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## International Journal of Human Capital and Information Technology Professionals

Volume 7 • Issue 2 • April-June-2016 • ISSN: 1947-3478 • eISSN: 1947-3486
*An official publication of the Information Resources Management Association*

### Research Articles





The *International Journal of Human Capital and Information Technology Professionals* is indexed or listed in the following: ACM Digital Library; Bacon's Media Directory; Cabell's Directories; DBLP; Google Scholar; INSPEC; JournalTOCs; MediaFinder; SCOPUS; The Standard Periodical Directory; Ulrich's Periodicals Directory

International Journal of Human Capital and Information Technology Professionals
Volume 7 • Issue 2 • April-June 2016

# Assessing Foreign Language Learning Through Mobile Game-Based Learning Environments

Manuel Palomo-Duarte, Escuela Superior de Ingeniería, University of Cadiz, Spain
Anke Berns, Facultad de Filosofía y Letras, University of Cadiz, Spain
Alberto Cejas, Escuela Superior de Ingeniería, University of Cadiz, Spain
Juan Manuel Dodero, Escuela Superior de Ingeniería, University of Cadiz, Spain
Juan Antonio Caballero, Facultad de Ciencias de la Educación, University of Cadiz, Spain
Iván Ruiz-Rube, Escuela Superior de Ingeniería, University of Cadiz, Spain

## ABSTRACT

With increasing globalization, foreign language skills have become one of the main requirements when applying for a job in leading ICT companies. Due to their ubiquity and multi-functionality, mobile devices allow teachers to provide technology-friendly students with highly dynamic learning contents in line with their lifestyle. Unfortunately, most of the available APPs still support a mainly one-way interaction (teacher to learner or computer-client interaction). The authors have designed an APP based on a highly interactive, ubiquitous and constructive learning approach. The current paper illustrates firstly how the APP has helped learners to get actively involved in their own learning process sharing and assessing their foreign language knowledge. And secondly, how students' logs can be used to automate the assessment of different skills such as the ability to explain terms in a foreign language or to assess definitions created by other game players.

## KEYWORDS

APPs, Foreign Languages, Gamification, MALL, Peer-Assessment

## INTRODUCTION

With the increasing globalisation foreign language skills have become one of the main job requirements when applying for leading ICT companies (EGFSN, 2013). Most ICT professionals are used to reading technical documentation in English having good reading skills. But the needs of ICT companies go beyond, requiring also good communication skills in order to effectively

DOI: 10.4018/IJHCITP.2016040104

communicate and work on a global level (ICT Ireland, & ISA, 2011). With this increasing rise of the Information and Communication Technologies (ICTs) in people's daily lives many educational institutions have started integrating ICTs in their course syllabus. This is illustrated, amongst others by the growing use of different kinds of Learning Management Systems (LMSs) (Del Blanco et al., 2011) providing teachers and learners with new opportunities as well as challenges. Whilst teachers get the opportunity to more easily manage and administer course contents and learning resources, these become much more accessible for students, since they are no longer restricted to factors such as time and place. Additionally LMSs offer their users the opportunity to create highly interactive learning environments allowing both teachers and learners to interact and communicate amongst each other beyond the classroom.

Other types of learning platforms that are becoming increasingly popular are the so called Personal Learning Environments (PLEs) (García-Peñalvo et al., 2014). PLEs allow students to manage and control their own learning processes. Since many students access these environments by using their mobile devices, they are often called mobile Personal Learning Environments (mPLEs) (Conde González & García-Peñalvo, 2014). This and other examples highlight that mobile devices can be used not only as tools for browsing the Internet, but also for educational purposes.

In line with the growing trend and interest in exploring mobile devices for educational purposes in general and foreign language learning in particular, in the present study we have designed a gamified APP, called *GuessIt!*. *GuessIt!* is a highly interactive APP which aims to enhance students' motivation towards independent foreign language learning through a game-based learning environment. Since gamification has been identified as a highly potential tool to engage students' motivation as well as learning outcomes (Bytheway, 2011; Connolly et al., 2001; Hamari et al., 2014), the use of games has attracted the interest of many practitioners in the area of education (Burston, 2013; Vassilev, 2015; Minovic et al., 2012).

The impetus in exploring the possibility of integrating gamified APPs in our course syllabus (Chinnery, 2006; Sharples et al., 2005; Steel & Levy, 2013; Berns & Palomo-Duarte, 2015) was the fact that nowadays devices such as smart-phones are amongst our learners' most frequently used gadgets (Agudo et al., 2011).

