# REAP.PT
# Serious Games for Learning Portuguese

André Silva[1,2], Cristiano Marques[1,2],
Jorge Baptista[2,3], Alfredo Ferreira Jr.[1,2], and Nuno Mamede[1,2]

[1] Instituto Superior Técnico, Universidade Técnica de Lisboa, Lisboa, Portugal
[2] Spoken Language Lab., INESC-ID Lisboa, Lisboa, Portugal
`andre.silva@l2f.inesc-id.pt`, `cristiano.jlm@gmail.com`,
`alfredo.ferreira@ist.utl.pt`, `Nuno.Mamede@inesc-id.pt`
[3] Universidade do Algarve, Faro, Portugal
`jbaptis@ualg.pt`

**Abstract.** Language learning resources are constantly evolving alongside technology. Computer-Aided Language Learning (CALL) is an area of research that focuses on developing tools to improve the process of learning a language. REAP.PT is a system that aims to teach Portuguese in an appealing way, addressing issues that the user is interested in. Initially conceived for vocabulary learning, this paper presents new trends in the REAP.PT development. For text-based exercises, it focus on automatic generation of syntactic and vocabulary questions. These exercises are set in a gaming context, to better motivate students. The paper also introduces a new evolution of REAP.PT, a 3D gaming environment for the learning of expressions denoting spacial relations between objects and object manipulation. These gaming aspects increase students motivation and help promote language learning.

**Keywords:** Computer Assisted Language Learning, Serious Games, Pictorial Exercises, Vocabulary Acquisition, Syntactic-Semantic Exercises, Automatic Exercise Generation, Portuguese.

## 1 Introduction

With the advancement of technologies for information systems, the use of Computer Aided Language Learning (CALL) has emerged as a tempting alternative to traditional modes of supplementing or replacing direct student-teacher interaction, such as the language laboratory or audio-tape-based self-study. Currently, CALL can be seen as an approach to language teaching and learning in which computer technology is used as an aid to the presentation, reinforcement and assessment of material to be learned, usually including a substantial interactive element. It also includes the search and the investigation of applications in language teaching and learning [1]. Gamper and Knapp (2002) define CALL as "a research field which explores the use of computational methods and techniques as well as new media for language learning and teaching" [2].

Nowadays, people have come to expect more from language learning tools. It is known that video games have an intrinsic motivation appeal that makes them a valid tool for learning [3][4][5]. 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" [6]. 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 [7], 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 [8] – 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. For example, *Mingoville*[1] is an online learning environment featuring English lessons for children, and has currently more than one million users [9]; *Polyglot Cubed*[2] is an educational game designed to aid in foreign language learning, currently available for Mandarin Chinese and Cape Verdean Creole [10]; *Global Conflicts*[3] is a series of role-playing, educational games used for teaching history, citizenship, geography and media courses; finally, Tactical Language & Culture Training Systems[4] (TLTS) are courses that use virtual-world simulations to help people acquire communicative skills in foreign languages and cultures; these courses are in widespread use by U.S. marines and soldiers, and increasingly by military service members in other countries [11].

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. The scarcity of (good quality) resources for Portuguese is a strong motivation for research in this area. Thus, these systems served as inspiration for some of the aspects of our approach.

## 2   REAP.PT

REAP[5] [12] (REAder-specific Practice) project, is a tutoring system for second language learning taking advantage of CALL technologies and based on Natural Language Processing. The system focuses on vocabulary learning by providing the students real documents featuring target vocabulary words [13] in context.

---

[1] `http://www.mingoville.com` (last access: June 2011).
[2] `http://www.polyglotgame.com` (last access: June 2011).
[3] `http://www.globalconflicts.eu` (last access: June 2011).
[4] `http://www.alelo.com/tactical_language.html` (last access: June 2011).
[5] `http://reap.cs.cmu.edu` (last accessed in June 2011).

The REAP.PT[6] results from porting the REAP system, originally built for English, to Portuguese [14][15]. It presents to the students rich and authentic study material (texts, exercises, etc.) that is deemed interesting by the students and adequate to their learning needs and current skills, thus being able to advance their learning process. 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.

