Enhancement and extension of the printed book: An online gamification model to complement educational textbooks

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Abstract

Despite the significant increase in the use of digital devices, and the access to e-books by younger ages, the printed book still remains very important. Nowadays, although many communication processes and information exchanges have a digital support, the importance of using printed paper is acknowledged in many contexts. Both the paper and the digital media have unique advantages: digital media integrate with audiovisual and interactive resources, and the paper book supports interactions such as tactile and kinesthetic feedback given to both hands.

In recent years there have been several commercial products designated as "augmented books", using augmented reality technologies to provide the reader with more layers of information, thereby fostering the use of the book in new ways. So, in this concept paper we describe part of the research and outcomes of project CHIC – C3, aimed at designing and developing a platform for managing the production of digital content connected with printed books. Furthermore, we propose a model for the gamification of digital content based on the printed book, mainly aimed at educational purposes. A proof of concept for the model was built in the form of a companion platform, supported by the Moodle LMS, fully integrated with the main CHIC website. Readers are able to access the platform, engage in several content related games, and interact with other readers.

Keywords: gamification, Moodle, e-learning, textbook.

1. Introduction

Despite the significant increase in the use of digital devices and the access to e-books by younger ages, mainly explained by the diffusion of tablets, the printed book still remains very important. Even for parents who prefer digital books for themselves, printed books remain the objects of choice for their children (Richtel and Bosman, 2011).

Nowadays, although many communication processes and information exchanges have a digital support, it is acknowledged the importance of using printed paper in many contexts. Both the paper and the digital media have unique advantages: digital media integrate with audiovisual and interactive resources and the paper book, as underlined by Jürgen Steimle (2012), supports interactions such as tactile and kinesthetic feedback given to both hands.

The use of augmented reality (AR) technologies in the context of the printed book has also been arousing an enormous interest both from academia and publishers. In recent years there have been several commercial products in the area of "augmented books" (e.g., The Little Mermaid; Storybooks alive; Popar), that is, books that use AR technologies to provide the reader with more layers of information, thereby fostering the use of the book in new ways.

Education in general, like any other human activity, has not been immune to the phenomenon of the "Internet of Things" (Gómez, Huete, Hoyos, Perez, & Grigori, 2013). The ubiquitous learning potential is reflected in increasing access to learning from collaborative learning environments and content supported by computers anytime and anywhere. It also allows for the right combination of physical and virtual spaces.

In this concept paper we describe part of the research and outcomes of project CHIC – C3, a project financed by the Portuguese Programme Compete 2020. The project aimed to design and develop a platform for managing the production of digital content connected with printed books. From this perspective, the book is not anymore considered as being just made of plain paper, but something that can be enhanced and become "alive" in terms of end-user experience. Mainly through the use of AR technology and a gamification platform, the project developed ways to enhance and extend the traditional book. In this paper we will discuss and report on the latter component, namely, the development of gamification and digital content based on the printed book, mainly for educational purposes supported by the Moodle learning management system.

2. Background

2.1. Gamification

Research in educational technology needs to go far beyond learning with multimedia to recognize the role of new learning experiences, for example, one that games and simulations can reveal. The learning model which we call "ludic" - based on games - can be used in formal or informal education by well-defined age groups, and can be introduced in various scientific fields. In the educational context, considering that "ludic" is not usually a priority in most activities, a game may be the motivating factor that is needed in many learning resources.

Gamification is a relatively new concept that has acquired considerable momentum over the last years. It is a concept that integrates the mechanics of gaming in non-game activities to make these more effective and enjoyable (Bidarra, Figueiredo & Natálio, 2015). When used in the educational field, gamification seeks to integrate game dynamics and game mechanics into learning activities, for example, using tests, quizzes, exercises, badges, etc., in order to increase intrinsic motivation and foster student participation.

So far, there have been essentially three approaches to Game-Based Learning (Gené, Núñez & Blanco, 2014):

- Using commercial off-the-shelf videogames, taking advantage of the existence of content in these games that can be used for educational purposes;
- Using Serious Games, a type of video game developed with non-recreational purposes where learning is the primary goal;
- Students building their own game which allows the development of problem-solving abilities, programming skills and game design skills.