The purpose of this ongoing study is to provide students with learning tools that are able to support them in their learning process, especially outside the classroom. The target group of the current study were students from a German language course (6 ECTS) at a Spanish university. The course was based on 48 hours of face-to-face teaching combined with 104 hours of independent learning per semester. Independent learning is seen as part of blended teaching practices and expected to be done, by each student, individually and beyond the classroom. Furthermore, since most of our language courses have a large number of participants it becomes even more necessary to provide them not only with additional learning resources, to foster and widen their language knowledge, but also with personalised feedback on their learning performance (Garrison & Kanuka, 2004; Berns et al., 2013a; Berns et al., 2013b).

The following paper is set out as so: Section 2 sets out the context of our project within related works. Section 3 outlines the teaching background for our experience. Section 4 describes the learning design we implemented, followed by section 5 that lays out the experiment settings and discusses the results obtained. Finally, in section 6 we will provide conclusions and an outline of our future work.

## RELATED WORKS

Mobile learning (m-learning) has created a new learning paradigm in educational settings as an extension of distance and blended education. Amongst the most commonly used devices are smart-phones, tablets and PDAs (Chao & Chen, 2009; Trinder, 2005). Mobile learning offers new learning tools that can be adapted to this approach. The Information Gathering and Lesson Tool (IGLOO) is one example of the many tools and applications that have been developed. IGLOO is a mobile

learning system that supports educators and students during the teaching and learning process with pedagogical practices. This is done both through formal as well as informal learning scenarios (Colomo-Palacios et al., 2014; García-Peñalvo et al., 2012; Samuel et al., 2009). Another example for mobile learning is the system created by the e-Learning Laboratory of the Shanghai Jiao Tong University (Qi et al., 2006). This system supports bidirectional and real time communication between instructors and students (it can transmit live broadcasts of real-time classroom teaching). Students can directly interact with their instructor, asking them questions or even making suggestions and receive quick feedback. Additionally mobile learning frameworks such as the designed for Madeira et al. (Girão et al., 2010) have also been proposed, covering the main topics of an analog electronics course (semiconductors theory, diodes, transistors, etc.).

Besides these generic applications and tools, others such as mobile learning games have been developed for a broad variety of learning contexts. All aim at increasing and improving the learning process of m-learning. Game-Based Learning (GBL) uses the motivational potential of computer games to engage students in learning (Prensky, 2005). Moreover it provides users with fun and highly interactive virtual environments, which often promote experimental learning through risk-safe problem-based tasks. Another interesting aspect of using computer games for educational purposes is the growing variety of game plays; from casual, direct subject up to co-operative games (Cornillie et al., 2012). Due to their variety of content, design and player modes teachers are able to deploy video-games according to their students' interests and specific learning needs.

In this work (Lilly & Warnes, 2009), three game templates of mobile Game-Based Learning (mGBL) are developed for educational purposes in the fields of e-commerce, e-health and e-career. Whilst Game Template 1 contains two modules, a quiz module and a simulation module, Game Template 2 uses an adventure game which aims to improve the player's avatar characteristics in an e-career context. Finally, Game Template 3 can be used to model games reflecting real world problem solving. Generally game templates include activities such as text messaging to communicate with other players, quizzes and simulations, as well as different kinds of media collection and sharing.

Aside from the above mentioned, other studies analyse mobile games focusing on the development of more specific skills. In (Sánchez & Olivares, 2011) three mobile games were developed and played by teams of four students in order to collaboratively solve problems. The first mobile game (*Evolution)*, used sophisticated 3D graphics, where the design of some elements such as time, actions, logic and resources were aligned with the real-time strategy commercial games. This type of game is a potential tool for developing problem solving skills. The second and third game (*BuinZoo* and *Museum*) were trivia-based designed for young learners to guide them through a visit to a zoo as well as museum, respectively. Both games allow players to widen their knowledge on curriculum related subjects such as the "Evolution of species".

There are other related works using gamified APPs (Berns & Palomo-Duarte, 2015). One of these APPs is *VocabTRAINER A1* and the other is *Catch me, if you can!* The first one is composed of 9 mini-games that can be played offline, whereas the second one is a collaborative online game. The game consists of a gymkhana during which players have to collaborate in order to identify and catch a serial killer before he commits his next crime. Whilst the 9 mini-games provide students with new language input and have to be performed by each player individually, the collaborative game offers students the opportunity to apply the previously-acquired language knowledge to real-world communication tasks.

Educational games are particularly powerful learning tools when used in adaptive learning scenarios as they allow adaptive content and fully personalised itineraries. In (Burgos et al., 2007) an authoring tool for creating and playing point-and-click adventure games called <e-Adventure> is applied. It provides an approach for including adaptive Units of Learning (UoL) in the developed games using flags as game states. In case that the state of flags is modified, the game can exhibit a completely different behaviour and propose other UoLs. For example, it can be adapted according to the player's performance using adaptation assessment rules (Moreno-Ger et al., 2008). So if a

Non-Player Character (NPC) asks a question and the player chooses the right question, a new stage with new learning objects could be shown. However, in case a player choosing a wrong answer the player might feel motivated to re-play the level to overcome the learning object and to reinforce the required knowledge.