This paper introduces two new trends in the REAP.PT development. The first is a set of exercises, presented in a gaming context, and focusing on aspects of syntax that are especially problematic for students of Portuguese as a Second Language (PSL). Because the exercises are generated automatically, careful design of the generation process is necessary in order to assure the linguistic adequacy and the relevance of the question. Above all, the exercises automatically generated by the system should not present ambiguous solutions. The second trend is the introduction of a 3D gaming environment for the learning of expressions denoting spacial relations between objects and object manipulation. Even if REAP.PT has been constantly evolving since inception, 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 paper is structured as follows: Section 3 present the four written-based games: the *Lexical Mahjong* (3.1), *The Right Mood* (3.2), *Nominal Determinants* and *Collective Nouns* (3.3). Section 4 presents *The Office*, the 3D game developed for REAP.PT. Section 5 describes the evaluation and presents the results. Finally, section 6 concludes the paper pointing new directions for future research.

## 3   Written-Based Games

### 3.1   *Lexical Mahjong*: Word-Definition Association

In these exercises the student has to make a correspondence between the lemma and the definition of a word. Words and their definitions are taken from the Infopédia[7]. Then, a set of filters performs the following selection procedures: (i) using the Levenshtein distance algorithm as an approximation to the linguistic concept of cognate words (e.g. *escrito/escrever*), definitions containing cognates of the target word are discarded, since they are an obvious cue to the student; (ii) only definitions of more than one word (to avoid similarities with synonyms' exercises) and less than 150 words (to avoid very long definitions) are considered; (iii) characters that hinder the understanding of a given definition are removed (e.g. numbering of definitions, semicolon, cardinal, etc.); (iv) the learning level

---

of the words in the definition must be equal or less than the level of the exercise and that of the target word it corresponds to.

As REAP.PT is student-oriented, the word-definition pairs are chosen according to the student profile. A set of classifiers is applied to the definitions in order to determine the appropriate level of the exercise. Three levels were considered: beginners, intermediate and advanced. The level of a given word is determined by a classifier trained on a corpus of secondary school textbooks and national exams, structured by grade, from the 5th to the 12th [15]. All these pre-processing steps are performed once for each word, and the results are stored in the REAP.PT database.

Additionally, a scoring mechanism was added. From an initial set of points, more points are awarded or taken depending on correct/wrong answer, the time elapsed, or the student's hesitations. The evaluation module, apart from the scoring' system, checks if the student hits/misses a given word-definition correspondence and if the student has finished the exercise. The implementation of this scoring' system tries to accomplish several objectives: to provide the student some feedback on his/her performance; to keep the student motivated in the exercise; to prevent the student from solving the exercise by repeating his/her tries; and to provide a "summary" of the student's performance to the teacher. The result of this evaluation is stored in the REAP.PT database and it will be used later to analyze the student's learning progress.

### 3.2   *The Right Mood*: Choice of Mood in Subordinate Clauses

Learning the vocabulary of subordinating conjunctions and conjunctive phrases implies the acquisition of syntactic restrictions imposed to the mood of the subordinate clause they introduce. This game consists of cloze questions allowing students to practice reading comprehension while enhancing their syntactic knowledge of the language. Thus, for example, *até* (until) impose the infinitive or the subjunctive mood (1), but does not accept the indicative mood (2):

(1) *O Pedro fez isso até o João chegar / até que o João chegasse*
(Peter did that until John arrive_**inf/subj**)
(2) *\*O Pedro fez isso até que o João chega / chegava / chegou / chegará*

For the automatic generation of the exercise, the CETEMPúblico Corpus [16] is used, after being processed by the STRING processing chain [17]. A large set of conjunctions and conjunctive phrases have been listed in the system's lexicon. A set of general chunking rules creates a `SC` (subclause) chunk that links these conjunctions to the first verb of the subordinate clause, e.g.

*O Pedro fez isso* `SC[até o João chegar]`
*O Pedro fez isso* `SC[até que o João chegasse]`
(Peter did that until John arrive_**inf**/until that John arrive_**subj**)

To run the filters that generate the potential stems for this exercise, the distributed computing platform Hadoop is used to process this large corpus. To generate the distractors (wrong answers, e.g. indicative/subjunctive/infinitive mood alternation), a verb generator was used with a set or filtering rules to avoid ambiguity, i.e. verb homographs.

