

MAGICLEARNING: A SERIOUS GAME FOR LEARNING BASED IN A MAGIC WORLD

PEDRO J. MUÑOZ-MERINO, FRANCISCO MARTÍNEZ SÁNCHEZ
MARIO MUÑOZ-ORGANERO AND CARLOS DELGADO KLOOS

Department of Telematic Engineering
Universidad Carlos III de Madrid
Avda de la Universidad, 30. E-28911 Leganés (Madrid), Spain
{ pedmume; munozm; cdk }@it.uc3m.es

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ABSTRACT. *This paper presents a new software educational system called MagicLearning that we have designed and implemented. MagicLearning enables each student to be in a multimedia virtual world in which he/she is a magician. The magician has to find several educational challenges (such as questions, crosswords, or reading contents) that are in the magic world and, depending on his/her performance, can then obtain various magic powers (such as invisibility, different types of attacks, or robbing colleagues' notes). The student can apply these powers against monsters, other players or himself/herself. As a result, students will experience more enjoyment while they are learning, so we can expect student learning and motivation to improve. The MagicLearning system also generates adaptive notes for each student related to the specific student interactions, meaning that the better notes a student produces, the better their performance in the game will be.*

Keywords: Intelligent tutoring systems, Education, Serious games, Motivation

1. Introduction. The use of Intelligent Tutoring Systems (ITSs) in education can create a set of advantages. ITSs allow students to create intelligent adaptations of contents or problems so that resources can be personalized in relation to the students' profiles or interactions. ITSs can be available anytime and anywhere (e.g., they can be accessible through the Web or installed as a standalone application in a computer). They use powerful multimedia materials which are very attractive, or can execute other complex processing tasks quickly (e.g., the automatic evaluation of exercises). All of these advantages can be applied for different purposes, such as for improving established educational pedagogies or motivating students more.

Different psychological works highlight the importance of motivation and enjoyment during the learning process. Article [1] explains how motivational factors in education have implications for students' behavior and learning gains. Two types of motivation can be distinguished: intrinsic and extrinsic [2]. Intrinsic motivation is related to the internal enjoyment of a person when they carry out an activity. Extrinsic motivation is related to some external factor (e.g., passing a course, or obtaining positive feedback) that can encourage a student to act. Key thinkers about motivation in education include Thorndike [3] who stated that rewarding a student for an action makes him/her want to repeat it, and penalizing a student for an action makes him/her to avoid it in the future. Thus a student who is motivated and enjoying the process can learn in a more thorough and productive way. If a student is enjoying something or receiving awards for making things correctly, then he/she will like to go deeper into it, and he/she will be able to make better use of their learning time.

The gamification concept is gaining momentum in science education. Activities that have traditionally been non-game activities and that might be in some way boring are increasingly being ‘gamified’. Gamification can also be applied to many different fields such as economics, social networks, or education. The first summit conference about gamification has been proposed [4].

In this context, the production of serious games for learning has been increasing, as they provide an excellent motivation and enjoyment scenario. A number previous of experiments with the use of serious games in the classroom produced very positive results. Several of these serious games for learning can be seen as specific cases of ITSs because they do not only provide typical features of a game but of ITSs. There are a lot of possibilities and options for combining games and learning, and it is a challenge to explore new games for learning. Our initial motivation for this work was to design an innovative computer based tool that allows students to learn in a “magic world” in which they are magicians who can gain more powers depending on their performance, while being motivated and having fun.

In this article, Section 2 explains how an innovative game, which is related to this magic world, works. Our approach is compared with those featured in previous works. Section 3 describes the tool being implemented in detail with an explanation of the different features, while Section 4 gives a practical example and Section 5 is devoted to our conclusions.

2. Problem Statement and Preliminaries. There are now a number of serious games driven by computers that try to promote student learning while students are engaged in different learning activities. There is a whole universe of possibilities for this approach. Our challenge here was to make a new game creation platform for learning by using computing technologies which would deeply enhance student learning. Specifically, the initial motivation was to design a “magic world” in which students can be magicians while they are learning. We think that students can have a great deal of enjoyment be very motivated in such a scenario, which involves them interacting as if they were movie or cartoon characters. The “magic world” environment can give them a powerful intrinsic motivation, while the various features of the game can provide extrinsic motivation, as outlined in the theories referred to previously. These include the provision of rewards or penalties for high or low performance. There are many options by which the learning process can be orchestrated through the framework of such a game.