Unfortunately, the production and deployment of educational games is not without difficulties, particularly:

- The high development costs and an uncertain market make investment in educational games and innovations too risky for producers;

- Institutions resist adopting innovations and do not want to make unnecessary changes and investments, including the use of new technologies for learning;
- Instructors, institutions and publishers do not (traditionally) want to replace textbooks with educational games;
- The value of specific educational technologies (games, simulations, etc..) have not been proven in many cases;
- Parents and teachers still have very negative attitudes about the use of games in the classroom;
- Games are especially suited to teach higher order skills that are not typically assessed through examinations (multitasking, decision-making, strategic vision, etc.);
- Easy access to computers and the Internet cannot be taken for granted in educational institutions (the case of many developing countries).

2.2. Moodle and gamification plugins

In order to address some of these issues, we built a learning environment based on the Moodle platform[1] Moodle is an open source learning management system with a huge user base around the world, and is widely used for distance learning. Founded on a social constructivist perspective, it is in fact a flexible enough system, to allow for the implementation of various pedagogical models (ex. Pereira et al., 2008). In particular, for the work reported in this paper, we used Moodle to test the book gamified complement model proposed in the following section.

Moodle can be extended with a plugin system in order to fulfil one's needs and application context. For this project in particular, we used the H5P[2] and "Game"[3] gamification plugins.

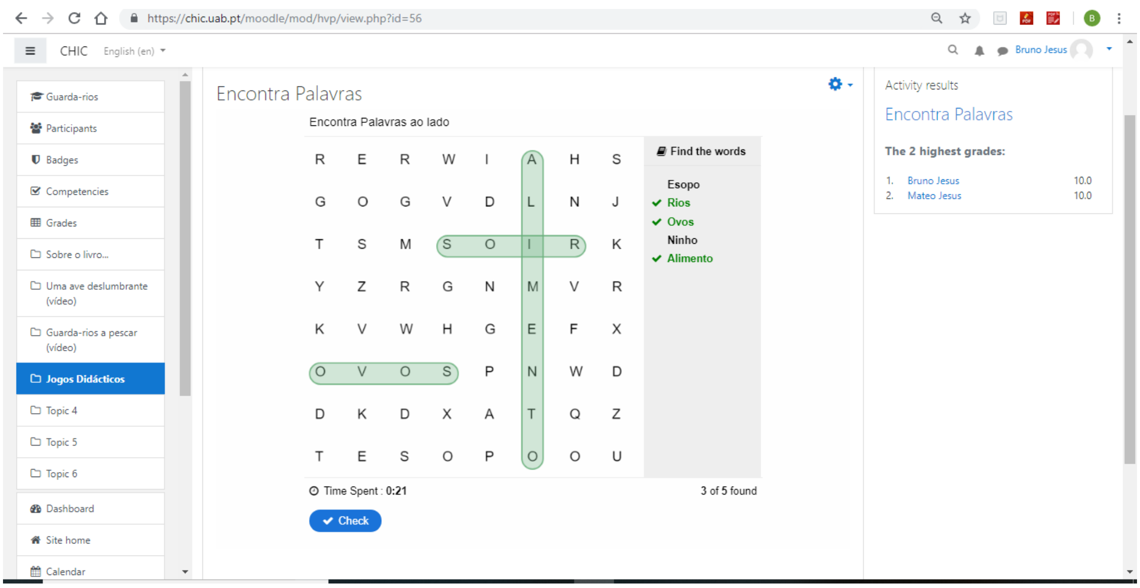

Figure 1: "Find the words" game in H5P

[1] https://moodle.org
[2] https://h5p.org
[3] https://moodle.org/plugins/mod_game

H5P is a framework for including rich media content in online learning environments. It uses recent technologies such as HTML5, Javascript and CSS for creating interactive activities with rich multimedia contents (see figure 1).

The “Game” plugin was also used to provide additional gamified activities, in particular crosswords.

A course in Moodle corresponds, in this project, to a specific book, and complements it with several online activities based on the H5P and Game plugins, as described. Books/courses are organized in categories, according to the book genre (adventure, romance, crime, western, textbooks, etc.).

Each course has a discussion forum, and a set of games from both plugins, complementing the contents of the book and providing additional engagement with it.

