# Analysis of Gamification Techniques to Learn Complex Subjects through Collaborative Applications

Brandon Méndez and Elena Lloret

***Abstract*—Learning concepts about specific subjects may be regarded differently depending on the level of the difficulty of concept itself and the background or cognitive capacity of the student. This article analyses the motivation and perception of real users towards learning literary figures by means of a proposed application called GRAMA that includes gamification elements, and provides a collaborative and social environment. The results obtained show that this type of computer applications are motivating and useful to learn new and complex concepts in an easier and funnier manner.**

***Index Terms*—Computer Aided Instruction, Computer Applications, Creativity, Educational Technology, Social Computing.**

## I. Introduction

NOWADAYS, there are many Websites and applications devoted to the educational field, where the aspects of knowledge acquisition and entertainment are combined together through gamification and collaborative techniques in order to allow users to learn new concepts/subjects in an easier and funny manner as well as sharing this knowledge and the progress achieved with other users. An example of these applications can be concerned with the learning of concepts or subjects that may be regarded as difficult, either because they are hard to understand and involve some level of complexity, or because they require to develop creative thinking, which may not be trivial. Learning specific aspects of language, such as the understanding and creation of literary figures may be within this category.

In this article, the motivation and perception of real users towards learning literary figures is conducted through the testing of GRAMA, our proposed application that allows a user to learn and create different types of literary figures integrating gamification and collaborative techniques. To the best of our knowledge, the proposal of language-based games for this subject is innovative, which apart from learning and reinforcing concepts, they may also contribute to develop the user's creativity. Creativity is important in the educational field, since it allows to catch the attention of the students and stimulate any kind of innovative idea in them [1]. Accordingly, creativity can be enhanced with technology through games, infographics or digital storytelling tools, which improve users' creative skills and help them explore the meaning of their own work and experience [2].

The remaining of the paper is organized as follows. In Section II, a brief background with the most relevant research fields related to our application is provided. In Section III, the web application is explained as well as its different modules, design and implemented options. Then, in Section IV, the results obtained during the evaluation process are discussed. Finally, the conclusions and the future work are outlined in Section V.

Manuscript received November 14, 2016.

Brandon Méndez is with the Department of Software and Computing Systems at the University of Alicante, San Vicente del Raspeig, E-03690, Spain (e-mail: bmm53@alu.ua.es).

Elena Lloret is with the Department of Software and Computing Systems at the University of Alicante, San Vicente del Raspeig, E-03690, Spain (phone: 0034965903400 ext.3772; e-mail: elloret@dlsi.ua.es).

## II. Related Work

### A. Gamification

Gamification consists of the use of techniques, elements and dynamics of games used in environments, applications or non-recreational activities [3]. Its main purpose is to enhance the motivational, cognitive, social and emotional aspect, favoring the concentration, effort and loyalty that people usually develop in a game. Gamification has gained popularity focusing on different areas, such as language learning (Duolingo[1]) or learning more about various subjects (Khan Academy[2]). The main purpose of gamification is to enhance the motivational, cognitive, social and emotional aspect, favoring the concentration, effort and loyalty that people usually develop in a game. Among the many advantages offered by this methodology are: the improvement in the acquisition and retention of knowledge; improvement in attention and reaction time; increased user participation and the implementation of knowledge without stress or risks [4].

One of the most recognized structures for designing gamification strategies is the one proposed by Kevin Werbach, known as DMC (Dynamics, Mechanics, Components) [5].

Previous studies on gamification have proven that these techniques can engage students in learning complicated concepts related to electronics, such as digital circuit course [6]. Moreover, providing proper feedback mechanisms is also important to enhance the participation and long-term motivation of users as it was analyzed in [7].

[1] https://duolingo.com/
[2] https://khanacademy.org/

### B. *Collaborative Learning*

Collaborative learning is a didactic technique that promotes student-centered learning by promoting tasks in small groups, where students with varying skill levels use a variety of learning activities to improve their understanding of a subject. Each member of the working group is responsible not only for their learning but for helping their peers learn [8]. Online collaborative learning, on the other hand, involves learning cooperatively by sharing, with others, objectives and tasks, being the information and communication technologies mediating the process [9].

Recently, much attention has been paid to the effects that Web technologies have on commerce, the media, business and government. In particular, the interest in the impact that these tools can have on education is also growing, especially in educational institutions. The traditional approach to learning in this area tends to be driven more by the needs of the institution than by the needs of individual students [10]. A collaborative environment can be built using existing tools and APIs as long as they support some element of collaborative learning, like Mindmeister[3], Elgg[4], and Google Docs[5].