### 3.3    Nominal Determinants

Two more new games were built with the purpose of help learning the subtle distributional constraints observed between a determinative noun and the noun it determines. This syntactic-semantic relations may also serve to teach the classifying relationship between collective nouns and common nouns, since collectives often function as determinants on the common nouns they classify. Thus, while based on similar syntactic-semantic relations, two distinct exercises could be produced. For example:

**Exercise:** *O Pedro bebeu um … de vinho* (Peter drank a ... of wine)
**Possible answers:** *copo* (glass), *saco* (bag), *cesto* (basket), *molho* (bunch)
**Exercise:** *O Pedro encontrou uma … de ovelhas* (Peter found a ... of sheep)
**Possible answers:** *rebanho* (herd (sheep)), *cardume* (school (fish)), *exame* (swarm (bees)), *bando* (flock (birds))

These exercises are generated from real sentences, taken from the corpus. In these sentences, a quantifying dependency (QUANTD) has been extracted by the syntactic parser [17]. This dependency holds between a nominal determinant functioning as the head of a nominal or prepositional phrase (NP or PP) and the head of the immediately subsequent PP introduced by preposition *de* (of). The same relation holds for collective nouns. In the exercises above, this dependency links *copo* (glass) with *vinho* (wine) and *rebanho* (herd) with *ovelhas* (sheep), respectively. Again, the distributed computing platform HADOOP is used to retrieve from the large-sized corpus the sentences that can be potential stems for this exercise.

A new layer of lexical information was added to the lexicon in order to generate adequate distractors for the exercises. To do that, a list of determinative and collective nouns was added and a set of semantic features was defined and accorded to these words. These semantic features are based on categories such as: *Human*, *Animal*, *Food*, *Organization/Institution*, *Object*, *Nature*, *Military* and *Local*. By using these features, potential distractors that share the same traits as the target word are never select, thus avoiding to generate unwanted correct solutions as foils. Another set of constraints prevents general-purpose nominal determinants, such as *conjunto* (set) or *grupo* (group), from being selected as foils. An additional set of constraints was also added to prevent the generation of distractors that, in a figurative use, would make for possible solutions. For example, while normally nominal determinants associated to the *Animal* feature (e.g. *alcateia*, "pack", speaking of wolves) are not used for human nouns,

**Fig. 1.** *The Office* 3D game: One of the rooms available

this combination might, however, be used in a ironic turn (v.g. *Uma alcateia de políticos* "a pack of politicians"). To make the exercise more interesting and adequate, the distractors' generation keeps the same number and gender of the target word.

For these last two games, a feedback mechanism has been put in place: when a wrong word is chosen, the systems presents a real sentence taken from the corpus and showing an appropriate use of that wrong word. If available, the system also shows an image of the wrong word. In this way, positive feedback is provided.

## 4    *The Office*: Learning Spatial Relations in a 3D Game

This game also takes advantage of a Serious Games approach to language learning in order to make both the interface and the exercises more appealing to the student. It provides a 3D environment filled with objects that the student can interact with. In this environment, students perform exercises that focus on the verbs and prepositions used to describe the spatial relations between objects. Exercises consist in asking the student – represented by an avatar on screen – to perform different actions in an office scenario (Fig. 1). These actions include rearranging the position of objects so that certain spatial conditions are fulfilled, e.g. *Coloque o objecto A **em cima de** o objecto B* (Put the object A **on top of** the object B). The office scenario allows for the student's avatar to move around different rooms, unlocked by successful completion of a set of challenges put to him/her, and thus getting points.

The list of action verbs denoting the avatar movements and object manipulation, as well as the locative prepositions denoting spatial relations has been taken from lexical resources specifically built for and integrated in the STRING NLP chain[17]. This list has been validated by teachers of the Portuguese as Second Language (PSL) from University of Algarve, who also provided information regarding the appropriate level of each item.

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 synthesizer already in use in REAP.PT, so that the student is able to hear the instructions, as well as any words he/she selects. In fact, although of a very diverse nature, the game is fully integrated as any other module of REAP.PT, namely, the system databases are used to retrieve information on the student using the application and also for storing her/his results and progress. Using the same databases allows the teachers to check their students' progress.

The Transformative, Adaptive, Responsive and enGaging EnvironmenT (TARGET) Platform[8] was the framework chosen to implement the game [18].