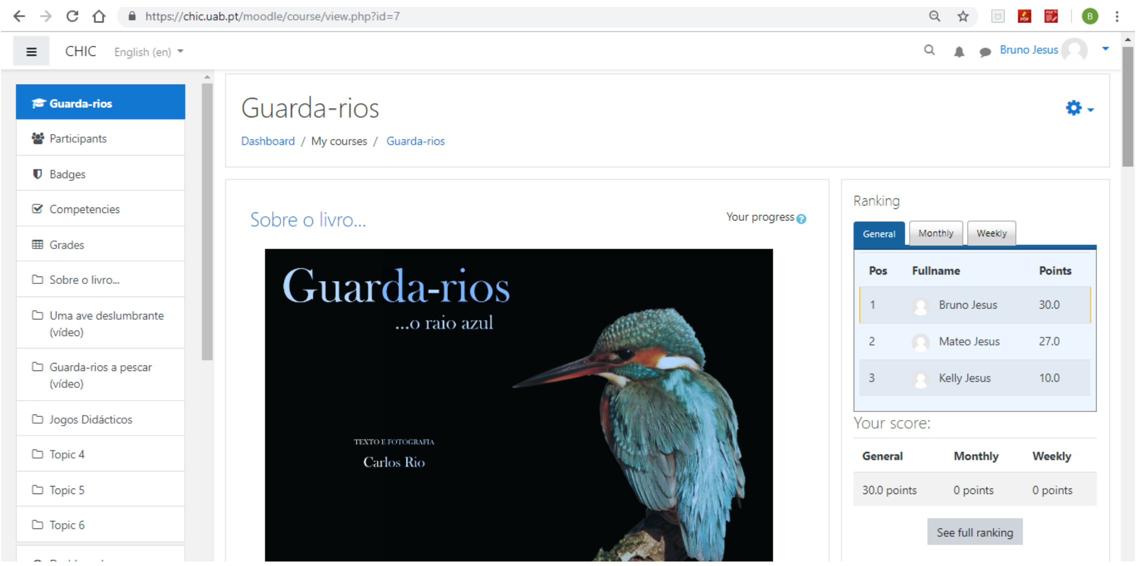

Figure 2: Score ranking block

An additional gamification element was also incorporated in the form of score ranking tables (i.e. “hall-of-fame” tables), as shown in figure 2.

3. Development of a gamification model for augmented books

The main platform of the CHIC C3 project allows the creation of an “augmented” book and its connection via external interfaces to external devices and the Moodle platform. In this sense, the structure for the platform includes the following modules:

- Users - provides user-type management features;
- Permissions Control - responsible for assigning permissions to various user types;
- Notifications and internal communication - provides functions of communication and internal collaboration, fundamental for a collaborative platform;
- Content Management - This module is responsible for the storage, organization and availability of the content;
- Connection with Moodle - responsible for integrating and exchanging data with Moodle platform;

- Collaborative book project - this module will provide all the collaborative and interactive authoring features for the “augmented” book;
- Web2Print - This is module will be integrated into the platform to allow digital printing of the book via Web;
- External API - the external API will expose a set of endpoints to enable the contact and transfer of relevant data, content, and information between the platform and external devices to be used to extend the use of the traditional book (e.g.: Mobile devices and others that may arise in the future);
- Purchase - The Purchasing module will allow to manage the functionalities of purchase orders, payments and content subscriptions;
- Hybrid experiments - This module will allow to manage the events of external devices.

The platform will be integrated with external systems such as Moodle in order to provide specialized functionalities such as transmedia content, gamification strategies, interaction through augmented reality and context dependent, etc. The creation of communities around the book and the development of gamification and transmedia strategies is being done through Moodle, an educational platform that allows the creation of personalized learning environments. Figure 3 shows the overall proposed architecture.

The main goal to attain, with the gamification tools in Moodle, is the application of elements present in video games to other activities outside the usual contexts and with educational purpose, namely:

- Comply with rules;
- Establish clear objectives and reward achievements through scoring systems or trophies (reward and return system);
- Launch challenges;
- Develop the action according to difficulty levels in order to stimulate performances and promote the creation of plots/narratives and avatars.

By this means, we are proposing a new way to develop a narrative on multiple platforms, increasing the learning and involvement of the potential user. This will help to achieve the conversion of the traditional paper into a universe of the transmedia narrative. It is a real possibility of increasing its diffusion and consumption.

4. Moodle integration and API

In order to develop this multi-platform environment, we put in place two mechanisms to promote seamless navigation: user integration and an API to exchange information with the main portal.