A problem statement can be formulated to describe how to design this magic world and to provide aims for the learning process, so that students can enjoy, be motivated and learn, according to theories of intrinsic and extrinsic motivation. In addition, there should be a way of enabling teachers to design different features. A number of different issues can be identified regarding this problem statement. These include the need to

- Specify the final objective of the magicians (students) in the game.
- Specify the different powers that the magicians might have.
- Specify how the magicians can obtain the different powers.
- Specify how the magicians can apply those powers.
- Specify the different learning activities in the game.
- Specify the connection between the learning activities and the magicians’ powers.
- Specify a graphical interface for the magic world.
- Specify how learning materials for each student in the system can be personalized.
- Specify how teachers can adapt different pedagogical materials into attractive formats in the “magic world”.

Different games have been proposed that use information and computation systems. Some examples are described in [5-10]. In these educational games, some learning challenges are usually generated for students. Depending on the students' performance in them, they can obtain certain rewards. For example, article [5] presents a crossword challenge and paper [7] different types of questions. The novelty of our MagicLearning system is not the types of questions or challenges, since they can be present in other games and systems, with even more powerful features. For example, there are systems that provide different types of exercises but also include different hinting functions (e.g., [11-13]). Our MagicLearning system might implement other types of exercises and features that are included in other games or ITSs, and these features could be independent from the game's fantasy story. For example, adaptation of hinting techniques might be included, taking into account that they can produce different learning gains, depending on the circumstances.

On the other hand, the state of the art games have implemented different scenarios for the learners. The work of article [6] converts students into virtual pets. In our MagicLearning platform, students are converted into virtual magicians. This is obviously a different concept, but the idea of converting them into something that is not possible in real life would still be the same. Article [9] shows a graphical adventure in which doors are opened or closed depending on the students' performance. In our MagicLearning system, powers are given to magicians depending on the students' performance, so there is a similarity in that the students' performance influences something, but the story is different. Finally, article [10] mentions an authoring tool for the creation of different scenarios, while our game has a specific given scenario based on the "magic world".

Other competition tools are also introduced, based on questions such as [14] and [15]. With our MagicLearning tool, there is some competition (e.g., arriving first to challenges can have an analogy to procedures in [15]), but its main focus is not on competition but is oriented towards the motivation and enjoyment provided by a "magic world".

Therefore, although there are certain features of other games or systems that can be seen as analogous to ours (questions as challenges, rewards or penalties depending on the performance or virtual fantasy characters), the novelty and innovation of our work relies on the way in which the "magic world" fantasy is designed, particularly in terms of the specific types of powers implemented in a learning tool (e.g., invisibility, copy a part of notes, teleportation, push, fly, paralyze) and the possible interactions between the players in a learning context (with different graphical screens, monsters and other magicians). This will be explained in detail later.

3. Description of the Tool and Justifications of Its Features. This section features a description of the tool with its different features, showing how the problem statement issues of Section 2 can be solved. First of all, there are two different accessible profiles: teachers (or administrators) and students (or magicians). Teachers can access different screens to create different games driven by the magic environment, manage the game contents (including creating challenges and additional support material) and configure some parameters of the magic world, while students can view the different screens of a specific magic world game. Figure 1 shows the initial screen of the platform in which students and administrators can make requests for registration or log in if they already have an existing account. Each teacher can create as many games as they desire, but these are not shared with other teachers (so each teacher has its own space within the system). The teachers are required to create specific materials for students and different games for different courses, so that the tool can be used for many different topics, but not only for a specific topic.



FIGURE 1. Initial registration and log in screen for the system

The final objective of a student in the game is to obtain the best final course notes they can without being removed from the game by other ‘monsters’ or students. This objective is intended to provide motivation for students so that they can obtain the best learning materials, and doing so will depend on their performance within the system, as will their survival as a character in the system. In addition, students can enjoy the experience while interacting with ‘monsters’ and other students, and this enjoyment can produce a better learning experience.

A student can move through different screens within the game, in which he/she can find monsters, other players and walls. A student should look for different learning challenges that are present in the different game screens, and depending on his/her performance on those challenges, a student will obtain different magic powers that can be applied later against monsters, other players or even himself/herself. Depending on a student’s performance on the different learning challenges, the number of learning challenges that a student can find in the game, and in the interaction with other players, each student will receive different final notes.

