Plug-in for creation of gamified courses in the e-learning environment moodle

M Gachkova\(^1\) and E Somova\(^2\)

University of Plovdiv “Paisii Hilendarski”, 24 Tzar Assen st., 4000 Plovdiv, Bulgaria

\(^1\)mariq.gachkova@gmail.com; \(^2\)eledel@uni-plovdiv.bg

Abstract. The article examines the challenges associated with designing and delivering effective training. The authors propose the use of serious games in learning (in particular gamification) to achieve higher motivation in learners than traditional e-learning. Pedagogical approaches, theories and pedagogical models, suitable for the design and construction of gamified e-courses are presented and analysed. A plugin is presented for creating gamified e-courses in a Moodle e-learning environment. The plug-in can be used to automatically transform a standard e-course into a gamified one or the initial creation of a gamified course. It is shown how standard Moodle environment elements can be used in game contexts.

1. Introduction
The accelerated development of technologies has led to a drastic change in the image of the modern learner. The passive trainee of the past has become an active, searching and demanding learner who wants fast, attractive, quality and effective education based on the latest technologies and tools. This change is naturally leading to, if not a shift, then at least an adaptation of the pedagogical methods, approaches and strategies, used in contemporary education.

According to Garrison [1], effective learning requires a large repertoire of techniques or "recipes" that poses the challenges of designing and delivering satisfying learning content. E-learning technologies provide different kinds of opportunities for studying and assessment, which cannot be ignored. Therefore, it is imperative to reconsider the purpose, approach and nature of the learning activities used [1] in contemporary learning.

While blended learning and e-learning approaches have great potential to improve the learning process compared to the traditional learning environment, many pedagogical models are not designed (intended) to be suited to such environments [2].

Pedagogical models, besides the effectiveness of learning, also address other aspects. Similar to architectural models, pedagogical models should not prescribe a specific way of realization, but rather provide a science-based framework for pedagogical design [3]. Designing a learning environment includes a cascade of design solutions that are made at different levels: from the "strategic level" (ex., the type of learning objectives) to the "application level" (ex. screen design of the environment) [4].

Games have a strong motivating mechanism, so they are increasingly used to motivate learners to achieve more effective learning (through so-called serious games).

Known serious games categories [5] are:

- Game-based learning (GBL) – uses video and electronic games for achieving educational goals;
- Gamification of learning – integrates game elements and techniques with the e-learning process;
• Organizational-dynamic games – they teach and reflect the dynamics of organizations at 3 levels: individual behaviour, group behaviour and culture dynamic;
• Simulation games – games, used for the acquisition or training of different skills, teaching effective behaviour in the context of simulated conditions or situations;
• Edutainment – presents content, designated simultaneously for education and enjoyment (the term is a combination of the words education and entertainment).

The generation, currently entering the higher education system, grew up with access to the Internet and early use of computers, mobile devices and gaming devices. This group has a different pattern of behaviour in media consumption, communication, and therefore different expectations in the educational environments. Passive use of educational content and traditional “face-to-face” and “distance learning” pedagogical methods are no longer sufficient for the new generation learners [6].

The article presents a study of learning approaches for designing game-based e-courses. The authors rely on the game-based methodology to meet the new requirements and expectations of learners in contemporary learning.

Section 1 of the article discusses learning approaches, theories and pedagogical models suitable for designing and constructing game-based e-courses with common concepts and components with gamification in learning: Keller's ARCS model for enhancing learners motivation, Malone's theory for Inner Motivation Based Learning, Motivational Active Learning (MAL), Kolb's Modeling Process Based on "Learning Style," and Bloom's Revised Taxonomy for Assessing Cognitive Outcomes.

Section 2 introduces the authors' plug-in for creating game-based courses in Moodle. The paper ends (Section 3) with a conclusion summarizing the contributions of the authors as well as with some ideas for future works.

2. Approaches and models for designing game-based e-courses

The key concept in gamification of learning is motivation. According to Kapp [7], two types of motivation are distinguished, namely intrinsic (internal) or extrinsic (external). Intrinsic motivation originates from the learner, while extrinsic motivation is driven by external factors (for example, the teacher sets a high score in fulfilling predefined learning objectives).

Games are a powerful motivation tool that is used in many learning methods and approaches. The authors make a correlation between the learning motivation and the motivation to play.

2.1. ARCS model

In the 1980s, educational psychologist John Keller presented the four-component ARCS educational model, which is an instructional design approach. The ARCS model [8] examines the following components: Attention, Relevance, Confidence, and Satisfaction.