Learning through games has traditionally been assessed indirectly in an after play manner, called summative assessment. However, in recent years there has been an increasing trend to apply real-time assessment. Real-time assessment aims to give students quick feedback on their performance, helping them to succeed in their learning process. Learning through digital games is often evaluated using pre- and post-tests measuring content knowledge. Nonetheless research has shown that such traditional assessment methods often do not capture and analyse the complex learning process, informing of the competences a learner might have acquired due to the game (Shute & Ke, 2012). One way to improve assessment procedures and measures, in terms of quality and utility, consists in using Evidence-Centered Design (ECD) (Mislevy et al., 2003). It supports the design of valid assessments, yielding real-time estimation of students' competence levels, based on a wide range of knowledge and skills. Stealth assessment refers to ECD-based assessment procedures that are interwoven with the game-environment itself and thus invisible for the player (Shute & Venture, 2013). During the game play, users produce different sets of actions, whereas the interest here is to analyse and assess, the skills and competences students employ to perform the game task. Therefore the evidence needed to assess students' skills and performance is provided by the players' interactions with the game itself.

In educational settings, authentic assessment plays an important role for evaluating students' competences. Though researchers differ in their opinions on this topic. Some researchers consider authentic assessment as an evaluation of students' performance (Torrance, 1995), others (Herrington & Herrington, 1998) argue that authentic assessment emphasises the meaningful content of the task and its context. After reviewing different definitions Gulikers (Gulikers et al., 2004) describes authentic assessment as one that requires students using the same competences and attitudes they would need to apply to common situations in their professional life. So, this approach could be integrated in games through an analysis of the player's behaviour, whereas the required competences are employed to solve very specific situations.

Currently, an emerging field that is being incorporated in GBL is Learning Analytics (LA), which aims to make an efficient and effective use of educational data. It includes capturing, tracking, aggregating, analysing and utilising/visualising information on both students' interactions with the learning content itself as well as on their learning progress. A key issue when using LA is to determine which information is going to be extracted (Shoukry et al., 2014). The classification of the data collected depends on the fact if a general (extensive data) or a more detailed observation (intensive data) is desired. Collecting data from a single player game differs from collecting data from a multi-player game mode since in this last one students interact with other players. Mobile devices are very promising platforms for LA. Due to their wide availability, accessibility and ease of use, they make data collection much more natural and non-invasive than sometimes traditional platforms do. Furthermore ubiquitous LA are becoming increasingly popular as it allows considering additional information concerning the context learning takes place. This way factors such as time, location, activity, noise, light and social environment can be analysed (Aljohani & Davis, 2012).

Educational Data Mining (EDM) is a concept related to LA. The International Educational Data Mining Society defines EDM as "an emerging discipline, concerned with developing methods to explore the unique types of data that come from educational settings and to use these methods to better understand students' learning processes." So both disciplines aim to use collected data to improve learning processes as well as their assessment. However they also differ from each other in some of the following ways: the type of discovery that is prioritised (while EDM focus on automated discovery, LA focus on leveraging human judgement), the type of adaptation and personalisation typically supported (EDM models are more often used as the basis of automated adaptation and LA models are more often designed to empower instructors and learners), the distinction between holistic

(LA) and reductionists (EDM) frameworks, the most common origins (semantic web or intelligent curriculum for LA and educational software and student modelling for EDM) and methods and techniques used (social network analysis or sentiment analysis for LA and classification or clustering for EDM) (Siemens & Baker, 2012).

Another relevant approach is the use of educational games based on competition, in which learning is achieved throughout the competition amongst two or more players. This approach is often used to engage students in learning through competitive and thus challenging learning environments.

Literature review has shown that there are numerous examples of game-based learning via competition. One of them is FLEQ (Free Libresoft Educational Quizzbowl), which is a tournament management software that allows its participants to synchronously play against other players on an Internet Relay Chat (IRC) channel. The game mechanism consists in competing amongst each other, answering Trivia-like questions (Robles et al., 2012). As such, it is a competitive out of class GBL learning initiative.

Location-based learning is another relevant aspect of mobile GBL since it offers different possibilities to enrich learning experiences. Learning processes can be extended from traditional classroom settings to those out of class and thus more closely related to students' everyday life. This allows, for instance, to create learning environments in which their users can interact with physical objects, developing productive learning experiences involving exploration and cooperation (Hwang et al., 2008) or even accessing contextualised information, communication, analysis and interrelation of real places (Roschelle, 2003).