This section is divided into the following subsections: Subsection 3.1 presents the graphical environment of the magic world, Subsection 3.2 explains the different types of learning activities and challenges, how challenges can be taken up and the implications in terms of the possible powers the magician can gain, Subsection 3.3 enumerates the different powers, Subsection 3.4 explains all the different interactions of a magician (with other magicians, ‘monsters’, or how they can apply the magic powers), and Subsection 3.5 is devoted to explaining how the final notes for each student can be created.

3.1. Graphical environment. Figure 2 shows the main game player screen for MagicLearning. The screen is divided into 4 parts: options menu (upside), obtained powers (left side), additional features (downside), and graphical section (in the centre).

The options menu contains choices to save or pause the game, configure the keyboards for different actions, request for help about the game, or close it. In addition, the “topic information” is particularly important. Using this option, a player can obtain a set of contents about a specific topic. These contents are support material for helping students achieve the different learning challenges and are submitted by teachers. Teachers configure the number of topics. For each topic, there is a screen like the one in Figure 2. For each screen or topic, teachers set the contents (which can be viewed in the “topic information” option). All students can see the same contents (which are not adaptive), that are established by teachers. This feature enables students to request content and allows them to use new content to learn new things, some of which may well be useful in their learning process if they are stuck on some question, e.g. it can be seen as hints as to the usefulness verified in different works.



FIGURE 2. Main game player screen

The powers a student obtains are contained in a list (left side of Figure 2) including the different types of powers in the game and with a corresponding number indicating the number of powers that a specific student has at a specific moment.

The additional features include a sound button (to enable or disable the game sound), a notes button (with which the student can add his/hew own notes related to the topic, and edit or remove previous notes that he/she has entered), an attack button (to attack 'monsters' or other players using the current powers of the player), and a compass (for indicating the position on the screen of the closest challenge related to the magician).

In the graphical section, we can observe the following different objects in Figure 2.

- Magician. This represents the own student's character. The magician can move through the different positions and go into other screens.
- 'Monster'. These are represented in black, and they are objects that are moving and can take players' lives if they touch the players.
- Walls that can be traversed. They are represented as leaves.
- Walls that cannot be traversed. They are in the lower side of the screen for Figure 2.
- Challenges. Figure 2 shows a challenge represented as an eye. Players can take up challenges by moving into them. Each challenge can only be taken by one player. Once a challenge is taken by a player, this challenge is not visible to the rest of the players. Three different types of symbols are used for challenges, and which one is used depends on the importance of the challenge, which is configured by the teacher.

The graphical element is created to involve students in an enjoyable gaming experience, so that they can learn while they are having fun playing a game with different characters.

3.2. Learning activities and challenges. The different learning activities or challenges are represented graphically in different ways depending on their importance. There are 3 levels of challenge importance, so 3 different graphical symbols (one is an eye) are used. For each topic (that is associated with a specific screen), there are different challenges

that can be visualized through that screen. The first player that takes a challenge can try to solve that learning activity, and the rest of players cannot view that challenge again. In this way, a certain amount of competition with other players is created, in order to see who will be the first to obtain the challenges, because once a challenge is taken, other players will not be able to take it again. All of this motivates students. In addition, a player can know the direction on the screen of the learning activity that is closest by using the compass.

The challenges can be of different types and are configured by the teachers. Challenges and learning activities are good for learning by themselves, as students learn while carrying out tasks by means of an active learning philosophy that justifies their inclusion. These are some examples of the possible learning activities that can be proposed in the game:

- Multi-reponse test. There is a question with N possible choices and S solutions ($S \leq N$).
- Association. Different terms or concepts must be paired two by two.
- Fill in the blank. A student must fill in one or several blanks with one or several words.
- Guess the mistakes. A student must guess sentence mistakes and provide a correct one.
- Find. A student must find some bibliographic information.
- Search. A student must search a list of terms in a password diagram.
- Read. A student must read a text and understand it. Later, the student is asked about some questions in the text.
- Memorize. A student must read a text and memorize it. Later, the student is asked to reproduce the full text.
- Numerical. A numerical exercise is presented and the student must give solutions. The teacher can also help with a blackboard explanation, and can include an image that supports students in resolving the challenges.
- Sort. A student must sort out a list of given terms or facts.

The MagicLearning platform provides an environment in which teachers can create various different games (e.g., for different university courses). For each game, MagicLearning enables the configuration of different topics, and for each topic, the tool provides a teachers' interface to configure the different challenges. Moreover, MagicLearning provides a player with the opportunity to show and perform the different challenges or learning activities for students. Figure 3 shows, e.g., the search challenge interfaces for a teacher and for a student. A teacher must introduce the different words to search for in the crossword. The computer game can put these words in different ways in a random way within a crossword (e.g., row or columns, direct or inverse reading) and a student must later find these words in the crossword.