Attention can be acquired in two ways: achieving through perception - by using a surprise or an unexpected event to gain interest; or achieving by asking - by stimulating curiosity through asking challenging questions or placing difficult problems that need to be addressed. Methods of attracting learners' attention include the use of:

• Active participation - use of game strategies, role plays or other practical methods to attract the learners' attention to participate actively;
• Variability - using a variety of methods for presenting learning materials (e.g. videos, short lectures, mini-discussion groups) while taking into account the individual differences in the learners' studying styles;
• Humour - use of a small amount of humour;
• Mismatch and conflict - use of the "devil’s advocate” approach, in which those who contradict the previous experience are presented;
• Experience - using visual stimuli, illustrating teaching materials with examples from the real world, etc.;
• Inquiry - Asking questions and problems that learners must solve (e.g. brainstorming activities).

In order to achieve relevance, it is recommended to use terminology presented with concrete examples familiar to the learners. The possible strategies outlined by Keller are:
• Target orientation – learner orientation about the importance of a learning objective, describing both the importance of achieving a goal and how it will help the learner now and in the future;
• Conformity - compliance of the learning motivation with the students’ motivation;
• Familiarity - shows how new knowledge is related to the learners’ existing knowledge.

Methods for achieving confidence in students include the use of:
• Helping learners understand the probability of success – learners’ motivation will decrease if they think their goals are unachievable or the cost to achieve them (time or effort) is too high;
• Setting goals and prerequisites – with clear student performance requirements and assessment criteria, the probability of success can be assessed more accurately;
• Meaningful student success opportunities – explain to the learner what the meaning of achieving the specific learning objectives are;
• Learners’ growth - making small steps for growth during the learning process;
• Feedback - providing feedback and opportunities to acquire achievements / successes in the course for which feedback is received;
• Learning control – provide learners the ability to control learning and evaluation and make them believe that their success is a direct result of the effort they’ve made.

Learners’ satisfaction can be achieved by:
• Rewarding - receiving rewards for an achievement;
• Usefulness – opportunity for learners to feel the usefulness of the learning by using newly acquired knowledge in a real environment or a real task;
• Satisfaction – giving learners feedback about their results and ensuring results are enhanced;
• Avoiding underestimation - avoiding overly easy jobs.

2.2. Malone’s theory of learning through intrinsic motivation
Thomas Malone [8] explores the motivating power of games by analysing predominantly the elements of entertainment. As a result, he presents a model of game motivation analysis that has three key elements: challenge, fantasy, and curiosity.

The challenge depends on goals set with unspecified results (there is no certainty that the final goal will be achieved). A variety of difficulty levels, sets of level crossing objectives, hidden information detection, or game-based challenges can be used. According to Malone, the learning objectives should be learner relevant and easily attainable. To enhance the challenge, it is desirable to provide feedback on learner’s progress in the course of achieving the learning objectives.

Malone defines fantasy as an environment that "induces mental images of things that are not present within the real experience of the learner." Using fantasy can make learning environments more interesting and more educational, because fantasy has both cognitive and emotional advantages. Fantasies in games mostly satisfy the emotional needs of gamers. Fantasy is defined as extrinsic (external) and intrinsic (inner).

Learning environments can trigger the curiosity of the learner if they provide an optimal level of information complexity and an exciting environment. According to Malone, curiosity is sensory (attracting attention by reflecting changes in light, sound or other sensory stimuli of the environment) and cognitive (provoked by the prospect of changing cognitive structures to a higher level, which can be achieved by making students believe that their knowledge is incomplete or inconsistent, thus motivating them to learn more). To engage the curiosity of learners, it is proposed to use surprising and constructive feedback as well as hidden resources in the learning environment.

2.3. Motivational Active Learning (MAL)
Pirker & Guetl [2] presents a strategy game-based approach used to design Motivational Active Learning (MAL) in traditional, mixed and distance learning. According to Pirker & Guetl [2], the approach has a great potential for implementation in both primary and secondary education and for raising students’ interest and commitment.

The typical learning material for MAL is divided into small pieces of information (called theoretical units). Learners are introduced to the key concepts with the theoretical units. Then they use the
acquired knowledge to solve small problems and tasks. In addition, learners are committed to apply the theoretical knowledge in researches or discussions. Most of the offered assignments are group ones (with group size of 2-4 learners). Before and after each learning material, students take an individual test and compare their knowledge before and after the material.