Different from existing works, our research is focused on complex linguistic concepts (i.e., literary figures), where, apart from learning, users can also develop their creativity and imagination by generating their own literary resources and sharing them.

## III. Facilitating Learning of Complex Concepts through the Use of Technologies: Case Study in the Linguistic Context

The application proposed as a case study is called GRAMA (see Fig. 1), developed in the context of the linguistics field in Spanish. More specifically, it deals with the learning of some literary figures through gamification and within a collaborative environment. GRAMA is not targeted at any particular group of users, as it is intended to be useful to any user who wants to learn about literary figures, have fun and develop their creativity. However, it is recommended that users are older than 10 years to have a solid base in the use of language and have an interest in the subject.

### A. *Literary Figures as Complex Concepts*

Literary figures are unconventional forms of using words, since they are accompanied by some phonetic, grammatical or semantic peculiarities, which differs them from their habitual use, and make them especially expressive [11]. These literary figures are considered complex because they play with the meaning of the words, using figurative language. They are mainly used for literary purposes, and their creation and use encourage creativity [12].

For our case study, we have selected 6 literary figures. The first 2 are the most popular and normally used for joy and entertainment; whereas the rest are less known, but they stand out for their expressive and creative character, where the user is bound by some condition that forbids certain things or imposes a pattern:

- Tongue-twister is a sequence of words difficult to pronounce, especially rapidly. E.g., "Can you can a can as a canner can can a can?"
- Cryptogram is a phrase or quote that has been encrypted by simple letter substitution. E.g., "2gether"
- Pun is a rhetorical figure consisting of the union of two or more syllables words, by varying the usual separation between them, in order to obtain a different meaning from its meaning in its normal position. In English, the definition of pun is different from Spanish and it refers to a word game in which two (or more) words have similar sound but different meaning. E.g., "Esconde vs. es conde" in Spanish, whereas "bears go barefoot" in English.
- Palindrome is a word, phrase, number, or other sequence of characters which reads the same backward or forward. E.g., "A man, a plan, a canal, Panama!"
- Lipogram is a literary figure in which one or several letters of the alphabet have to be avoided. E.g. (excluding letter e), "Mary had a tiny lamb."
- Pangram is a sentence using every letter of the alphabet at least once. E.g., "Pack my box with five dozen liquor jugs."

### B. *Implementation of Gamification Elements*


Fig. 1. Main view of GRAMA. URL: http://www.grama.gplsi.es/

Gamification is implemented in GRAMA by various simple games, one for each proposed literary figure:

- Tongue-twister: The user has to pronounce, using a microphone, a tongue twister proposed.
- Cryptogram: The user has to decrypt an encrypted message with the aid of an alphabet of characters.
- Pun: The user has to choose words between several proposals and replace them in the original sentence to change its meaning.
- Palindrome: The user has to match all the proposed sentence pairs, which are read in reverse of each other.
- Lipogram: The user has to find the letters that do not appear in the proposed sentence.
- Pangram: The user has to choose a word among several proposals to replace it in the original sentence, so that the resulting sentence contains all the letters of the alphabet, repeating the least number of them.

In all of them, typical elements of gamification appear:

- Difficulty levels: There are 3 levels of difficulty (Easy, Normal, Hard), in which various complexity ranges are

[3] https://mindmeister.com/
[4] https://elgg.org/
[5] https://docs.google.com/

established adapted to each game.
- Countdown: There is a timer adapted to the chosen difficulty of each game.
- Score: Depending on whether the user surpasses or not the game, can win or lose points, whose amount is determined by the difficulty level selected in the game.

### C. Implementation of Social and Collaborative Part

GRAMA has an important social part, which requires the collaboration of its users. On the one hand, a complete authentication system (registration, login, and password recovery) to access the content of the application. Once inside the application, the user can create literary figures, with the help of different resources (search for words that contain or not certain letters, that have a certain prefix or suffix, etc.), depending on the literary figure, to post and share them later. All publications can be viewed with the possibility of using several filters for it (more/less recent, better/worse rated, or only user's own publications). In addition, these publications can be evaluated positively or negatively, and reported, justifying previously the reason (incorrect category, syntactic error, grammatical error, inappropriate content, etc.). Furthermore, each user can perform a search to add other users to his/her friends list, manage their friend requests (sent and received), and view his/her friends list. The user can also view his own profile (which is visible to other users as well), edit it and exit the application.