In location-based learning games usually several students have to share a single mobile device to jointly perform a game task. An analysis of this situation is done in (Melero et al., 2015). The analysis is done through the design and evaluation of a location-based learning game in which students had to play in groups sharing a mobile device whilst visiting a contemporary museum. During the game, students are asked to visit specific places in the museum solving a number of questions, which are placed all over the museum. Players are provided with positive and negative feedback on their game performance, indicating the correct and incorrect answers. To successfully complete the game all questions need to be answered correctly. After evaluating different characteristics of location-based learning games the authors conclude that this type of game is more suitable for smaller learner groups, especially if it aims to keep all learners actively involved in the game task.

Additionally there are some ethical considerations that should be taken into account when using games, simulations and virtual worlds for educational purposes. Generally, considerations about ethics start with social concepts on what is right or wrong concluding with several moral principles on what people are expected to do in terms of rights, fairness and responsibilities to local and global benefits. In a research work on this topic (Warren & Lin, 2013) some guidelines and key issues are provided along with an illustrative example. Furthermore, to minimise risks, the authors recommend designers to critically reflect on questions such as: if a game, simulation or virtual world is appropriate for the target audience, if there are means to measure whether the product influences learning or not and if the design variables can be controlled to minimise social, psychological and learning risks for its users.

## THEORETICAL BACKGROUND

The game we have designed for the current project, is based on the pedagogical framework of mobile learning. As outlined by Sharples and other researchers (Sharples et al., 2005) mobile learning theories recognises not only "(...) the essential role of mobility and communication in the process of learning (...)" but also the importance of the context for meaning construction. Mobile learning has also been described as a process in which knowledge is gained throughout multiple contexts amongst people and personal interactive technologies". In line with the aforementioned aspects Sharples et al. propose a framework that is based on Engeström's expansive activity model (Engeström, 1987) and which aims to analyse the interdependencies between learning and technology. The framework

he proposes is mainly based on five factors (subject, object, context, tools and communication), which are themselves analysed under two different layers: a technological and a semiotic layer. The technological layer describes learning as "an engagement with technology, in which devices such as mobile phones (...) function as interactive agents (...)" that help its users to acquire knowledge, to communicate amongst each other, to share and negotiate contents and meanings and, finally, to reflect on them. In contrast, the semiotic layer describes learning as "a cognitive system in which learners' objective-oriented actions are mediated by cultural tools and signs".

*GuessIt!* has been designed on the aforementioned framework combined with a social constructivist approach. This considers learning as "an active process of building knowledge and skills through game-based learning activities within a supportive community" (Sharples et al., 2005). Hence some of the key-issues, when starting with the design, were that in order to guarantee an effective learning environment, the APP should be *learner-*, *knowledge-*, *assessment-* as well as *community-centered* (Moreno-Ger et al., 2008; Belloti et al., 2013). This means firstly, that content builds on students' competences, background knowledge and interests (Sharples et al., 2005; Krashen, 1985), secondly, that the curriculum is built from "sound foundation of validated knowledge" (*knowledge-centered*) (Sharples et al., 2005), thirdly, that assessment is matched to our students' ability offering them individualised feedback and formative guidance (assessment centered). And fourth, that the APP should engage learners in sharing knowledge and in supporting weaker students (*community-centered*) (Sharples et al., 2005; Moreno-Ger et al., 2008).

*GuessIt!* offer learners a highly interactive and flexible learning environment allowing them to ubiquitously get and produce new language in- and out-put. This is done through a variety of tasks which focus on students' reading and writing competences. All tasks are based on the idea of guessing and explaining words from a huge corpus in the target language. Corpus is gradually augmented, assessed and reported by the players themselves, being formative (Van Zundert et al., 2010; Gikandi et al., 2011; Taras, 2002). This way, our learners are encouraged to get actively involved in their own learning process reviewing and reflecting on the target language and hence gradually co-constructing the system knowledge (Marty & Carron, 2011; Berns et al., 2013b). On top of this and in order to make the different learning tasks more challenging several game features such as a score system, rankings, a time-limit as well as a competitive game model were integrated in the APP design (Dondlinger, 2007; Berns et al., 2013a; Hamari et al., 2014).

## DESIGN AND ARCHITECTURE

The software we have developed specifically for the current project is available as GPL free software in its forge[1]. The system follows a client-server architecture (see Figure 1) and can be downloaded from Google Play[2]. Once students have installed the client software in their Android smart-phones or tablets, this identifies them and interacts with the server through the Internet to implement the game and to show the different rankings.