3.3. Magic powers of the magicians. Students can obtain different powers depending on their performance of the different challenges or learning activities and the established importance of each learning activity that they solve. If a challenge is of high importance and a student solves it correctly, then the system gives the student more powerful powers. Therefore, the powers obtained are adaptive for each student. Achieving of these powers creates motivation for students and allows them to execute specific actions that would not be enabled without those powers. These powers are designed in a way that can be encouraging for students (as a game, as a learning activity, for interacting with other students, for obtaining notes, etc.). The main types of powers magicians can gain are as follows:

- Taking lives. Each magician and each ‘monster’ have a number of lives (an integer) that can be increased or decreased. There are some attacks that make ‘monsters’ and magicians lose a number of their lives. If a magician loses all his/her lives, then game is over. If a ‘monster’ loses all his/her lives, then it will disappear from the screen.
- Copying a part of notes. If this power is applied against a ‘monster’, then it disappears. If applied against a magician, then the magician that applies the power copies a part of the note book of the other magician. The part that is copied is randomly chosen.
- Taking other magicians’ powers. If this power is applied against another magician, then the magician that suffers the attack will lose one power. The selected power that is removed is chosen randomly.
- Teleportation. This power allows a magician to teleport from one side of the screen to another in order to avoid situations in which he/she can be attacked.
- Flying. This power allows magicians to fly over all the objects and characters (e.g. through walls). In this way, walls, or other magicians are not a limitation for moving along the screen.
- Push. This power allows a magician to push ‘monsters’ or other magicians.
- Paralyze. This power allows a magician to paralyze ‘monsters’ or other magicians.
- Recovery. This power allows a magician to recover 10 lives.
- Immunity. This power protects a magician from any attack, power or ‘monster’ for about 10 minutes.
- Uncontrolled. When this power is executed, the receiver will not have the usual control (e.g., with the keyboards) and their movements will be unpredictable.
- Invisibility. This power allows a magician to be invisible for a certain period of time.