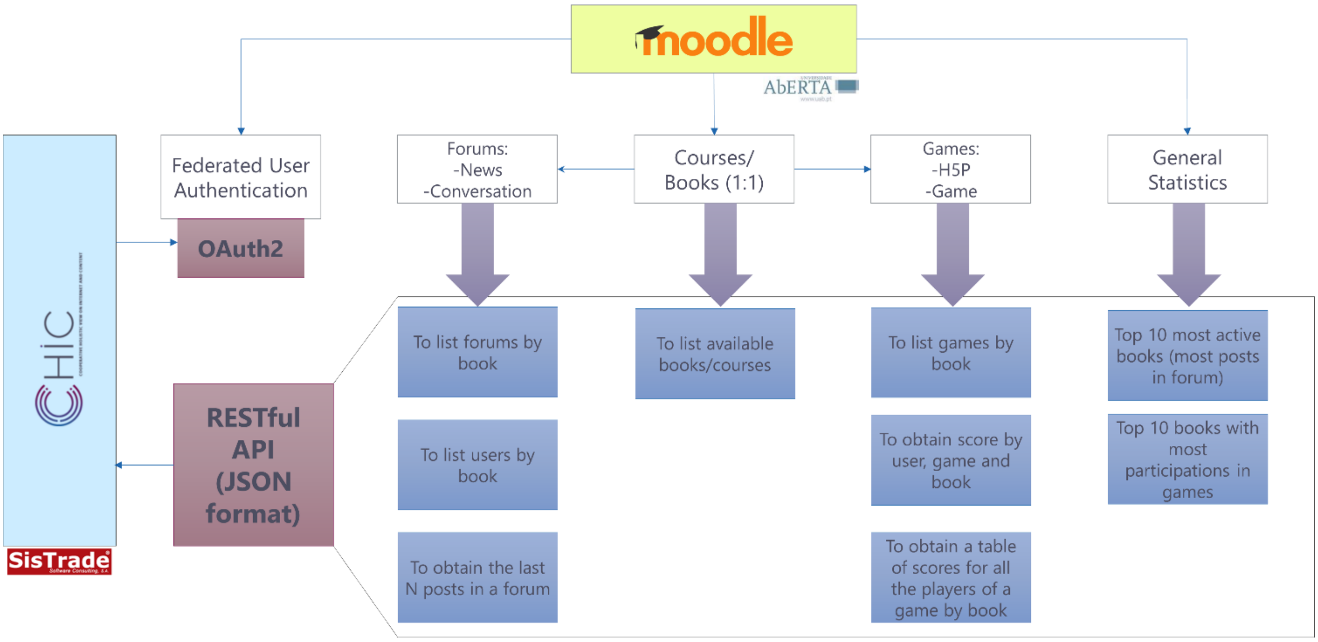

Figure 3: Platform and API architecture

4.1. User integration

As users register in the main portal, they can navigate to the Moodle platform without having to register or login again. Single sign-on is achieved through a mechanism based on the OAuth2 protocol, that Moodle fully supports, and an external federated authentication server, using the open source Keycloak technology[4]. The Keycloak server provides identity and access management services, as well as user federation, effectively allowing users to authenticate once and navigate among the various platforms of the project.

4.2. API functionality.

To further integrate information on the several platforms, we made use of the Moodle web service facilities to publish an API that provides data to be displayed elsewhere, especially in the CHIC main portal. Figure 3 graphically shows the functionality that needs to be displayed in the portal.

For this purpose, web services in Moodle were activated via REST protocol. For some of the functionalities (e.g. displaying available courses), Moodle already provides core functions to accommodate those needs. Other functions needed to be implemented as plugin web services, using templates and standard Moodle programming directives. The languages used were PHP and SQL for database queries. In what follows, we describe the API functions in some detail. A Moodle user account with adequate permissions is required, for whom an API access token is generated, and must be included in all queries, through parameter *wstoken*. The results may be given in XML or JSON formats, depending on the parameter *moodlewsrestformat*.

4.2.1. Functions related to Books/courses

- To list available books/courses

  Function: core_course_get_courses

  Parameters: <none>

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[4] https://www.keycloak.org

Call URL example:

<Moodle_address>/webservice/rest/server.php?wstoken=<token>&moodlewsrestformat=json&wsfunction=core_course_get_courses

Result: array of objects with all the information on the available books/courses

- To list forums by book

  Function: mod_forum_get_forums_by_courses

  Parameters: courseids (array)

  Call URL example:

  <Moodle_address>/webservice/rest/server.php?wstoken=<token>&moodlewsrestformat=json&wsfunction=mod_forum_get_forums_by_courses&courseids[0]=2

  Result: array of objects with all information on existing forums for the course. The main fields for each one are: id and name. Forums that allow discussion are of type "general", while the others can be ignored.

  Possible errors: if coursed does not exist, the function returns an empty array, []

- To list users by book

  Function: core_enrol_get_enrolled_users

  Parameters: courseid

  Call URL example:

  <Moodle_address>/webservice/rest/server.php?wstoken=<token>&moodlewsrestformat=json&wsfunction=core_enrol_get_enrolled_users&courseid=2

  Result: array of objects with all information on users. The main fields of each one are: id, fullname, email. The result must be filtered by the field "roles", since we are only interested in users with roleid 5 (student).