The typical application work-flow begins by asking the user to select the language they want to focus on. At the moment the system supports English, German and Russian, but it can easily implement other languages by simply translating a couple of text files. The language is used both, for the interface (buttons, announcements, etc.) as well as for the definitions to play. Once the user has selected the language they want to play, they are asked to identify themself introducing their email address and password. This way they can play on different devices, such as for instance on a smart-phone while waiting for the bus or on a more comfortable tablet at home.

Apart from this, before each game session the players have to choose the level, categories and number of definitions they want to play. This allows for a highly customisable learning process in line with the target students' learning needs: for instance, students with a higher level compared to the rest of the class can play more advanced levels, whereas those with a lower language proficiency can repeat already played terms, as many times as they need. Once within the game screen (Figure 2), the APP provides the players with a randomly selected definition of a term which they have to

**Figure 1. Architecture diagram of the system**

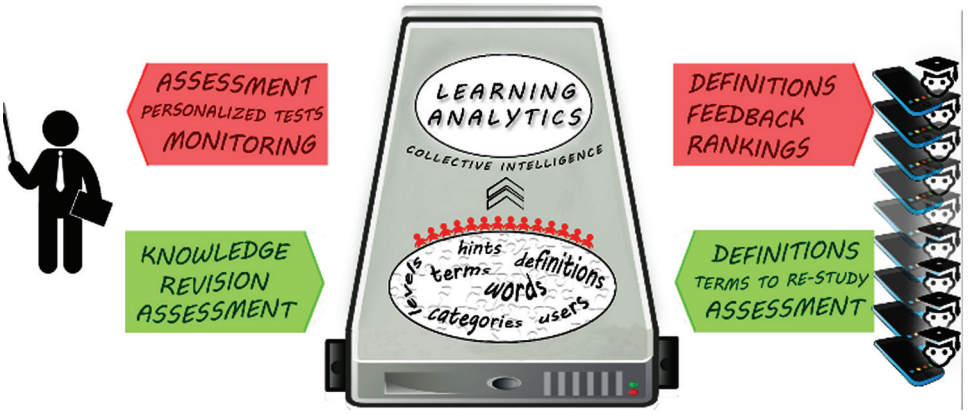
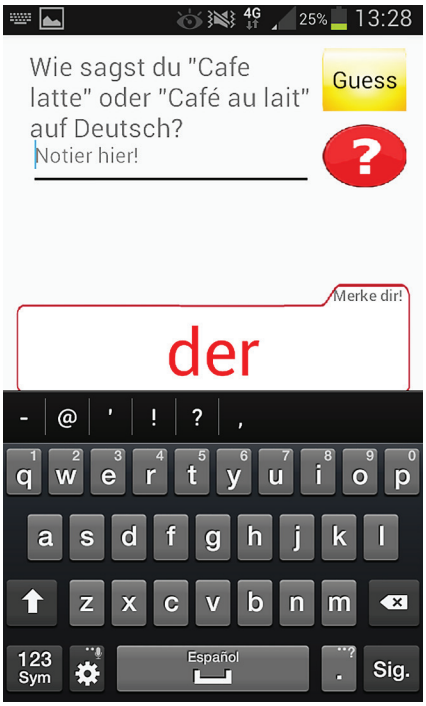



**Figure 2. Screenshot of the APP displaying a definition to guess**




guess with the optional help of a clue (e.g. Definition of cold: In Alaska it is always ____. The first letter is "c". Clue: In the summer it is usually hot, but in the winter it is often ____).

For each term players have to guess they are given the opportunity to guess the correct answer three times. After that the system provides them with instant and explicit feedback indicating the correct answer. Feedback here aims to be constructive, supporting and guiding students during the independent learning process (Sun et al., 2008).

Furthermore to enhance students' incidental vocabulary learning players get the opportunity to listen to the pronunciation of each definition through the Google Text-to-speech interface (Brown et

al., 2008). Additionally learners are allowed to copy definitions (or part of them) to their notebook and thus store them in their APP for later review. Finally, before going on to the next definition, users are always asked to grade the previously played definition. In case they consider a definition inappropriate, they are permitted to report it to their supervisor by always indicating the reason for their report: improper or offensive content, serious linguistic mistakes or inaccurate definition.

At the end of each game, an overall summary is shown along with some stats to gamify the APP. However, the *Statistics* option from the main menu will always preserve the last game data along with a bulk of additional useful information regarding the games and definitions played. The Statistics provide players with data on their success ratio, the number of definitions, which have been played, the categories in which the player guessed the most or the least definitions as well as the frequency with which each level has been played and selected. Furthermore some additional information on players' actions are provided. This is for instance, on the definitions introduced by the users themselves, including the average rating, the average success ratio and number of reports.