2.4. Kolb’s Experiential Learning Model
The Kolb's experiential learning model examines one aspect of learning – the learning style (the way students most effectively perceive, process, store, and reproduce information) that is completely independent of the other components. Learning style, according to Tennant [9], represents a relatively stable characteristic of one’s personality and expresses preference for the ways of perception and processing of the information, coming from the environment.
Kolb [10] introduces the notion of a "learning cycle" in which four phases of the learning process, requiring different skills, are distinguished:
- Feeling – gaining experience from personal experiences;
- Watching - based on a specific experience;
- Thinking - collecting observations and transforming them into theoretical models;
- Doing – based on what is already learned, new ideas and solutions are created, which are then tested in practice.
Kolb distinguishes four learning styles, resulting from combination between each of the two phases in the learning cycle [11]:
- The dreamer - specific experience, observation and reflection;
- The thinker – observation, reflection and abstract thinking;
- The decision maker - abstract thinking and active experimentation;
- The performer - active experimentation and specific experience.

2.5. A learning model based on Bloom’s revised taxonomy
Gloria, Bellotti, & Berta [12] define the Revised Bloom Taxonomy model as the most popular cognitive approach used in serious games (including their assessment). Based on the Bloom Taxonomy for Classification of Educational Goals [13], in 2001 the Bloom's revised Taxonomy was introduced, which gives a more dynamic concept of classification. Taxonomies distinguish six cognitive levels of learner knowledge. Bloom defines the definition of educational goals for different cognitive levels through certain actions (by verbs) and objects (by nouns), while the revised taxonomy uses actions - categories and subcategories (through verbs and gerunds).
Anderson and Cratul [13] further develop the idea by identifying 19 specific cognitive subtasks, which complement the six basic categories. According to Gloria, Bellotti, & Berta [12] the two pedagogical models of Kolb and Bloom are complementary and can be easily applied together.

3. Plug-in for creating gamified e-courses
The attempts have been made to gamify e-courses in Moodle [14], which show an increase in learners’ motivation and their success. Gachkova [14] describes an exemplary game-based course in which gamification is accomplished using standard Moodle game elements (points, badges, time and conditional constraints), and standard non-gaming Moodle elements, showing how they can be used in a gaming context (section, group, and course description - for storyline description).
To implement more motivating gamified courses that follow and apply the well-known pedagogical approaches and models, described in Section 2, the authors have created a Moodle plug-in called “Gamified course view” (“course format” type). When designing learning courses, the authors will be able to apply the models and approaches from Section 2 in practice. The plug-in allows users to design and create a game-based view of their e-learning course. Previewing a sample course through this plug-in is presented in Figure 1. The course design is accomplished on game levels that can be unlocked or locked, depending on whether the course author has set entry requirements for a given level and whether these requirements are satisfied by the learner at the time of the learning. Figure 1 shows that level 2 has already been reached (is visible) after
meeting its entry requirements, consisting of completing given Level 1 activities (with certain results). It also shows that the upcoming levels 3 and 5 are available, but for level 4 the entry constraints have not been reached yet and is inactive for opening.

With this plug-in, an already existing standard e-course can be automatically converted to a gamified course, ensuring effortless transformation of existing standard e-courses. The second way to use this plug-in is to create a new gamified course by including the desired learning resources and activities in an empty course from this format. To support the course-makers, a level template is offered in which all the specific game elements (see Table 1) are included with the appropriate support that can be applied in the course.

Table 1. Game elements in the level template of the plugin.

| Gamified element | Possible Moodle Element                                                                 | Additional Conditions                      |
|------------------|----------------------------------------------------------------------------------------|--------------------------------------------|
| Story/History    | Label, Page, File                                                                       | –                                          |
| Game Rules       | Label, Page, File                                                                       | –                                          |
| Challenge        | Page, File, Folder, URL, Book, Lesson, Assignment, Choice, Quiz, Glossary, Workshop, Wiki, Database, Forum, Chat, External tool, Survey | Bonus points (not required)                |
| Hidden Treasure  | Page, File, Folder, URL, Book, Lesson, Glossary, Forum, External tool                   | Conditional entry restrictions, Visible disabled element |
| Reward           | Page, File, Folder, URL, Book, Lesson, Glossary, Forum, External tool                   | Conditional entry restrictions, Visible disabled element |
| Combo            | Label, Page, File, Folder, Glossary, Database, Book, Lesson, Chat, External tool        | Conditional entry restrictions, Visible disabled element, Time constraint |
| Badge            | Badge                                                                                  | Receiving conditions                       |
| Socializing      | Forum, Chat                                                                            | –                                          |

The gamified course is built from several game levels (similar to standard Moodle sections), each of them containing learning resources and activities, made using game elements. The plug-in utilizes standard Moodle elements in a game context (Table 1). The proposed game elements in the template can be deleted (if they are unnecessary), added (to increase the identical items), edited and set (to be described and filled with the appropriate content), so that the user creates his own specific level (with a concrete methodology) as part of the course.