  Possible errors: if coursed doesn't exist, the function returns a structure {"exception":"dml_missing_record_exception","errorcode":"invalidrecord","message":"Can't find data record in database table course."}

- To obtain the last N posts of a forum for a book, including the users that posted them.

Function: local_get_latest_posts_from_forum

Parameters: forumid, maxposts (default: 5)

Call URL Example:

<Moodle_address>/webservice/rest/server.php?wstoken=<token>&moodlewsrestformat=json&wsfunction=local_wschic_get_latest_posts_from_forum&forumid=2&maxposts=5

Result: array of objects with the information on each post, with the fields userid, subject, message and timestamp.

Possible errors: if forumid does not exist, the function returns an empty array, []

4.2.2. Functions related to Games

- To list games by book

  Function: local_wschic_get_games_by_course

  Parameters: courseid

  Call URL example:

  <Moodle_address>/webservice/rest/server.php?wstoken=<token>&moodlewsrestformat=json&wsfunction=local_wschic_get_games_by_course&courseid=2

  Result: array of objects with game identification, each with fields id and name.

  Erros: if courseid does not exist, the function returns an empty array, []

- To obtain score by user, game and book

  Function: local_wschic_get_score_by_user_game

  Parameters: userid, gameid

  Call URL example:

  <Moodle_address>/webservice/rest/server.php?wstoken=<token>&moodlewsrestformat=json&wsfunction=local_wschic_get_score_by_user_game&userid=6&gameid=2

  Result: object with a single field score. If the game has never been played, the value is *null*.

  Possible errors: if userid or gameid don't exist, or if the user has not access to the game, the function returns the structure: {“score”:-1}

- To obtain a table of scores for all the players of a game by book

Function: local_wschic_get_score_table_by_game

Parameters: gameid

Call URL example:

<Moodle_address>/webservice/rest/server.php?wstoken=<token>&moodlewsrestformat=json&wsfunction=local_wschic_get_score_table_by_game&gameid=2

Result: array of objects with the scores of the various players, each with the fields <u>userid</u> and <u>score</u>, sorted by decreasing score.

Possible errors: if gameid does not exist, the function returns an empty array, []

4.2.3. Functions for General statistics

- Top 10 most active books (more posts in the associated discussion forum)

Function: local_wschic_get_top_active_courses

Parameters: top (default: 10)

Call URL example:

<Moodle_address>/webservice/rest/server.php?wstoken=<token>&moodlewsrestformat=json&wsfunction=local_wschic_get_top_active_courses&top=10

Result: array of <top> objects with the courses (books) and number of posts in forums, sorted in decreasing order.

- Top 10 books with most participations in games (most participated books)

Function: local_wschic_get_top_played_courses

Parameters: top (default: 10)

Call URL example:

<Moodle_address>/webservice/rest/server.php?wstoken=<token>&moodlewsrestformat=json&wsfunction=local_wschic_get_top_played_courses&top=10

Result: array of <top> objects with courses (books) and number of game participations, sorted in decreasing order.

All these API functions were developed and successfully tested in the multi-platform environment, using an example book/course about the kingfisher, a bird species occurring in Portugal. As a result, readers now have the gamification functionalities and scores on the Moodle platform, while also being able to check the same information in the main CHIC platform.

5. Conclusion

The increasing availability and use of books in the digital form has not replaced the printed form, especially in the case of children's literature. Instead of viewing digital technologies as an alternative to physical books, in this concept paper we proposed a model for enhancing the experience of reading printed books with digital contents and activities that complement the actual reading.

The proposed model is based on basic principles of gamification, and extends the content of the book by providing online activities that launch challenges, complying with rules and establishing clear objectives and achievement rewards through scoring systems or trophies (reward and return system). The action is developed according to levels of difficulty in order to stimulate performances and promote the creation of narratives and avatars.

We exemplified the application of the model in the context of project CHIC – C3, where a specific platform architecture was built to provide an enriched experience of printed books in all their phases, from production to user interaction. Through the use of Moodle and some of its gamification extensions (plugins), we were able to successfully integrate a digital dimension complementing physical books into the overall platform for the benefit of the end user. The integration was achieved through two main aspects: federated authentication of users, allowing them to login and navigate seamlessly among the various platforms, and a web service API for exchanging information on games and interaction in the Moodle platform, further adding to the sense of seamless interaction with a single system.

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