Much care has been taken in the a game plan developing in order for it to be successful regarding the user's enjoyment. Even more so when that game is intended for learning purposes. [19] 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, positive feedback.

## 5   Evaluation

### 5.1   Evaluation of Written-Base Games

To assess the performance of the REAP.PT, two groups of students tested it and comment on its use. This evaluation consisted in a session involving: filling-in an initial form (tracing the students' profile); solving the exercises; and answering a final questionnaire, aimed at a qualitative assessment of the system. For each game, three exercises were given, one for each level: beginners, intermediate and advanced.

The exercises generated by the REAP.PT for the games presented in this paper already require some knowledge of Portuguese as they call upon more advanced language contents. If they are non-native Portuguese speakers, they should already have an elementary knowledge of the language. Due to the impossibility of gathering in time a group of subjects with these features, the tests were conducted with a group with relatively similar characteristics - Portuguese native speakers in the 3rd and 4th grade (Group 1). The choice of Group 1 can be justified by their knowledge of Portuguese as mother language but their

---

[8] http://www.reachyourtarget.org/ (last access: June 2011).

still limited vocabulary - this being one of the REAP.PT main learning targets. In order be able to contrast the performance of this group , the same test was also performed by another group of native speakers, with at least a College degree (Group 2). Thus, 45 subjects performed this exercise, 18 in Group 1 and 31 in Group 2. Naturally, while the age of the subjects from Group 1 is quite homogeneous, age range of Group 2 varied from 19 to 70, the average age being 24.

The testing environment was also different for each group. Children from Group 1 did the exercises one at time in the classroom computer, and a team member of REAP.PT project helped them to access the starting page and occasionally had to explain the exercises or some unknown word since some children had not yet fully mastered their reading skills. Each child took about 26 minutes to complete the exercises and the questionnaire. Users from Group 2 did the test at their homes, without any aid from the REAP.PT team.

Based on the questionnaire, more than 77% of the users found the system easy to use, while only 39% needed to use the "Help" button. In this way, we can say that one of the goals of this project was achieved, namely, to create a system with a simple and easy to use interface, so that all users (even some inexperienced users) were able to use the REAP.PT. The pre-processing of the exercises is made in advance and stored in the system database. Thus, the generation stage, which is the most time-consuming step of the processing, is already done when the user access the system. This is why the system is so quick when responding to requests from users as it is reflected in their answers.

Users from both groups reported that the exercise they liked the most (44%) was the *Lexical Mahjong*, followed by the *Collective Nouns* (27%), and *Nominal Determinants* (17%), and, finally, by *The Right Mood* (12%). However, it is remarkable that the 2 Groups had clearly different impressions about these last three exercises. While Group 1 liked *Collective Nouns* as 2nd best (40%), Group 2 shows similar preference for each of these three (16%, 19% and 21%). This may have to do with the fact that collective nouns are an explicit grammatical subject at "Escola Primária" (Elementary School) thus contributing to a higher familiarity with the topic and the exercise, which entailed this preference trend. In the *Lexical Mahjong* exercises, Group 2 obtained better results with a performance of 84% (standard deviation = 6,6%), while the users from Group 1 made more errors and obtained a performance of 54% (standard deviation = 12,4%). Another interesting aspect to note is the error rate progression for each exercise. In both groups, as the difficulty level of exercises increases, so the students do more mistakes, which confirms the adequacy of the strategy here followed and its implementation, namely to distinguish the level of different definitions inside the dictionary entry of each target word. The results of the *Collective Nouns* and *Nominal Determinants* exercises were very similar. In Group 1, on average, students missed one in every three submitted exercises while Group 3 misses less, which is naturally understandable given the age difference and educational level of the subjects from each group. This information confirms the students self-assessment regarding the difficulty of the exercises.