In addition to the previously commented usual game flow, the student can also contribute to the game. And thus for every twenty definitions a student works on they are invited to create a new definition for a word the system automatically provides them with. Once the player has created and entered a definition this will be included in the database together with those previously introduced by other classmates and the teacher. Allowing learners to get actively involved in the game development, tailoring to their personal learning needs, makes the game a highly dynamic and interactive learning tool. As new definitions will be played and peer-assessed by the other mates, students are encouraged to do their best when entering a new definition. This way, the games' knowledge base is being increased and continuously reviewed by the users themselves. As a result of this process, the server will contain different graded definitions for each term.

The knowledge base, which is being stored by the server program includes the following data: the definitions available for each term, the definitions each student guessed or failed during each game-session, the assessment of each player and the terms that each player considered interesting to be restudied. Thanks to this information the system provides its users with constant feedback on their individual learning progress. In addition, since this knowledge base is increased and continuously assessed by the users themselves, the server will contain not only different definitions for each term, but also different grades.

In order to monitor and assess the process the course coordinator can access different learning analytics that include: the usage which has been made by each student of the APP, the grades students obtained (according to the terms that have been guessed and the grades students definitions have been given to) along with the grades each student gave when assessing the played definitions. A report of the low-graded definitions provides an insight into the difficulties a specific student (or a group of them) might encounter. In addition those definitions that unfairly received high grades can help to identify students who are unable to detect mistakes in the target language. Furthermore the system will provide the supervisor with different recommendations. For example, if the ratio of students guessing a concrete definition is below a certain threshold, it may indicate that its linguistic level is too complex.

Finally, the server can automatically create personalised tests for each player according to the supervisor's instructions. In particular, the tests can include a certain number of random definitions as well as those definitions that the student previously guessed several times. In this way, the test can detect if they cheated by using a dictionary or if they guessed them due to their personal knowledge. Additionally, the personalised tests might also include a certain number of definitions that a student either did not guess or did not focus on during the different game sessions.

## EXPERIMENT

### Settings

The experiment has been carried out with more than 120 students from an A1.1 level German foreign language course (CEFR) at a Spanish University. From the very first moment of their German language course all participating students were exposed to the target language and this was the only vehicle to interact and communicate with other classmates.

The experience lasted about 4 weeks. During that time students were asked to focus on levels 1 and 2 (first week), then on level 3 (second week) and finally on levels 1 to 4 (third and fourth week). Before giving students access to the *GuessIt!* APP we aimed first to test their vocabulary knowledge at the outset of the experiment, asking them to take part in a pre-test. This consisted of about 60 questions that were randomly selected from the knowledge base comprising vocabulary from all four levels. As our target students were from the A1.1 level of the CEFR (Common European Framework of Reference for Languages) the vocabulary of the APP as well as the different pre- and post-tests were based on this level.

Once students had taken part in the pre-test, they were allowed to access the APP and to get familiar with its interface, toolbox and learning contents. To give students some initial guidance on how to use the different tools provided by the APP (notebook, statistics, game, reports, definitions, etc.) we gave them a short training session. This took place within the German language seminar and lasted about one hour.

Hereafter students were invited to use the APP for their independent and out of class learning, focusing each week on different levels (see above).

To become familiar with the APP we recommended our students first focus on levels 1 and 2, which comprise mainly of the already known vocabulary from the previous language classes. Once students had practised levels 1 and 2 they were encouraged to continue on to the following levels. Unlike the first two levels, levels 3 and 4 were only in part known to our learners offering them the opportunity to foster and widen their knowledge.

After one week using the APP, students were asked to fill in a first post-test, followed by a second and third one, each of which took place in an interval of one week. All tests were completed off-line and focused as the pre-test did, on about 60 questions that were randomly selected from the knowledge base. Nonetheless, unlike the pre-test, the three post-tests comprised of vocabulary from different levels. Whilst post-test 1 focused on levels 1 and 2 (223 definitions), post-test 2 focused on level 3 (65 definitions) followed by post-test 3, which comprised of again levels 1 to 4. However, this time its content had been selected on the basis of a much larger corpus (826 definitions) compared to when learners took part in the pre-test (282 definitions). Since students started introducing (from the second week of the experiment onwards), new definitions, the knowledge base increased significantly each week and differed quite a lot from the initial one at the outset.

### Analysis and Discussion

An analysis of the different tests and their results allows for the following insights: Firstly, all of the 100 students, who took part in the 4 tests (one pre-test plus three post-tests), greatly improved their test scores, comparing their results from the pre-test with those obtained in the post-test 3. The latter was completed by all students at the end of the game experience. The positive results are especially valuable taking into account that the knowledge base increased on a daily basis. When preparing the tests, we were always concerned about including at least 50% of the definitions proposed by the learners themselves blended with another 50% of definitions, which was proposed by the supervisor. All definitions were selected due to linguistic as well as content-based criteria. And thus we selected those definitions, which were linguistically speaking very good definitions combined with those which were very clever and outstanding in terms of content.

