QUADRIVIA: A quiz-based serious game app to train university degrees knowledge

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Abstract—QUADRIVIA is a mobile app oriented to give university students a tool to learn while playing. It is a quiz serious game, where questions are defined by teachers/experts following a methodology defined by experts in learning, serious games and gamification. Questions are generated from academical resources and lectures used in real university official courses. In its current version, the game counts with more than $30,000$ questions from 16 different degrees (e.g. Computing, Laws, Management, Psicology, Anthropology, etc.) It has been developed over a set of social-based features which allow players to interact with the rest of the community (e.g. challenges, leaderboards, etc.) The app is free and available for iOS and Android systems, and allows users to play alone or compete in specific subjects, degrees or with the complete set of questions. This work presents the tool, the content generation methodology, the current analytics on the tool and, finally, shows a few ideas on how this is going to be evolved and used in the academical scope.

Index Terms—Serious game, university degrees, social, QUADRIVIA

I. INTRODUCTION

The Open University of Catalonia [1] is the first full online (Internet-based) open university in the world. It is based in Barcelona, Spain and offers graduate and postgraduate programs in Catalan, Spanish and English in fields such as Psychology, Computer Science, Sciences of Education, Information and Knowledge Society and Economics. It was born in 1994 and currently counts with $55,000$ students and over $60,000$ *alumni* [2]. Oberta Publishing [3] is an educational company based in Barcelona that belongs to the UOC Group. With a wide experience in formative content, Oberta Publishing develops all kind of e-learning materials for UOC studies, from traditional resources to innovative formats such as games, video, digital and interactives. Oberta also houses the University's publishing department.

A serious game is a game designed for a primary purpose other than pure entertainment. Being a serious game, QUADRIVIA's main purpose is twofold: to be a resource to support students' learning and to motivate them to broaden their knowledge. The second is specially important in online university degrees, where drop-out rates due to frustration and lack of motivation to continue studying may appear more easily than in non-distance universities [4]. As stated in [5], the use of serious games is a pedagogical resource which tries to deal with this reality.

Although there are a few experiences on the use of videogames as an educational medium [6]–[10], this is not a generalised resource. No more than 60% of the papers published present experiences in the university level [11] (this is a study on 102 papers chosen from 1199 found). As a matter of fact, serious games are normally used for specific subjects like programming [12]–[15] by building tailor-made solutions, not being generalisable like QUADRIVIA.

II. QUADRIVIA

As said before, QUADRIVIA (See Fig.1) is a quiz-based serious game mobile app to help university students to train some knowledge related to the subjects they are taking. Although, at a first sight, it may seem another serious quiz-based game more, it has got some features that differentiates it from other proposals:

- The game and the questions generation methodology have been designed by experts in the field of learning, serious games and gamification. This ensures the accomplishment of its objectives (see below).
- The authors of the questions are the corresponding subject university teachers (or alternatively, experts).
- Three different levels of difficulty have been used to define the questions, depending on the competence levels expected along the subject.
- QUADRIVIA is an M-learning [16] tool offered to real students.
- The app runs over the widest spread mobile platforms, allowing most of the students to have it. Furthermore, it can be played on the move (e.g. home, underground, bus, etc.)

The game can be played (at the moment) in Catalan and Spanish, and it is available for free in the Google Play [17] and App Store [18] markets.

Players do not need to create a specific user-password for the app. They can sign up using (if they have them, of course) their accounts in UOC, Facebook [19] and/or Google [20].

Players can play in single-player, random-opponent or invite-a-friend challenge modes. All these can be either in a combo (with the same 7 random questions and 25 seconds/question for both) or in a 60 seconds answer-as-much-as-you-can random questions mode. As said before, players decide if they want to play only the set of questions belonging to a specific subject, to a specific degree (containing different subjects) or like in a classical Trivial pursuit game, answering questions from many all the available areas (See Fig.2).

Fig. 1. Main menu

Fig. 2. Category choice

Currently, more than $30,000$ questions are available in QUADRIVIA (from 223 subjects of 16 degrees). These have been designed to represent three (transparent-to-the-player) difficulty levels. Every question has got a "problem statement" and four possible non-ambiguous answers (See Fig.3). Only one of these can be the right one[1]. The questions try to cover skills related with decision making, theoretical knowledge, and knowledge update.

