errors with constructive messages.

These categories of exercises are presented in a gaming context, where the student is challenged to keep up with the increasing difficulty of the exercises, while, at the same time, s/he is rewarded with points for correctly finishing them. For this reason it is expected that the students will enjoy solving the exercises and become more motivated throughout the whole learning experience.

5   Conclusions and Future Work

The work described in this paper represents an evolution of REAP.PT towards a new direction, introducing exercises that use gaming aspects in order to further capture the student's interest. These are also the first non-text-based exercises, taking place in a 3D virtual environment. However, this is a work-in-progress and more features are being added to the preliminary version described in this paper.

To enrich the game, more categories of exercises are planned. "Object Interaction" is a new category involving interacting with objects. These exercises consist in asking the student to interact with the various objects that compose the scene

independently. For example, the student can be asked to call an elevator in order to go to a certain floor, or to pick up a book from the correct shelf.

Another feature that will be added is a multiplayer component, which gives students a way to share their environment with other students. This would allow for the exercises to be taken in a competitive or cooperative manner, opening a variety of new ways to present the same exercises.

The current application features an office as the main scenario; however, it would be interesting to provide the student with more locations, not only to make it more fun, but also because it would allow for different expressions to be taught. Possible new locations are a mall, a street, a school or a farm.

This application will also be subject to an evaluation. The most appropriate way to do it consists in having real students interacting with the system. While this is a very time and resource-consuming method, it will provide the most accurate measure of quality. Aspects evaluated will include knowledge acquired by the student, knowledge sustainability – an important aspect of language learning –, and the student's opinion on the application itself, such as ease of use, interest and self-reported learning. The evaluation method will make use of two groups of students, having one of them using our system and the other using traditional exercises. A comparison of results will be made afterwards.

We believe that this new approach can offer satisfying results in language learning. Although we can not validate such claim before the evaluation, we expect that it will be ascertained by the user study. In case it is, our architecture will allow easier creation of future modules that feature similar requirements.

References

1. Heilman, M., Eskenazi, M.: Language learning: Challenges for intelligent tutoring systems. In: Aleven, V., Pinkwart, N., Ashley, K., Lynch, C. (eds.) Proceedings of the Workshop of Intelligent Tutoring Systems for Ill-Defined Domains. 8th International Conference on Intelligent Tutoring Systems, pp. 20–28 (2006)
2. Levy, M.: Computer Assisted Language Learning: Context and Conceptualization. Clarendon Press, Oxford (1997)
3. Marujo, L., Lopes, J., Mamede, N.J., Trancoso, I., Pino, J., Eskenazi, M., Baptista, J., Viana, C.: Porting REAP to European Portuguese. In: ISCA International Work- shop on Speech and Language Technology in Education, SLaTE 2009 (September 2009)
4. Baptista, J., Costa, N., Guerra, J., Zampieri, M., Cabral, M., Mamede, N.: P-AWL: Academic word list for portuguese. In: Pardo, T.A.S., Branco, A., Klautau, A., Vieira, R., de Lima, V.L.S. (eds.) PROPOR 2010. LNCS, vol. 6001, pp. 120–123. Springer, Heidelberg (2010)
5. Correia, R.: (m.sc. thesis) automatic question generation for REAP.PT tutoring system IST-UTL (July 2010)
6. Kirriemuir, J., Mcfarlane, A.: Literature review in games and learning. Technical report, NESTA Futurelab (2004)
7. Malone, T., Lepper, M.: Making learning fun: A taxonomy of intrinsic motivations for learning. In: Snow, R., Farr, M. (eds.) Aptitude, Learning, and Instruction. Cognitive and Affective Process Analyses, vol. 3, pp. 223–253. LEA, Hillsdale (1987)

8. Gee, J.: What Video Games Have to Teach Us About Learning and Literacy. St. Martin's Press (March 2008)
9. Squire, K.: Game-based learning: Present and future state of the field (2005)
10. Wong, W.L., Shen, C., Nocera, L., Carriazo, E., Tang, F., Bugga, S., Narayanan, H., Wang, H., Ritterfeld, U.: Serious video game effectiveness. In: Proceedings of the International Conference on Advances in Computer Entertainment Technology, ACE 2007, pp. 49–55. ACM, New York (2007)
11. Michael, D.R., Chen, S.L.: Serious Games: Games That Educate, Train, and Inform. Muska & Lipman/Premier-Trade (2005)
12. Grace, L.D.: Polyglot cubed: the design of a multi-language learning game. In: Proceedings of the International Conference on Advances in Computer Entertainment Technology, ACE 2009, pp. 421–422. ACM, New York (2009)
13. Buch, T., Egenfeldt-Nielsen, S.: The learning effect of Global Conicts: Palestine. In: Conference Proceedings Media@Terra, Athens (2006)
14. Srensen, H.B., Meyer, B.: Serious Games in language learning and teaching - a theoretical perspective. In: Akira, B. (ed.) Situated Play: Proceedings of the 2007 Digital Games Research Association Conference, pp. 559–566. The University of Tokyo, Tokyo (2007)
15. Johnson, W., Valente, A.: Tactical language and culture training systems: Using artificial intelligence to teach foreign languages and cultures. In: IAAI 2008: Proceedings of the 20th National Conference on Innovative Applications of Artificial Intelligence, pp. 1632–1639. AAAI Press, Menlo Park (2008)
16. Johnson, W., Marsella, S., Mote, N., Vilhjalmsson, H., Narayanan, S.S., Choi, S.: Tactical language training system: Supporting the rapid acquisition of foreign language and cultural skills. In: Proceedings of the InSTIL/ICALL Symposium, Venice, Italy (July 2004)
17. Malone, T.: What makes things fun to learn? Heuristics for designing instructional computer games. In: Proceedings of the 3rd ACM SIGSMALL Symposium and the first SIGPC Symposium on Small Systems, SIGSMALL 1980, pp. 162–169. ACM, New York (1980)
18. Ribeiro, C., Jepp, P., Pereira, J., Fradinho, M.: Lessons learnt in building serious games and virtual worlds for competence development. In: Taisch, M., Cassina, J., Smeds, R. (eds.) Experimental Learning on Sustainable Management, Economics and Industrial Engineering, pp. 52–62 (2010)