



PlayWithUnicam: An extensible platform for serious games

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Abstract

Nowadays, teaching methodologies have been fostered by the integration with game-based approaches leading to the birth of the so-called serious games, i.e. games that do not have entertainment as their main purpose but are designed primarily for educational purposes. Although they have always been the subject of debate and criticism, *serious games* leverage game-based learning for playing an important role in education, showing that they are not just a form of entertainment, but are effective vehicles for dissemination and sharing of knowledge. The effectiveness of serious games is proved by the wide list of software providing this kind of solution. However, it is difficult to find tools that offer at the same time a good level of content customization and the possibility of multiplayer to ensure a more engaging, stimulating, and competitive teaching experience. Nevertheless, almost all these tools are fee-based. With the aim of filling this gap, this paper presents an open-source and free-to-use platform for serious games that is extensible both in the number of games and in the games' content. More in detail, we propose a platform hosting a catalog, expandable over time, of multiplayer serious games that can be easily tailored to different learning topics, e.g., math, history, and informatics, depending on the teachers' needs. The platform is meant to be easily extensible and scalable by means of reusable components and features. In addition, the developed application was validated in a series of events, together with students, to check the effectiveness of game-based learning and the general usability of the tool.

1 Introduction

Teaching methodologies have historically been the subject of constant study and innovation. The desire to provide the most enjoyable, engaging, and effective learning experience possible has led over time to discover and adopt new means of dissemination with the aim of facilitating and stimulating learning. In this regard, gamification and game-based learning [4] mechanics can be useful. Indeed, by introducing typical game elements in everyday life, such as in educational processes, these mechanisms break the tedious ordinary patterns, capturing interest and enhancing the results achieved [6].

With this in mind, serious games have been adopted in recent years for their great potential for education, and as they are able to involve the player completely, unlike classic passive learning methods. In a research conducted by Utrecht University [8], no less than 28 scientific

studies were examined that compared the effectiveness of serious games with other learning methods, showing that the former improves the acquisition of knowledge and cognitive as well as motor skills. In fact, serious games offer a new and engaging approach in comparison with classic passive learning processes, where students usually learn new concepts by reading books or listening to lectures.

Due to these characteristics, traditional learning predominantly favors learning the *what* rather than the *how* [1], and students are involved in tasks defined by the teacher rather than in research or problem-solving activities. It is precisely in the type of learning offered that the strength of serious games lies, namely experiential learning which, starting from the assumption that the information and sensations experienced in the first person remain strongly imprinted, allows the player to refine his perception, attention, and memory, thus favoring behavioral changes through learning by doing.

This paper aims to contribute to this field by proposing a platform collecting a catalog of serious games to be used in support of teaching activities. The platform we propose is called PlayWithUnicam, it is the result of the desire to have in our hands an open versatile tool (as well as one that can be extended in the future) that will make teaching more interactive and consequently stimulate the interest of students in various teaching topics. Aiming at non-specific users and various needs, the objective is to guarantee a general purpose and free-to-use tool that can assist anyone in enhancing their education. In detail, PlayWithUnicam is a web application that allows several users to connect and play together a certain game from the catalog, thus offering the possibility of creating ‘game rooms’, i.e., ‘lobbies’, in which it is possible to participate with or without limitations to play the same game, which can then be enriched by a final ranking.

Moreover, the platform permits a registered user to create custom game instances by choosing from a list of currently available game templates, and then enriching them with the contents they wish to disseminate, in order to offer a type of active learning through which students, personally involved, can hopefully internalize the concepts more effectively. Thanks to the choice of using web-based technologies in the platform development, users can access the PlayWithUnicam from multiple devices, e.g., PCs, tablets, and smartphones, and at the same time multiple authentication systems are offered, including a simple and immediate one (without the need for an account) to start playing immediately, and one that requires registration (useful for future implementations).

To assess the reliability of the proposed platform and its functionalities, and the effectiveness of the proposed teaching method, we made experiments in real contexts involving several schools and students of different ages.