QUADRIVIA, apart from the questions-answers game itself, offers some features to increase the engagement by sharing the experience with others. Thus, as said before, the game can be played challenging other players (random or friends). Furthermore, there is a general leaderboard where a player can see her performance against the others. Players also keep a level of progression (there are 10 levels: beginner, novice, amateur, able, competent, skilful, expert, teacher, master and professor) once they reach specific points' thresholds. Finally, they can unlock until 25 badges related with several different objectives (e.g. to bring friends, to reach a certain number of wins, etc.)

The app offers a search system which allows players to

look for others. This includes a suggest system to show the alternatives once the player has started writing a name. Furthermore, if the person to invite is not a QUADRIVIA player, she can be invited by the platform inviter.

QUADRIVIA's main objectives are:

- Self-assessment of acquired knowledge
- Learning of non-acquired knowledge by the random repetition of questions
- Learning engagement by the use of a game mechanics (by competition against others)
- Learning engagement by the self-competition and improvement perception
- Knowledge updating and challenge (both in own and other fields)

From the point of view of the University, one of the main aims of the tool is to provide UOC students with a resource that can be taken everywhere (e.g. home, underground, bus, etc.) and can allow them to train their improvements anywhere any time.

The codification of the app has been done in native for each of the platforms. One of the main reasons to do this is the aim to keep QUADRIVIA alive (specially from the graphical point of view) for long, independently from changes in the operative systems.

The game has been programmed in a modular architecture. This eases its scalability and also allows to adapt it to new needs that may appear. For instance, the game is ready to be adapted and sold to external companies. They can generate their questions and categories and can use it to train their workers or give to their customers.

The game architecture has been thought to maximise the speed of load in order to offer players the best possible user experience. Furthermore, all the data related with the game is stored in external servers to make the app the smaller and lighter possible. This also allows the asynchronous matches, avoiding making players to wait for other's "movements". In order to manage these situations, the app implements a "push" notification system which completes the players communication protocol.

III. QUESTIONS DEFINITION METHODOLOGY

For the generation of the questions, a methodology has been defined. This is an important point since the game must be homogeneous in several different aspects (e.g. language, typologies, complexity, etc.) Thus, players should feel this homogeneity independently on the subject they are playing on. A set of rules, advices and revision loops achieve this aim.

First of all, teachers are given a set of rules and advices. Here there are a few of the rules to follow:

- There must be 150 questions per subject[2]. At least, 25 must be related to the decision taking skill and 25 with the update knowledge skill.

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[1]Notice that it is not completely true since some questions may include the "All the previous" answer

[2]A subject in UOC is usually equivalent to 6 ECTS (European Credit Transfer and Accumulation System)

- Questions should improve player's:
  1) decision taking skills
  2) theoretical, memoristic and thought skills
  3) learning and update skills
- The level of difficulty usually depends on the "granularity" of the question: the more specific, the more difficult.
- Given a 1 ECTS written module (around 40 pages) the teacher is asked to prepare around 25 questions (20 are extracted from the contents and 5 from present and news.
- The questions generated are classified depending on what they may improve (i.e. decision taking, etc.) This is important to try to balance the types of questions offered.
- To formulate questions, authors are given some specific grammar/vocabulary tips to avoid inconsistencies and ambiguities. These tips can also determine the kind of skill that will be worked with.
- The language register is the most general one: The question (and answers) must be understood there where the game's language is spoken.
- Before people proper names, their profession is specified (if they might not be known *a priori*).
- Questions appear randomly, so they must be totally independent from the others.
- Avoid the two common mistakes in this kind of games: the longest answer is usually the good one, and if there is an "All the previous answers are right/wrong" possibility, that is probably the one to choose.
- For the "decision making" questions, all the answers must be close to the right one, since we are expecting the player to think about what makes one answer better than the others.
- The questions must be understood (which does not mean correctly answered) not only by the subject students but by all the QUADRIVIA players.
- Statements must be balanced between several possible approaches to avoid boredom. Some of these, depending on the kind of question are:
  1) Inductive $--$> Deductive
  2) Deductive $--$> Inductive
  3) Closed questions
  4) Open questions ('?' at the begining, middle or end)
  5) Affirmative questions
  6) Negative questions
  7) "Intuitive" questions

  and depending on the difficulty (from less to more):
  1) Closed
  2) Open ('?' at the end)
  3) Open ('?' at the beginning)
  4) Open ('?' at the middle)
  5) Negative closed
  6) Negative open ('?' at the end)
  7) Negative open ('?' at the beginning)
  8) Negative open ('?' at the middle)

