

**The application of gamification
methodologies to e-learning
contexts in order to enhance its
students' performance,
motivation, and collaboration**

Inaki Iglesias-Cancio, Universitat Oberta de Catalunya

Universitat Oberta de Catalunya
Av. Tibidabo, 39-43
08035 Barcelona
Spain

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Introduction

The research this proposal belongs to will consist on the study of the gamification concept and methodology, as well as its benefits and downfalls, as a potential solution to increase collaboration, motivation, and engagement in e-learning students. Thus, this research will analyse in-depth what gamification stands for, how its application in other contexts has worked, what steps are necessary in order to gamificate an institution e-learning approach, and what benefits and perils can provide to e-learning. Also, a further study of previous similar approaches in e-learning will be necessary, as well as which solutions have been developed over the years to cope with low engagement and collaboration problems, as well as high dropout rates, in e-learning courses; compatibility of those solutions with the gamification approach should also be analysed. An e-learning-specific gamification methodology should be developed as a result of the conclusions obtained, or else a detailed dissertation about why gamification isn't a good approach for e-learning.

1. INTRODUCTION

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Proposal

2.1 Justification of topic interest

E-learning has posed a great advance in bringing high-level education and formation to individuals often banned from this kind of knowledge due to the circumstances of their personal life, such as time availability, personal responsibilities or geographical location. Although long-distance education has been present for decades, if not centuries, around the world, it has been its fusion with the Internet that has opened up the possibilities of e-learning. From large databases to collaboration tools, e-learning disposes of a large array of methods not previously available to education that could help provide quality high education to people and communities that otherwise would have not been able to achieve. With software engineering and methodologies, as well as the Internet and its community growing exponentially, so grow the possibilities for e-learning to adapt itself and develop new ways to provide and teach students worldwide.

Gamification, on the other hand, is a relatively recent concept as well as research field. It has been defined as the use of game design elements in non-game contexts, and it is applied as an additional design and development layer to either existing or in-development applications of all kinds: software engineering or development, private companies' intranets, websites that require user participation, or even fitness applications and weight management. The gamification process does not create a game out of the application it was applied to, nor it creates a serious game -a game the objective of which is not entertaining, but otherwise, like solving a problem, or teaching something-; it only uses a series of game elements, classified in different levels of abstraction, for

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raising motivation, engagement, and meaningfulness among its users when performing the tasks associated to the application.

2.2 State of the art

E-learning is, nowadays, in a convoluted status. On one hand, the recent law modifications in behalf of European high-education unification -like Bologna reform-, and the wide adoption of some popular open-source LMS -like Moodle- by most high education centres and institutions around the world have brought together many pedagogical methodologies; it has also widened the range and quantity of research studies about e-learning as well as e-learning tools development projects (16) (8) (9) (7). On the other hand, it is falling behind the environment itself where it takes place, the Internet, and behind the growing online skills of each new generation of students; the Internet changes and evolves itself constantly, as well as its users, learning and adopting new technologies, tools, and trends as new ideas and concepts get popular in the network (9) (4). For example, when mathematical e-learning was writing about implementing a repository with content tagged and described with metadata, on the Internet that technology was already considered implied or classical for most online platforms that hosted files to a great number of users (8).

Furthermore to the global issues that e-learning has to solve as a subject, it has come to the attention of this research two particular problems the researchers have been aiming to mitigate: the low rate of participation in e-learning activities and tools, and the duality between personal motivation to participate and rate of abandonment in the e-learning courses (16) (7). Some statistics and research studies about the matter, however, differ greatly about its results: some of them establish attrition and dropout rates as high as 70-80% in e-learning courses, while others put that value around 20-50%; the conclusion accepted from this misleading data is that e-learning dropout rates are close to those in classroom-based education, always depending on the context of the courses (17). Previous studies already stated this assumption, slightly clarifying that e-learning attrition rates are a little higher than in traditional education (14) -although this could be due to the earliness of these studies in e-learning history.

Why students drop out in e-learning courses? Reasons vary, and it is usually stated those have different origins from attrition in traditional courses -as attrition

and dropouts depend both on learner's and course's context (14), the unique features that singularize e-learning also distinguishes it from traditional learning even in attrition. A usual approach is that students may feel intimidated by technology, thus falling behind on the course; however, this applies mostly to adult, mature learners than younger ones, as they have not grown used to the Internet implicit conventions and tools (11). Research studies, then, fall to the conclusion that it would be hard to construct a simple set of dropout reasons when learners, with its personal and academic context, are nothing but simple (17) (11) (14), although lack of sense of community and disconnection, isolation, distraction, and lack of personal attention have been related as causes to e-learning attrition by several studies (7) (11). But, while in classroom-based education is easier to deal with these issues, the only way to cope with them in e-learning is with careful planning (11).