The rest of the paper is structured as follows. In Section 2, we analyze platforms somehow similar to PlayWithUnicam coming from companies and academia. Then in Section 3, we present in detail PlayWithUnicam and its functionalities. Section 4 reports the results of the experiments we made with students. Finally, Section 5 concludes the paper by touching on possible improvements and future work.

2 Related Works

This section presents an overview of the tools similar to PlayWithUnicam. Indeed, there exist several software tools and services tailored to education that allow the integration of game-based approaches in training processes [5]. Two main categories of online platforms can be distinguished: tools for creating interactive resources and full-fledged learning management systems (LMS), i.e. platforms that allow organizations to host and create training content,

such as online courses or webinars, aiming above all to automate the process of assigning tasks and consequently keeping track of the progress of individual users. For this latter aspect, many LMSs make use of badge and certificate attribution systems that attest to the user's successful completion of certain tasks in order to make the process more fun and engaging.

The first tool we compare is Moodle (<https://moodle.com/>), an LMS designed to create customized learning environments. It contains a vast scale of resources, functionalities, and activities that can be applied to the creation of courses. It allows enrolment management and the creation of learning plans up to the assessment system, providing teachers with all the essential tools for teaching. Another one is Genial.ly (<https://genial.ly/it/>), a tool for teaching and learning through the creation of interactive content. These include presentations, infographics, images or videos, plus quizzes, a wide range of games, and various templates for EscapeRoom, based solely on questions and simple mouse actions (click, drag, and drop). Wordwall (<https://wordwall.net/it>) is a tool for creating interactive or printable purely educational resources, including quizzes or games with numerous templates to customize. A created activity is also offered with other compatible templates depending on the content used and can be embedded on other websites. The free plan allows only 5 activities to be created. Finally, Kahoot! (<https://kahoot.com/>) is a platform for creating quizzes of different types in which the question is projected onto a main screen and participants interact via their own device from which they view a button panel with the various answers. It is also possible to insert slides between questions and to create customized courses in which quizzes can be assigned to participants.

All of the above platforms are based on monthly/annual subscriptions and do not really provide the possibility of playing multiplayer, with the exception of Kahoot! quizzes. Few of them, such as Moodle, support open standards or possess certifications making them interoperable by design to enable integration of external applications and information. Among the principal standards, we find SCORM (Shareable Content Object Reference Model) [3], a set of standards for the production and use of e-learning content. In other words, any course or materials published in this format will work in any compatible learning management system or platform. Differently, Open Badges (<https://openbadges.org/>) is an online standard to recognize and verify learning using digital badges. Any institution, organization, or individual can create and issue badges to learners on their learning platform. To conclude, Learning Tool Interoperability (LTI) [7] is a global technical standard for integrating learning applications. It provides a simple but effective mechanism for integrating third-party content and products within virtual learning environments (VLEs) such as Moodle.

Summing up, platforms providing serious games are nowadays available in the market, however, none of them provide altogether the possibility of extending the game catalog with new game templates, creating new game instances tailored to the teaching activity to carry on, and using it without paying a fee.

3 The PlayWithUnicam Platform

In this section, we present PlayWithUnicam: an extensible platform for serious games.

The main characteristics of PlayWithUnicam are: (i) free access, (ii) multi-device support; (iii) multiplayer support; (iv) content customization.

The platform can be accessed here <https://play.unicam.it>, while the source code and instructions on how to build the project are available at <https://github.com/UnicamPlayGround/PlayWithUnicam>.

Aiming to ensure free access to the platform from different types of devices, it was decided to develop a web application, so that it would be available on the most popular browsers.

PlayWithUnicam has been developed using Ionic and Angular frameworks for the front end while Node.js framework was adopted for the back end along with a PostgreSQL relational database. A RESTful API was then set up to allow dialogue between the two parts (Figure 1).