In summary, apart from being able to search and add users, GRAMA offers the possibility of commenting on other users' posts, rating them or sharing them. Likewise, by way of correction, users can warn of any errors found in any post, either grammar or because it does not correspond with its category.

### D. Design and Development of GRAMA

GRAMA is a web application, so it has been developed using the main techniques and web technologies, such as HTML5, CSS3, JavaScript, jQuery, Bootstrap, PHP, Ajax, and Speech Recognition, among others.

As for the design, several well known trends have been followed, such as Flat Design and Responsive Design, which allow the application to maintain a minimalist trend and adapt perfectly to the resolution of any device. In addition, we have followed the standards set and accepted by the W3C[6] in terms of accessibility.

Given its social and collaborative nature, as recommended by several studies on color psychology [13], different shades of blue and gray have been used for most backgrounds and containers, as well as simple but original and creative fonts for capture the attention of the user. In addition, User-Centered Design [14] has taken into account during the development of the application, where the Scrum-ban methodology [15] has been used.

The content is structured in several sections and subsections, where gamification techniques and social and collaborative aspects detailed above are implemented:

- Home: Literary figures, with the option to visualize, create and play, in each of them.
- Profile: View and edit the profile, with the option to exit the application.
- Friends: Search, add, visualize and manage friends.
- Statistics: Briefly visualize the total and specific score obtained in each literary figure, and view the history of actions performed.

## IV. Evaluation and Results

Once the application was finished, it was necessary to evaluate the users' knowledge and opinion regarding the learning of complex concepts in collaborative environments through gamification, and more specifically literary figures. Furthermore, as part of our case study, it was also necessary to obtain the evaluation of GRAMA after its use.

### A. Participants

The evaluation was aimed at users of any background (studies and occupation), age and sex. This is because we were interested in obtaining the general knowledge of different types of users in the field of linguistics and the use they make of applications dedicated to learning. Therefore, a sample size of 30 users was obtained as participants.

### B. Instruments and Methods

A questionnaire was the main instrument to conduct the evaluation. A survey was created using Google Forms[7]. It was anonymous and it was composed of 20 questions (18 of them compulsory and with a single answer, and 2 optional ones for feedback and suggestions). The survey was divided in 4 sections:

- Preliminary information: it was intended to know the gender, age range and level of studies of the user surveyed to verify that the results were not biased by a specific type of users.
- Learning methodology: it was sought to know if the user used learning applications that employed similar methodologies, the concept and knowledge they had of this field and the literary figures and the utility they attributed to it.
- Use of GRAMA: the user was required to access the application and use it to answer the last part of the survey.
- Feedback: it was intended to know the assessment and the user's opinion after having tested the application.

Another method used during the evaluation process was the preliminary observation of a small group of users, different from the 30 participants, to know how to interact with the application as well as their initial opinion. This method allows to obtain important data that with other methods goes unnoticed.

### C. Results

The online survey was distributed via several channels (social networks, mailing, orally, etc.) and we finally got the answers of 30 users, who used the system for a while (spending most of the time on the games). The users were

[6] https://w3.org/standards/

[7] https://goo.gl/wmMhC8

balanced according to their gender and they belong to the age range between 20 and 50 years old. Most of them had at least university studies in fields such as science or education. As far as the remaining sections of the survey (learning methodology, and use of GRAMA), positive and encouraging results were obtained, which are discussed in more detail in the next section.

Finally, regarding the feedback provided, users think that GRAMA is very nicely designed and useful for the society. As for the method of observation, it was confirmed that the application was entertaining and easy to use, as the users found everything quickly and repeated some of the actions, like playing, for fun. As suggestions, users encourage the adaptation of the application to other languages, as well as to include more literary figures and more types of word games for each one.

### *D. Discussion*

We focus now in the results obtained with respect to the learning methodology and use of the application.

Concerning the learning methodology, only the 53.3% of the participants had previously used applications that integrate the gamification aspect (e.g., Duolingo). However, 80% of the users thought that the use of the Web 2.0 would be very useful for sharing doubts, questions it they had difficulties for learning a complex subject. With respect to their previous knowledge about literary figures, 40% of them did not have any idea of them. Moreover, we also confirmed that literary figures are not frequently used, since 86.7% of the responses stated that literary figures were never or seldom used, being only studied at school by the 6.7% of them. This confirms that this is very specific subject not normally used, and therefore it could involve some level of difficulty when learned.