One of the earliest -and, nowadays, most extended- solutions e-learning has come to in order to increase learners' engagement is the introduction of classical online interaction tools: discussion forums and chatrooms. They are included in nearly every distance education course/tool, and they palliate part of the isolation and sense of disconnection mentioned before, integrating the students and making them feel like part of a community (11). Its efficacy as participation encouragement, either alone or in conjunction with pedagogical methodologies -private chats and/or forums for reduced study groups, with direct access to the tutor, f.e.-, not only has been proved, but it is assumed as a fact by case studies, ethnologies, and other kinds of research studies alike (7) (11).

As efficient as they are those measures, however, they only address the attrition problem in a general sense. They aren't effective enough against what researchers consider the most worrisome problem within e-learning attrition: early attrition -those students that drop out of the course on its earliest stages, a worrying issue because teachers, LMS and researchers alike are usually unable to measure the real performance and potential of those too soon lost students (17) (11). Learners become overloaded by the course at the beginning of it, as they have to assimilate not only the course's initial contents, information, and resources, but how the LMS's and tools' provided work, how to fit their reasoning and data within them, and how to effectively interact with other students and their tutors. This initial difficulty processing information into knowledge and skills is called working memory overload, it can cause anxiety and

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confidence loss to students, and it is related with studies about how the human brain learns and memorizes new concepts (17). Introductory, optional courses so students can access earlier to the LMS and the course's contents without the dire consequences of failing the real course, as well as simple alternatives like paper-based How to get started pamphlets or clear and accessible tutorials about the tools, are some of the strategies developed to cope with early attrition, with some success (16) (17).

Attrition, then, as well as motivation, participation, and community feeling, is a matter of emotion. Subjective variables, such as personal context of each learner, are involved when measuring it and considering its causes (17). Thus, an emotion e-learning approach would be needed; however, there is no comprehensive, empirically validated, theory of emotion that addresses learning, although there are some approaches regarding the generation of positive emotions on learners, such as affective design, which uses enjoy and personal integration as a guideline to make students feel part of a big social community where they can participate (3).

There is some consensus, then, that increasing motivation and desire to engage in learners is a positive approach to counteract attrition and enhance the learning process (7) (3); also, feedback, performance assessment, capturing learners attention and providing learning guidance have been considered essential steps for an effective learning model. Attention, relevance, confidence and satisfaction have also been considered axis for a learning model aimed to motivate and engage students. More recent theories have carried this notions into online learning, stating that students must be in learning through interaction with others -students must be highly motivated and able to work independently successfully, as it's easy to fall behind but very difficult to catch up later when there is no scheduled classroom (7) (11).

All those qualities for a good and motivating e-learning model/LMS/course/tool can be defined, and promoted, by what researchers call engagement. Engagement consists on occupying the attention or efforts of a person, that occurs when the brain is rewarded by perceiving something as positive or as positive emotion evoking (13). So, to raise engagement and, then, raise participation, motivation, and collaboration, and decrease attrition, we must make students' brain feel rewarded through the learning process (7). However, as we have seen before, we cannot address this matter the same way we do in classroom-based education due to the lack of real interaction between students and between students and tutors/teachers. We have to take advantage of the

environment where e-learning moves, the Internet, and apply concepts known to the modern generations of students.

Games have been an initial approach, as it is known that games create intrinsic motivation through fantasy, control, challenge, curiosity and competition. Initial game introduction into learning, however, demotivates most students, as they have to surpass the difficulty of learning the most basic aspects of the game; also, some of them question why and how can games be useful for studying (15) -the same problem we had before, and one of the causes of early attrition. Games are not a panacea to traditional learning problems; they can, even, introduce new problems and costs -developing a whole new game is far from cheap- (10). It is needed, then, an elastic alternative, something that can appeal to all kind of students: opportunities for different students with different interests, abilities, and capacities to learn. A proper e-learning tool must adapt to this, offering options that appeal, motivate, solve problems and raise participation to multiple student profiles, instead of generating new attrition issues (15).

But, how do we adapt games functionality into e-learning? In fact, their processes are not so different. Games are structured so that players have various layers of goals of increasing difficulty; this way, they are able to, first, put into practice basic and new skills acquired and get used to them before, at last, having to demonstrate their mastery over them in final challenges between layers. This is very similar to designing e-learning material, as different lessons have to be broken into tiny pieces of knowledge and assessments before having to prove they have acquired the desired skills in tests or assignments, where it is considered if they have met the objectives of the lesson (13). Taking advantage of these parallelisms, we might be able to include some of the games strategies to reward and motivate its players into e-learning courses with little difficulty, through a process known as gamification.