Given all these, a first version of the questions list (for each subject) is proposed by the teacher. Those questions are peer-
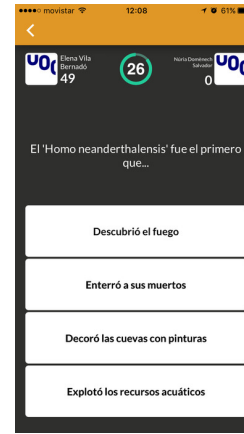

Fig. 3. Question example

reviewed by another expert on the subjects (usually another teacher in the university). The second can propose changes, detect ambiguities, etc. Once, the proposal is agreed by the experts, is passed to a specialised editor, who applies not only a syntactic/semantic/... revision but also checks for the homogeneity of all the questions of the game. Finally, once the final version of the questions is completed, it is checked again by the teacher to avoid any changes in the edition process. If it is accepted, the set of questions are added to the game pool.

IV. RESULTS

A. Current state

QUADRIVIA is currently available for free both for iOS and Android. Last month a new release an important upgrade was released. Now, it is possible to play specific subject whereas in the previous version, games where limited to complete degrees and the whole set of questions.

At the moment QUADRIVIA has got around 3,000 dowloands. These are quite balanced between Android (with a little bit more) and iOS. Notice that these downloads are not (specially) related with UOC students use, since most of them are related with the previous release, which did not allow to play with a single subject. Thus, once the new version has been released, teachers can now use it in their classrooms.

A quick assessment of the analytics show that most of the people does not play more that a couple of times. We presume this is due to the following reasons:

- In general, it seems that players prefer specialised questions.
- Since most of the people usually does not return to the app, it frustrates those who try to play against random players (they challenges are not answered).
- One of the main objectives of the app is to give a resource to UOC students in their studies. This is to be done yet.

Although these might seem unbeatable challenges, we think that the work started last month will bring in one or two semesters the app to reach the objectives defined.

In the last month, Trivialang, a very similar tool to QUADRIVIA (based in the same technology but oriented to

training the learning of languages —at the moment, English, French and German), has been released. The main features related with the game itself and the social part are the same. This game allows the use of images and/or audio (to train listening) and offers four specific categories: grammar, vocabulary, communication and culture related to the places where the tongue is spoken.

B. Near future of QUADRIVIA

Now it is the moment of truth for QUADRIVIA: The publication of the new release (with the subject-only-game new choice) and the inclusion in UOC subjects should push the app to overcome the problems detected (see above):

- Currently, players can play only around their favourite areas.
- The fact that UOC students are going to be playing to learn/check their learning, makes more feasible to find other players' responses to challenges. Anyway, we find it would be a good feature to include some filters to avoid randomly challenge non active users.
- Once we have the possibility to play in only one subject, QUADRIVIA becomes an extra resource in those where the questions are already done. Furthermore, in the near future, we expect this to be generalised to the rest of subjects of the different degrees. This, besides, will increase the pool of questions of the whole app.

Finally, a new bunch of subjects are being included in the project, but this time will they are subjects coming from master degrees. This may allow the game designers to include apart from new contents, new complexity levels.

V. CONCLUSIONS

QUADRIVIA is a serious game developed by Oberta Publishing, the UOC publishing house. This open app, which can be freely installed in Android and iOS devices, combines the learn by playing and M-learning philosophies by offering a Quiz-based game where questions surge from specific subjects on the University degrees. These questions are formulated by the teachers themselves and follow a methodology proposed by experts in learning, serious games and gamification. This gives the game some important features: ambiguity avoidance, different difficulty levels, different competences types work, etc. In order to give a social component, QUADRIVIA allows to challenge other players, appear in leaderboards, collect badges, invite friends, etc.

The analysis of the last months data is related with the first version of the tool which was released with the main features but not all of them. The app seems to be interesting for players but we have noticed the need of the specific subject game, on the one hand, to increase players "loyalty", and on the other, to allow teacher to use the app in their classroom. This feature has been added in the new version, just released, so we expect the objectives will start to be accomplished soon.

The tool is in continuous improvement and the pool of questions increasing with the addition of new subjects to the game. In fact, a new set of questions will be arriving soon,

all of them coming from master degrees taught in UOC. Some operative improvements we propose are: to filter non-returning users when random challenges are done and to include leaderboards related to degrees and subjects (one per level).

Finally, say that the tool is technologically very sound and has been designed in a way that it is easy to adapt to similar needs. Thus, some enterprises have already bought it to include their specific knowledge and train their workers.

VI. ACKNOWLEDGEMENTS

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