Regarding the evaluation of GRAMA, 73.3% of the users found it really helpful to be able to see examples of literary figures created by other users so they can better understand the concept and create their own ones. All the participants fully agree (100%) in the usefulness of being able to rate other's literary figures and get comments about the ones they created. This reinforces the collaborative aspect within GRAMA that allows users to publish and share their own literary figures and get comments from other users.

Also, the integration of gamification is seen very positive by all the users (100%), since they think that it is a funnier manner to learn and acquire new knowledge in which they would not be interested in without this type of games. These results indicate that gamification techniques increase the motivation of users towards learning new concepts and their engagement with the application. In addition, users find the system useful because the games and resources offered have also enabled them to develop their creativity and improve their expressive skills in some ways. About the societal impact of this type of applications, 66.7% of the participants thought that it would be a good idea to integrate and use them at education centers (e.g., schools, learning centers) to reinforce and practice the concepts taught about this subject. Finally, there is full agreement among the users (100%) in the fact that the existence of similar applications for learning complex concepts applied to other subjects would be necessary and desirable.

## V. Conclusion and Future Work

We have introduced learning methodologies based on gamification as well as including social and collaborative aspects in a web-based application called GRAMA to facilitate the knowledge and use of complex concepts, such as literary figures. The application has been tested with real users to know their opinion and assess their motivation towards learning these concepts through a computer application. The results obtained clearly show the benefits of gamification and collaborative learning to acquire new knowledge about unknown concepts, as this issue was noted by all the users who tested the application.

In the future, we plan to take into account the feedback given by users to improve the application, as well as to conduct a more exhaustive and longer evaluation with targeted user groups, such as students.

## References


[1] M. Csikszentmihalyi, R. Wolfe, “New conceptions and research approaches to creativity: Implications of a systems perspective for creativity in education,” The systems model of creativity. Springer Netherlands, pp. 161-184, 2014.

[2] L. K. Gundry, L. F. Ofstein, J. R. Kickul, "Seeing around corners: How creativity skills in entrepreneurship education influence innovation in business," The International Journal of Management Education, vol. 12, no. 3, pp. 529-538, 2014.

[3] S. Deterding, D. Dixon, R. Khaled, and L. Nacke, “From Game Design Elements to Gamefulness: Defining ‘Gamification’,” in Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments, pp. 9-15, September 28, 2011.

[4] W. H. Huang and D. Soman, “A Practitioner's Guide to Gamification of Education,” Technical Report, Rotman School of Management University of Toronto, Canada, December 10, 2013.

[5] K. Werbach, and D. Hunter, “For the Win: How Game Thinking Can Revolutionize Your Business,” Wharton Digital Press, October 2012.

[6] Q. Wu, Y. Zhu, and Z. Luo, “A Gamification Approach to Getting Students Engaged in Academic Study,” Bulletin of the IEEE Technical Committee on Learning Technology, vol. 17, no. 4, December 2015.

[7] A. Mazarakis, “Using Gamification for Technology Enhanced Learning: The Case of Feedback Mechanisms,” Bulletin of the IEEE Technical Committee on Learning Technology, vol. 17, no. 4, December 2015.

[8] Strijbos, J. Willem, “Assessment of collaborative learning,” Handbook of human and social conditions in assessment, pp. 302-318, 2016.

[9] A. Enein, Basil H, “Online collaborative learning: Opportunities for interprofessional education,” Computers & Education, vol. 54, pp. 1137-1144, 2017.

[10] E. Karahan, G. Roehrig, “Use of Web 2.0 Technologies to Enhance Learning Experiences in Alternative School Settings,” International Journal of Education in Mathematics, Science and Technology, vol. 4, no 4, pp. 272-283, 2016.

[11] R. A. Harris, “Writing with clarity and style: A guide to rhetorical devices for contemporary writers,” Routledge, 2016.

[12] J. Pollack, “The Pun Also Rises: How the Humble Pun Revolutionized Language, Changed History, and Made Wordplay More Than Some Antics,” Gotham Books, 2011.

[13] A. Elliot, and M. Maier, "Color Psychology: Effects of Perceiving Color on Psychological Functioning in Humans," in Annual Review of Psychology, vol. 65, pp. 95-120, January 2014.

[14] M. R. Endsley, “Designing for situation awareness: An approach to user-centered design,” CRC press, 2016.

[15] A. Reddy. “The Scrumban [r] evolution: Getting the Most Out of Agile, Scrum, and Lean Kanban,” Addison-Wesley Professional, 2015.