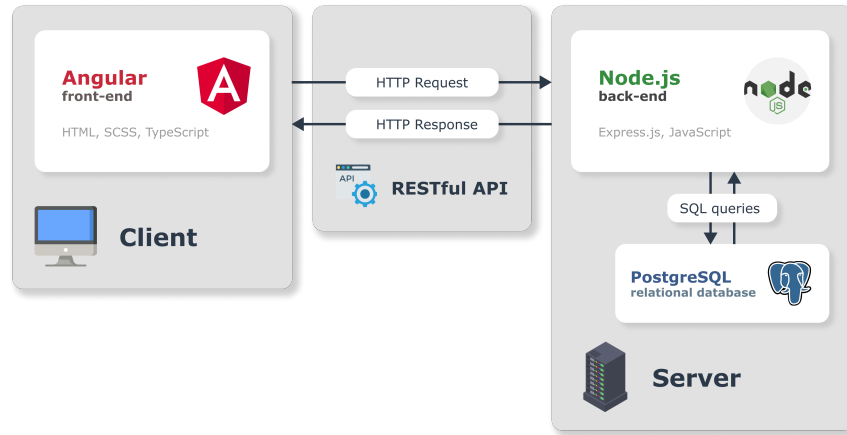


Figure 1: Architecture of the application.

The app provides two ways of authentication:

- **Authentication upon registration:** if the user has previously registered on the platform, they can log in with their own credentials.
- **Authentication as guest:** the user can decide to access the platform as a temporary guest, i.e. without the need to register, simply by choosing an identifying username.

Once logged into the app, the user can view the catalog of currently published games and interact with them, choosing whether to create a new game room or join an existing one.

In order to guarantee the possibility of playing in multiplayer (in compatible games), the platform is based on a mechanism of game rooms, called lobbies, which allow several users to gather in groups to play the same game in real-time.

Once the user has chosen a game to play, they can create a lobby hosting as many players as the game supports, choosing whether to make it public or private (the user is considered the admin of that lobby). Public lobbies can be accessed by any user of the platform, while private ones can only be accessed if the user knows their unique identification code or has the invitation link.

When all players have joined the lobby, the admin can start the game and everyone will be shown the game screen.

The first two games developed were two reinterpretations of the classics Goose Game and Memory. In the first one, players take turns playing on the same game board, rolling the dice to advance with their token and answering questions when they reach certain squares on the board.

Two versions of Memory were developed: a first shared-screen multiplayer version and a second single-screen version. Players compete by trying to discover as many pairs of identical cards as possible by answering a question related to the image on the two revealed cards.

A teacher registered as a system administrator (Figure 2) user also has the possibility of creating new game instances using one of the available templates and enriching it with the content of their choice, such as the number of cards to play with in the Memory game or the questions to ask the player.

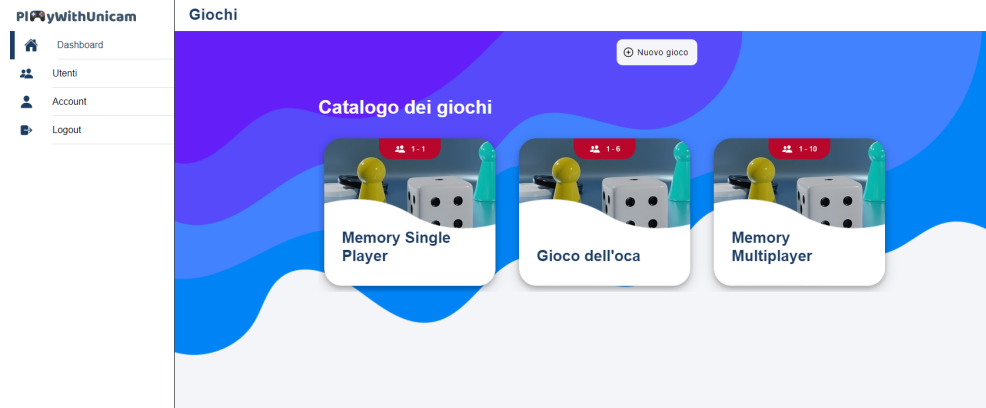


Figure 2: Main dashboard of the admin.