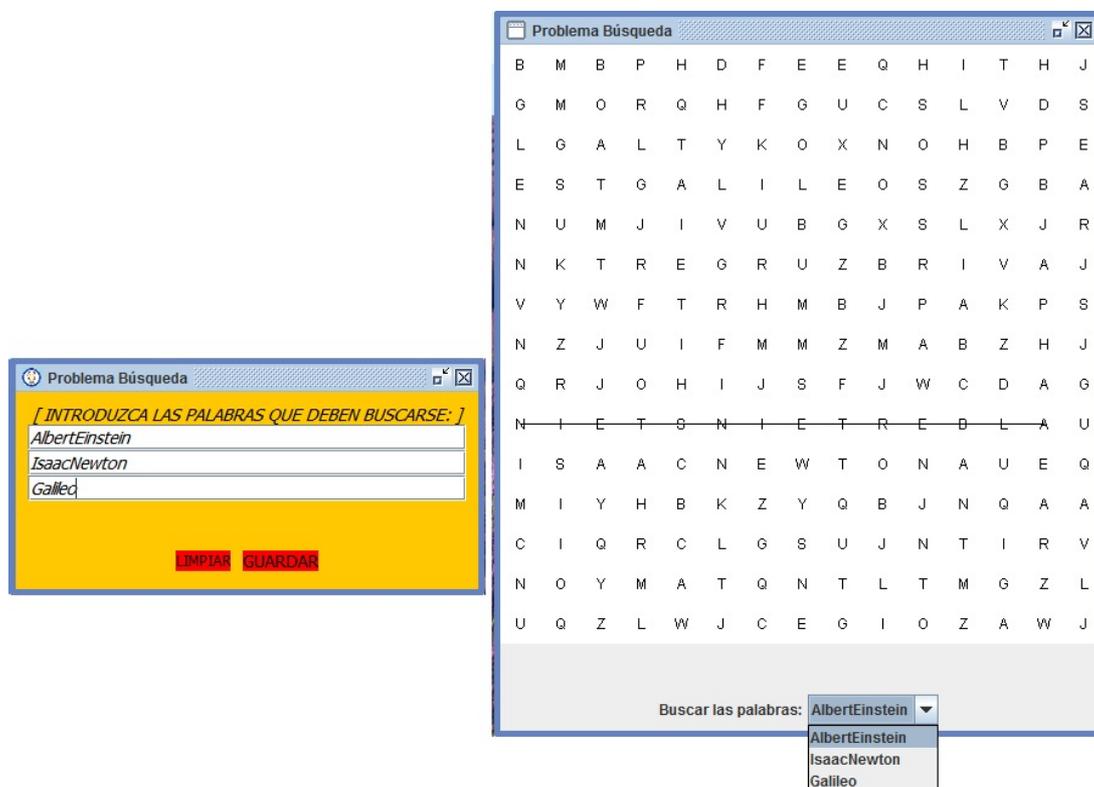


FIGURE 3. Search challenge interface for teachers (left) and students (right)

- Massive attack. This power will kill all the ‘monsters’ around the magician, and will take some lives from the magicians that are around him/her.

3.4. Possible interactions. MagicLearning enables a wide spectrum of interactions for magicians during the game. These interactions can consist of interactions with other subjects (magicians or monsters) or with some objects (e.g., challenges, or walls). These interactions are intended to encourage fun, learning, competition, etc.

A magician can apply some of the powers against another magician or another monster. To do so, he/she must press the “attack” button and select the power to be applied and the person or ‘monster’ to be attacked. The different powers are represented by different graphical symbols (see Figure 2). If a magician receives an attack, the student that receives the attack is notified.

‘Monsters’ can catch magicians. If a monster catches a magician, then the magician loses lives. Magicians have an initial predefined number of lives that can be increased with different powers, but that can also be decreased if ‘monsters’ catch them, and also if other magicians apply certain attacks to magicians.

Magicians have to find the different challenges through the screen. The closest challenge of a magician is indicated by the compass sign. Once a challenge is taken by a magician, then this challenge cannot be taken by another magician. Therefore, there is a kind of competition for obtaining the different challenges or learning activities.

Magicians can go through the different screens. In a screen, they cannot jump the walls of the scenario unless they have a special power that allows doing it.

3.5. Final notes for each student. Finally, each student obtains personalized notes regarding the topics of the configured game. This is a motivational objective for students during the game. These specific students’ notes are adaptive and depend on the students’ interactions with MagicLearning. The specific students’ notes include the following:

- All course materials that the teacher has uploaded for the different topics. These materials are common to all students or magicians.
- The materials related to the challenges or learning activities that a student has experienced during the game, removing such materials that were stolen by other magicians because of the application of a power.
- The specific written notes of that student in his/her digital notebook, removing such specific notes that were stolen by other magicians because of the application of a power.
- The materials that a magician stole from other players because of the application of a power.

4. Example for a History Course. This section presents a practical example of use of the MagicLearning innovative tool in a history course. The initial context of the example is the following: some students find studying history using the traditional educational approach rather boring. In a traditional approach, teachers explain historical concepts and students are basically listeners. Sometimes, students are asked certain questions that they must solve in the classroom. In place of that approach, we propose the use of MagicLearning for that history course. With MagicLearning, students can be involved in a game, be motivated and have fun while they are learning history.

Next, we comment on the teachers and students’ views on this practical example of using MagicLearning.

Firstly, teachers configure the number of screens of the game, the content related to history, the history challenges, and the parameters of the system. Figure 4 is an example of teachers’ generated contents regarding the American revolution and the early United

States (this can be seen as material help for students), as well as a reading learning activity challenge that is composed of 3 questions about American history.