In the overall assessment of the system, 50% of the subjects classify it as "very good", 17% as "good", 9% as "acceptable" and the remaining 18% classified it as "bad" or "very bad". In this way a global positive appreciation was achieved (67% good or very good). Group 2 is more critical about the system: only 41% found it very good against 55% from Group 1. The most critical opinion relates to the high repetition of the infinitive in *The Right Mood* exercises. This is due to the fact that most of the stems found in the CETEMPúblico corpus show the verb in the infinitive. Because of this skewed distribution of mood, a high proportion of stems has also the target verb form in the infinitive. This can lead the users to sense that this exercise is the easiest, due to repetition, but also the less interesting one. Finally, we verified that Group 1 takes on average 5 minutes more than the Group 2 to finish the exercises, the *Lexical Mahjong* being the game that takes the longest time to complete.

## 5.2   Evaluation of *The Office* 3D Game

In a preliminary evaluation of *The Office* 3D game, a total of 14 students from the Portuguese as Second Language (PSL) course of University of Algarve have played with the application. 32 exercises were scattered throughout five different rooms. When starting the game, the students were encouraged to complete a brief tutorial that explained the various mechanics of the game, including how to control the avatar, start exercises and interact with objects. When this tutorial was finished or skipped, the first level was unlocked and the students were on their own. When the student finished playing, a questionnaire was presented focusing on the interaction with the application and its interface; and on the student's learning experience. From the group of players, 8 students, 3 female and 5 male, also answered this questionnaire. Students' age varied from 23 to 29, average age being 27. Contact with Portuguese averages at 6 months. Students native languages included Spanish (the larger group), Russian, Romanian, Bengali, Nepali, Catalan, and Ukrainian.

62,5% of the students considered the tutorial helpful, and only 12,5% did not find it helpful. Some students did not notice the option to change the interface to English, and this may have impacted negatively in their opinion on the tutorial, seeing as it was text-heavy. Moving the objects was easy for most students, only 12,5% found it difficult. Controlling the avatar was less positively assessed, as 25% did not find it easy. The two results are related as those who found it very easy to move objects also had less trouble controlling the avatar and vice-versa. Future work should focus on polishing these controls in order to improve the results. Most students did not think that learning how to play the game interfered with their learning experience. When asked this question, only 10% said it had interfered at all.

The questionnaire also asked for the students' perception of how much they had learned, the difficulty level of the exercises and their general satisfaction with the knowledge provided by the game. 25% answered that they thought they had learned more with the game than with a traditional class, while everyone else thought they had learned the same. No one thought they had learned less with

the game, which is good. Also, every student considered the difficulty to be at their own level, neither being too high nor too low and 62.5% answered they had noticed an increase in the difficulty level of the exercises as they progressed. This means that the progression system may still need some tuning, even if it is already sufficiently well implemented to become noticeable. In general, students were satisfied (50%) or very satisfied (25%) with the game. In their general comments, students seem to prefer knowing exactly where to go and what exercise to do next, thus showing an attitude different from the games' expectations, where an inquisitive attitude towards exploration of the scenario had been envisioned. Some students wished to exit the office setting and explore different scenarios. This is certainly something to be done as future work.

Using the interaction logs, it was possible to compare, for every exercise, its expected time for completion with the average time taken in the evaluation, and the maximum points obtainable with the average points awarded. For lack of space, only the conclusions are presented here. Three levels of difficulty were defined, and for each one an expected time for completion was set to 60 seconds (easy), 90 seconds (intermediate) and 120 seconds (difficult), respectively. In average, students concluded the exercises in 40% of the expected time, but standard deviation is high (35%). The forfeit rate of the exercises is very close to zero. There was only a single case in which a student tried the same exercise 3 times unsuccessfully and then decided to move to another exercise without returning. Every other failure resulted in the student trying again – either right away of after solving other exercises in between – and then finishing correctly. This may be interpreted as a result of the successful development of the game plan and, in particular, of constructive/positive feedback the system provided for wrong answers.

This first evaluation shows that this learning resource has the potential to be well received by PSL students and may contribute to improve learning these particular expressions of spatial relations an place actions in a motivating and appealing way.

## 6    Conclusion and Future Work

CALL resources, based on NLP technology, can contribute to the development of a new learning paradigm, where the student has a more active role, and the motivation for learning can be enhanced by presenting learning materials and game-like exercises more appealing and adequate to the student profile, language skills and topics of interest.