4 Evaluation

This section presents the results of the evaluation we carried out on PlayWithUnicam. We were driven by the aim of answering the following questions: (i) Is PlayWithUnicam reliable enough to be used in real teaching activities?; (ii) Can PlayWithUnicam effectively support and improve students' learning?

To this aim, we organized events involving students of different ages and schools. Specifically, we made three experiments with the following schools: Istituto comprensivo 'Enrico Mestica' of Cingoli, see Figure 4, I.T.E. 'A. Gentili' of Macerata, see Figure 3 and I.I.S. 'Leonardo da Vinci' of Civitanova Marche, see Figure 5. Overall, we tested PlayWithUnicam with 60 students ranging from 10 to 19 years old. During the events, we gave seminars about ICT concepts (e.g., blockchain) that were almost totally unknown to the audience. At the end of the seminar, the students participated in a serious game, based on the seminar topic, using the PlayWithUnicam platform from their own device (e.g., PC and smartphone). Finally, we asked the students to fill out questionnaires for assessing their own feeling about the platform features and the overall system usability. The latter questionnaire has been based on the System Usability Scale (SUS) [2].

The strategy used in the questionnaire alternates questions for which the "positive" answer is somehow inverted. In particular, for questions 1, 3, 5, 7, and 9 the greater the number the better, while for questions 2, 4, 6, 8, and 10 the smaller the number the better. This technique somehow tries to avoid answers provided in a superficial way. Once all administered questionnaires have been filled, the following formula has been computed:

$$S = \frac{\sum_{i=1}^N \left(\sum_{j=1}^5 (5 - res_{i,2j}) + \sum_{j=0}^4 (res_{i,2j+1} - 1) \right)}{N} \times 2.5$$



Figure 3: Experimentation at high school.

It provides a way to get an overall score (\mathcal{S}) that can be used to globally assess the experiment results. In the formula, N represents the number of returned questionnaires, while $res_{i,j}$ is the response provided to the questionnaire by each participant (i) to every single question (j). The formula at first reconducts all the answers to the scale 0 – 4, where positive answers now always correspond to higher values. Then, for each questionnaire the total sum is computed, getting a number between 0 and 40, and the average over all the questionnaires is derived. Finally, the number is multiplied by 2.5 to get a final score \mathcal{S} in the range 0 – 100. For the experiment we ran, the calculation of the SUS score gives us the value of 76,18. According to the proponents of the SUS approach, this is a good result. Indeed, in their experience values for \mathcal{S} greater than 68 relate to perceived usability somehow better with respect to other used software. Being the involved users somehow experienced with gaming tools, this suggests that overall they got a relatively positive experience in using PlayWithUnicam.

5 Conclusions and Future Work

One of the aims of this final paper was to study the possible effects of applying game elements and video games in educational processes.

The work done and the tests carried out during the experiments showed how the game context stimulates in the students a sense of positive competitiveness and the desire to put themselves to the test by exploiting all their abilities.

The awareness of being put through a series of interactive challenges at the end of the lesson encouraged greater attention and concentration on the part of the students.

These statements were confirmed by the results of the questionnaires given to students, which also showed a unanimous belief in the versatility and effectiveness of innovative tools such as the one proposed.

Further future developments will certainly include the implementation of new game tem-



Figure 4: Experimentation at primary school.



Figure 5: Dissemination before the use of the platform.

plates to offer to the teachers to allow the creation of more interactive content, as well as the study of possible integration of standards implemented by the above-discussed competitor platforms such as Moodle.

The foundations have undoubtedly been laid for an interesting project with potential for growth, which is a valuable vehicle for dissemination and which will hopefully, in its own small way, enhance and make the processes of teaching and learning more enjoyable.

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