A different view of the gamified course (see Figure 1), compared to Moodle’s standard course, is realized to increase awareness and confidence of the learner on the progress of the course and its level of progress over the course. The course is visualized as a wizard (with level sequence). Learners has the opportunity to see the resources and activities for learning presented in a game context.

Moodle's default course settings have added additional features like using / changing the default level names, changing the section zero position, changing the list style for the levels, colouring the high level in the course, colouring the current level with specific colour, etc.

The plug-in is implemented with multilingual support in Bulgarian and English. The functionality for automatic update of the plugin version is added.

The plug-in was created on the base of PHP, HTML, JavaScript and CSS.

To fully implement game concepts in the Moodle e-learning environment, a second plug-in called the "Block gamification dashboard" is being developed, in which completely new gaming elements that are not standard for Moodle. The new elements that are being developed are: Leader Board, adding a setting for achieving next level based on algorithm, activity course log by avatars, etc.
4. Conclusion
The reviewed pedagogical models and learning approaches are built upon similar theories and are partly complementary. Active experimentation and repeatability in Kolb's learning cycle, the attracting of attention in the ARCS model, the challenge, fantasy and curiosity elements of Malone's theory are just one part of the examples of similarity with the concept of gamification and their application for enhancing the intrinsic and extrinsic motivation of learners. Games or even the application of certain game elements give better attitudes towards learning than traditional teaching methods and increase motivation in different learner groups and learning situations. E-courses designed with the help of gamification provide effective training for different learners in areas of higher declarative knowledge and memory levels [15]. They are perfectly suited for the new generation (the so-called Y generation), which enters the educational environment and grew up with access to the Internet and early use of computers, mobile devices and gaming devices.

A plug-in is being developed to support the education of students at the “Paisii Hilendarski” University of Plovdiv, which offers game-based learning in the Moodle e-learning environment, using the Moodle elements in a game context. The next goal of the authors is to offer a second plug-in with more game elements that are not specific to Moodle.

References

[1] Tennant M. 1988 Psychology and Adult Learning.
[2] Pirker J, Guetl C. 2016 Engaging Students in Digital Learning, on Motivational Active Learning in Blended and Virtual Learning Scenarios.
[3] Niegemann HM, Hoscheidt-Maue D, Molz M, Eckhardt A, Schnottz W, Hessel S. 2004 Reconstructing Instructional Design Models. Developing a Heuristic Advisory System as Support for Instructional Design Research.
[4] Niegemann H. and H. S. &. H. S. 2018 Pedagogical design patterns for e-learning: A new approach to instructional design theory.
[5] Malone TW. 1981 Toward a Theory of Intrinsically Motivating Instruction, Cognitive Science, volume 5, № 4, pp. 333-369.
[6] Kolb A. Y. и Kolb D. A. 2005 Academy of Management Learning & Education Learning Styles, Acad. of Man. Learning and Education, volume 4, № 2.

[7] Kapp K. 2012 The Gamification of Learning and Instruction: Game-based Methods and Strategies for Training and Education, Pfeiffer.

[8] Keller JM. 2010 Motivational Design for Learning and Performance. SSBM;

[9] Greenaway TP. Experiential learning articles + critiques of David Kolb's theory Available: http://www.reviewing.co.uk/research/experiential.learning.htm. [last accessed: 20.02.19].

[10] Gloria A. D., Bellotti F. и Berta R., 2014 Serious Games for education and training. IJSG, volume 1, № 1.

[11] Garrison DR. 2011 E-Learning in the 21st Century: A Framework for Research and Practice, 2nd edition. Available: https://dl.acm.org/citation.cfm?id=1996369. [Last accessed 8 12 2018].

[12] Gachkova M and Somova E. 2016 Game-based approach in e-Learning, on IX National Conference ERIS.

[13] Anderson LW, Bloom BS and Krathwohl DR. 2001 A taxonomy for learning, teaching, and assessing: a revision of Bloom’s taxonomy of educational objectives.

[14] Chang V, Guetl C. 2010 Generation Y Learning in the 21st Century: Integration of Virtual Worlds and Cloud Computing Services, Global Learn, volume 2010, № 1, pp. 1888-1897, 2010.

[15] Gachkova M, Somova E and Takev M. 2018 Learning and Assessment Based on Gamified e-Course in Moodle. Mathematics and Informatics; 61:444–54.