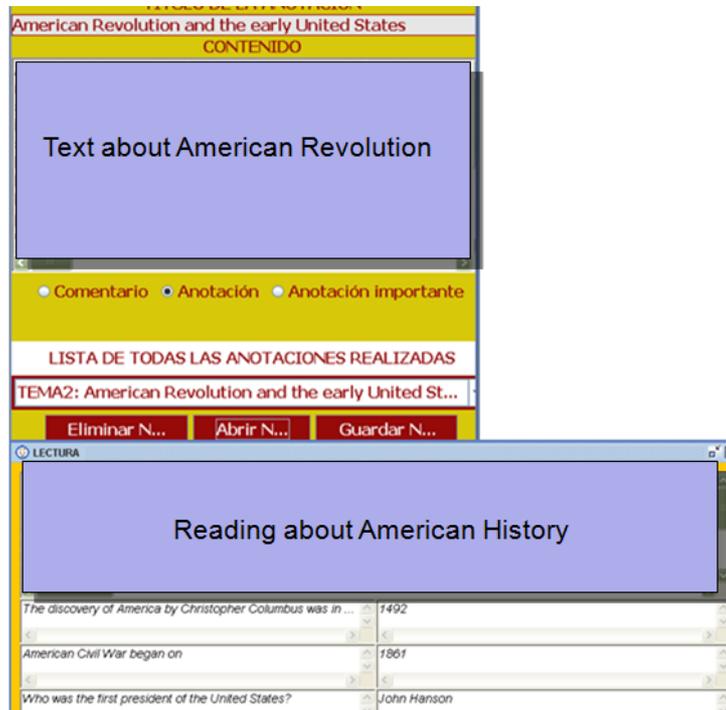


FIGURE 4. A teachers' interface when configuring a history course

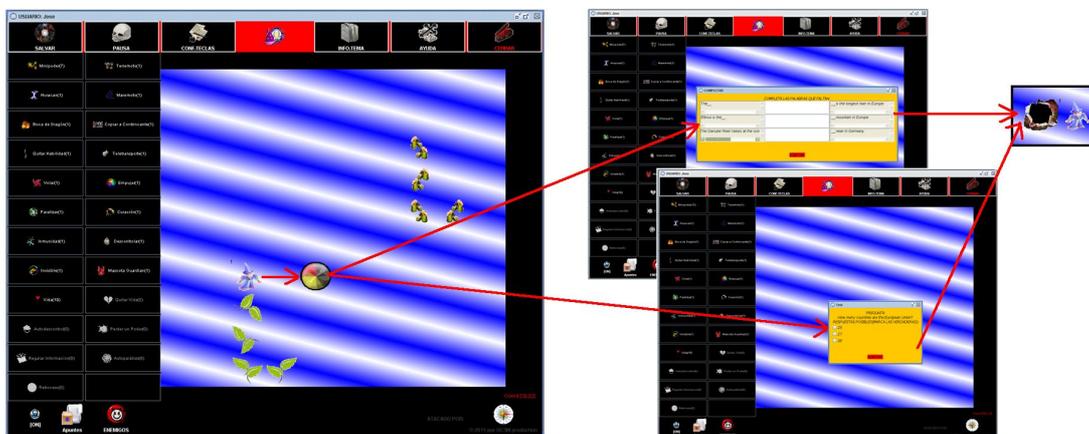


FIGURE 5. Students interface when interacting in a history course

Each student can access the game to learn history. Figure 5 is an example of a student view of the history course. Each student can view himself/herself as a magician, and can see other students as other characters, as well as 'monsters' and walls. This creates an environment that motivates and encourages students to learn history while having fun. They do not only solve history questions but also try to avoid losing lives, and can try to attack other monsters or classmates, and apply different magical powers over them for their own benefit or to attack others. These other tasks that are connected to games are enjoyable for them, improving the learning experience of learning history through these additional non-related tasks.

Students also compete to be the first to get the challenges (the circle of Figure 5 represents a challenge) because the one who is first obtains a specific power if he/she solves the challenge correctly. Students perform different learning activities and challenges related to history that are automatically corrected by the computer based system. In this way, students learn history. Furthermore, students can view the teachers' general content materials that explain the different concepts about history.

Students have also the final objective of obtaining the best notes, and for this purpose, they can interact with other students, adding notes directly, or can copy classmates notes.

To summarize, with MagicLearning, students can relate learning history to having fun. If they have fun, they will learn more and will want to spend more time learning by themselves, so the learning process will be improved.

5. Conclusions. In this paper, we have proposed an innovative game environment for learning using a computer based system. The idea is that if students are using an engagement game, they will enjoy their learning process and will learn better and more. The game scenario is innovative as it involves a magic world in which students are magicians, and have to interact with monsters and other magicians. Magicians can obtain many different magic powers (some of them with educational implications), and need to solve different challenges or take on learning activities that have an educational content, but also a connection with the magic world. In this way they obtain powers, depending on their performance of the different challenges and how important they are deemed to be. In this way, a connection between the fantasy magical world and the educational materials is achieved, in a motivating environment. This work has a strong practical application as the tutor system is available as software and can be applied not only to one specific subject, but to many others as well. Many different future work can be carried out in this field, such as the detection of students' emotions during the games and the reactions of the system, referring to previous literature, or conducting evaluations with real students of learning gains, and improvements in motivation or behavior.

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