Additionally, in the last post-test we included an exercise in which students were asked to propose their own definitions for a number of terms we provided them with. This way, we aimed to reward especially those students, with additional scores, who enriched the knowledge base introducing new definitions, rather than only playing those already provided by their classmates or the instructor.

A comparison between pre-test and post-test 3 underlines the APPs impact on students' vocabulary learning. And thus there is an average of 5,35 points of difference in a range of 0 to 10. Even assuming that this difference could be due to the mentioned extra scores in post-test 3, the difference still remains significant: 4,8 points of gain average from pre-test to post-test 1 and 5,7 from the pre-test to post-test 2.

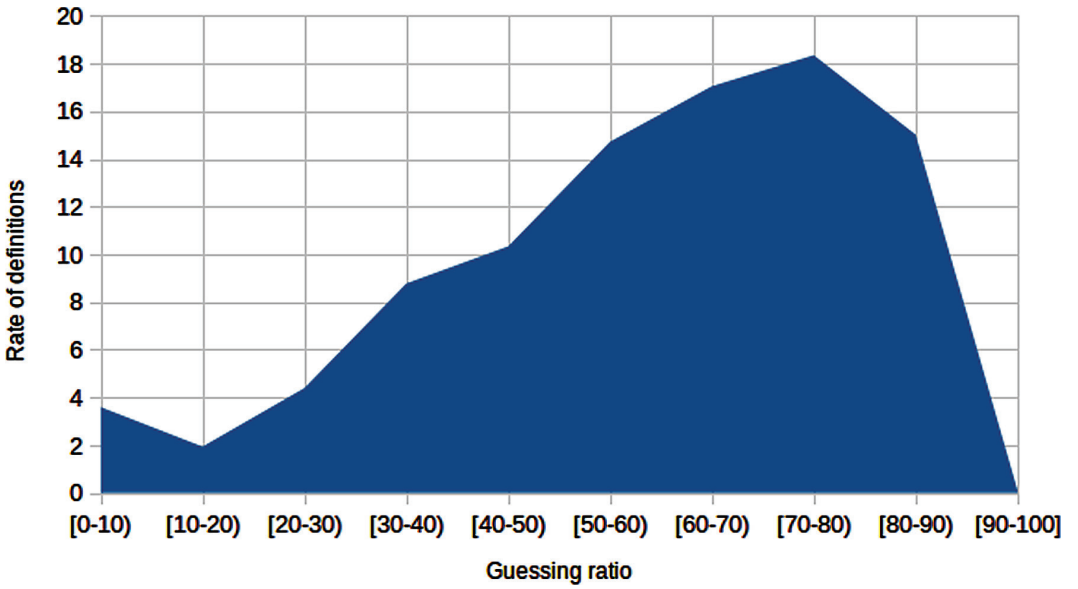
In fact, we can see that students performed the best in post-test 2, as the average grade evolved from 1,2 in the pre-test to 6 in post-test 1, getting to its maximum in post-test 2 with 7,1 and ending up in 6,5 points in post-test 3.

An analysis of the server logs provides interesting automated indicators for different skills. For instance, if we look at the time dedicated to play, we could easily check constant study skills. This could be done either by seeing if each student played a certain minimum number of definitions during a period of time (day, week) or by checking the total work effort (if we check the whole experiment length). In fact, 150 of the students registered in the system, played a total amount of 165178 definitions. We estimate that every definition needs a minimum of 20 seconds to be read and answered, and another 10 seconds on average to be assessed and if considered relevant, to be copied down by the users in their APP notebook. According to this estimation, each student had dedicated at least more than 9 hours to study using the APP. We consider this to be a significant amount considering that our pilot study lasted only 4 weeks.

To complement the previously mentioned indicators, we can retrieve from the system if students did actually guess the definitions or not. Once the experiment was finished some participants acknowledged that rather than using the APP as their main learning device, they only used it to note down the vocabulary in a physical notebook to learn the targeted vocabulary later on by heart.

So we can check their success ratio obtaining objective evidence of the level of definitions included in the APP and also if students preferred to use the APP compared to the traditional way of studying vocabulary (flashcards, etc.) In Figure 3 we can see the general statistics of guessing: each

**Figure 3. Ratio of guessed definitions chart**



y-axis value indicates the ratio of definitions played and which of them have been guessed in the interval in the x-axis label. For instance, the first point on the left indicates that 4% of the definitions played were scarcely guessed, ranging from 0% to 10%. The second one indicates that around 2% of the definitions played by the students were guessed between 10% and 20%, etc. If we look at the game definitions guessed more than 50% (adding the area delimited by the five points on the right), we can see that 65% of the definitions played were actually guessed. This means that students usually succeeded in guessing the definitions (note that this includes definitions that the server randomly assigned several times to each student).