This paper presented REAP.PT, a system that aims to teach Portuguese in an appealing way, addressing issues that the user is interested in. While initially conceived for vocabulary learning by Portuguese as Second Language (PSL) students, this paper presented new trends in the REAP.PT current development, now focusing on automatic generation of text-based exercises for syntactic properties and vocabulary, also relevant to native speakers. These exercises were set in a gaming context, to better motivate students. A series of NLP techniques

were used to automatically generate the stems and distractors from real texts, producing sets of exercises adequate to the student model (his language skills and level of proficiency), and with gradually increasing difficulty. The paper also introduced a new evolution of REAP.PT, a 3D gaming environment for the learning of expressions denoting spacial relations between objects and object manipulation. This is one of the topics covered by PSL courses where the 3D gaming environment can be most helpful in providing a motivating CALL setting.

These REAP.PT games were evaluated with real PSL students (and some with native children) and results showed a (very) positive feedback, while demonstrating the adequacy of the CALL approach. Particularly relevant is also the fact that all NLP tools, resources and scripts can now be reused to create new scenarios, and to pursue other venues in other Portuguese learning topics and in brand new gaming settings. For new text-based exercises, already being developed, REAP.PT will include topics such as clitic pronoun placement, active-passive and direct/indirect speech sentence transformation, idiomatic and formulaic expressions – topics particularly relevant to, but not exclusive of, PSL courses. For 3D games, extension to new scenarios (exploring the City, the School, the Mall, the Amusement Park) will allow the learning of specific vocabulary, and will include a more active role from the user, by having him/her producing small sentences and interacting with other gaming partners (real people or artificial agents). In the near future, attention shall be given to improve some features of REAP.PT: the interface needs improving in the design and conviviality, making more appealing and adequate to the users' age. The gradual difficulty of exercises makes REAP.PT particularly apt to be used in assessment of language skills, once extensive testing has been done. Field tries are already in place at University of Algarve to prepare these new developments in the near future. The web interface, tested on all major browsers, makes REAP.PT freely accessible all around the world to any registered user.

# References

1. Hacken, P.T.: Computer-assisted language learning and the revolution in Computational Linguistics. Journal Linguistik online 17, 23–39 (2003)
2. Gamper, J., Knapp, J.: A review of intelligent CALL systems. Computer Assisted Language Learning 15, 329–342 (2002)
3. Kirriemuir, J., Mcfarlane, A.: Literature review in games and learning. Technical report, NESTA Futurelab (2004)
4. 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, LEA, Hillsdale, vol. 3, pp. 223–253 (1987)

5. Gee, J.: What Video Games Have to Teach Us About Learning and Literacy. St. Martin's Press (2008)
6. Squire, K.: Game-based learning: Present and future state of the field (2005)
7. 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)
8. Michael, D.R., Chen, S.L.: Serious Games: Games That Educate, Train, and Inform. Muska & Lipman/Premier-Trade (2005)
9. Srensen, H.B., Meyer, B.: Serious Games in language learning and teaching - a theoretical perspective. In: Akira, B. (ed.) Situated Play: Proceedings of the Digital Games Research Association Conference, Tokyo University, pp. 559–566 (2007)
10. 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 (2009)
11. Johnson, W., Valente, A.: Tactical language and culture training systems: Using artificial intelligence to teach foreign languages and cultures. In: Proceedings of the 20th National Conference on Innovative Applications of Artificial Intelligence, pp. 1632–1639. AAAI Press (2008)
12. 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)
13. Levy, M.: Computer Assisted Language Learning: Context and Conceptualization. Clarendon Press (1997)
14. Marujo, L., Lopes, J., Mamede, N.J., Trancoso, I., Pino, J., Eskenazi, M., Baptista, J., Viana, C.: Porting REAP to European Portuguese. ISCA International Workshop on Speech and Language Technology in Education, SLaTE 2009 (2009)
15. Correia, R.: MSc Thesis, Automatic Question Generation for REAP.PT Tutoring System, Instituto Superior Técnico - Universidade Técnica de Lisboa (2010)
16. Santos, D., Rocha, P.: Evaluating CETEMPúblico, a free resource for Portuguese. In: Proceedings of the 39th Annual Meeting on Association for Computational Linguistics, pp. 450–457 (2001)
17. Mamede, N.: STRING - A Cadeia de Processamento de Lngua Natural do L2F. Technical Report, L2F/INESC-ID, Lisboa (2011)
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)
19. 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 (1980)