To measure participation skills we can check the number of contributions from each student. In our case, the APP started with 282 definitions provided by the teacher, but ended up with 850, so students contributed in total 568 definitions. This is a mean of almost 4 definitions per student. At first sight it looks as if the figure was not very high, but taking into account that writing in a foreign language in general and definitions in particular is quite difficult, especially at the A1.1 level (CEFR), the results obtained are quite positive. Furthermore bearing in mind the previously commented high guessing rate, we consider that the definitions were in general very encouraging. As for peer-assessment skills, the mean difference between supervisor grades and peer-grades is 1.28 in a scale from 0 to 5 points. The difference between supervisor grades and peer assessment ranges from 0 points (more than 32.000 assessments were exactly the same grades given by the supervisor) to 5 (more than 4.800 times). In the second case, it was usually the supervisor reporting and the students giving the maximum grade (only in 22 cases it was the opposite). As for individual assessment only 11 students got a mean difference below 1 point when comparing their assessment to that of the supervisor. 115 students got between 1 and 2 points and only 9 got between 2 and 3 (none of the students got more than 2,5 points of difference).

Students assessed 85% of the definitions with more than 4 points out of 5, and 12% with between 3 and 4 points. So 97% of the definitions were assessed as good/very good, whereas those definitions assessed with 0 points were automatically reported to the supervisor. The system registered more than 11.000 reports and there were one hundred definitions, which were never reported. Looking at the reports there were definitions which were reported more than one hundred times, which clearly suggests that they must be wrong, whereas others (395 definitions) were reported only occasionally (less than 10 reports). The low number of reports these definitions received suggest that rather than being wrong, it was the students who were badly reporting them. Surprisingly, several students reported even definitions which were entered by the teacher.

All in all there were 19 reports that considered definitions as improper or offensive in terms of content, followed by 80 that detected linguistic mistakes (spelling, grammar or syntactical mistakes) and 7 which were considered as inaccurate.

## CONCLUSION

In this paper we have described the work-flow of the gamified multilingual *GuessIt!* APP and the learning objectives it can be used for. *GuessIt!* is a client-server computer software which has been developed specifically for the current research project. Whilst most of the APPs only offer static and supervisor created content, *GuessIt!* is dynamically fed with new content from each of its users. This way, learners are actively involved in their own learning process making significant decisions on the learning content they want to focus on. In line with this, each player is constantly invited to enter new definitions for the terms the system has previously provided him with. Once a student has introduced a definition, the definition is entered into the game and becomes part of its knowledge base. Since all definitions are peer-assessed by other classmates, whilst playing the game, the author of each definition gets the opportunity to receive constant feedback on their performance. This feedback aims at providing players with the opportunity to critically review and to develop their language skills. In addition this process facilitates monitoring and automated assessment by the language instructor.

In our first experiment using *GuessIt!* we employed the APP in a Higher Education German foreign language course (A1.1 level of the CEFR). Students played the APP for a period of four weeks, focusing on different levels of vocabulary. Results from the pre- and post-tests have shown a significant improvement in students' vocabulary acquisition. Probably this is related to the time students spent on playing the APP, which was a much longer time than we estimate they usually employ for their independent learning beyond the classroom. These results are complemented with objective indicators on the acquisition of other skills that are automatically extracted from system logs. Those refer, for instance, to students' ability to explain words in a foreign language or the competence to assess definitions created by other mates. However further research is needed to get a stronger conclusion on the validity of the specific usage of the information retrieved.

Our next future work will focus on making a more detailed analysis of the results, trying to find correlations between the different independent indicators obtained and the final course grades. Additionally we aim to identify students' profiles to early detect those students who could fail the course providing them in this way with early feedback.

## ACKNOWLEDGMENT

This work has been funded by the Andalusian Government under the University of Cadiz programme for Researching and Innovation in Education. And by European Union under the OpenDiscoverySpace (CIP-ICT-PSP-2011-5) and UBICAMP (526843_LLP-1-2012 Es-Erasmus-ESMO) projects. We would also like to thank the OSLUCA, Aula Universitaria Hispano-Rusa (AUHR), as well as Elihú Salcedo, Pilar Romero Sevilla, Ignacio Calleja Olmedo, Andrea Calderón Marquez, Mercedes Paez Piña and Sebastián Pitula and Sammy Kleinberg for their much valued support.

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## ENDNOTES

1 https://github.com/AlbertoCejas/GermanLearningUCA
2 https://play.google.com/store/apps/details?id=es.uca.tabu

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