It should be understood, first, what gamification means, in order to find similarities within the e-learning research context. Gamification has been defined as the use of game design elements in non-game contexts (6) (12) (10). The gamification process does not create a game out of the application it was applied to, nor it creates a serious game -a game the objective of which is not entertaining, but otherwise, like solving a problem, or teaching something-(6); it only uses a series of game elements, classified in different levels of abstraction, for raising motivation, engagement, and meaningfulness

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among its users when performing the tasks associated to the application (6) (12) (5) (18) (10).

The basic gamification assumes the user isn't motivated and doesn't rely on internal motivation. Instead, it provides lots of extrinsic incentives to keep the player's motivation up (2). However, further studies have delved deeper into the matter and it has been found that a great quantity of extrinsic reward is not enough to motivate a user into doing something; yet worse, in a process known as overjustification, the excess of extrinsic reward can backfire and drain the user's intrinsic motivation (the meaning and purpose of a task), and, eventually, the relative value of the external reward (6) (12) (18). Those poor gamified systems with a serious lack of understanding of human motivation and emotion are mockingly called pointsification systems in the literature, due to their excessive use of scoreboards and points system for rewarding all kind of actions with a single number -or exploitationware, because of turning individuals into nothing more than a score in a list (12) (18)

Gamification has grown since then in order to solve its own problems. The most recent research studies have centered themselves in designing user-centered frameworks, after reviewing theories on human engagement psychology and educational theories on intrinsic motivation and its relation to the user's own goals, self-esteem, and reasoning (6) (12) (18) (13). Challenges of raising, but controlled, difficulty to keep the user attention and happiness inside a state known as the flow (6) (18), making each task have a purpose and meaning the user can internalize, and relate to, or being able to share its progress, and comment it inside a like-minded community (6) (12) are some of the studied ways found to raise the intrinsic sense of reward without devaluing the external one. Even in minor experiments, like Carrera Duarte's (5), it was found that the mere act of being felt taken into account was enough for the users to engage in the task required.

Within e-learning, gamification allows us to compensate the lack of emotional interaction a face-to-face class with a teacher implicitly has towards and between each of its students. So, it can be used to promote certain behaviors, as it gives to the interaction between the user and the tool/LMS a purpose furthermore to that of progressing through the online course (10). Through participation in the community, members establish norms and build collaborative relationships, termed as mutual engagement. The

notion of community creates the social fabric for that learning. A strong community fosters interactions and encourages the willingness to share ideas (1).

Is gamification the emotion-oriented theory needed to motivate students with a constant reward system we were searching before? Lets take a look back to the enjoy guidelines mentioned before that define the affective design of e-learning environments (3):

- Personalization
- Identity: the learner recognize its unique presence within the LMS, with its name, picture, and other data about him visible.
- Brand
- Community
- Surprise
- Innovation
- Zen: equilibrium, no overload of text, space.
- Search: shortcuts, simple search.
- Clarity: bright colors, readability.
- Situation: quick realisation of the environment structure.
- Aesthetics: consistent aesthetics.
- Recognition: icons and symbols easily and quickly understood.

If we compare them to the various features proposed by research studies about gamifying e-learning tools and by gamification case studies, we will see there is a clear parallelism between both methodologies:

- Editable personal profile (10). [Personalization, Identity]

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- Provide frequent feedback, as explanations to answers, right or wrong, or directions and/or links where the appropriate information can be found (13) (10), as well as access to an activity feed and notifications about the course and your progress (10). [Search, Situation, Surprise]
- Dividing the course into chapters and, then, into the smallest bits of coherent content. Each successfully completed chapter should award an achievement, points or badges to the students, as well as evaluation, or achieving difficult tasks (10). [Surprise, Innovation]
- Reward also effort, not just success. Even if the user takes the effort to expand their profile optional fields, or whether they go through the supplementary material, you have to give your earner a proportionate reward (13). In the SEGAN Serious Games community case study (1), they used used XP (eXperience Points) leaderboards and attainable achievements to value engagement and participation, rewarding with XP things so simple as visiting the website daily. Badges for academic and proper behavior should be awarded to students, too, encouraging good manners in their social interactions (10) [Surprise, Innovation, Community]
- Good presentation, clean design and compelling interfaces can also motivate and increase engagement among students/players (13). [Brand, Zen, Clarity, Situation, Aesthetics, Recognition]
- The evaluations and challenges achieved by students should have direct effect on his status, and reflect in scoreboards that compare his progress with that of others students (10); competitiveness is a great motivator, as well as peer recognition and respect of your fellows, so rewards and achievements should be visible to all the other students (13). [Community, Surprise, Identity, Search]
- Social interaction is a basic feature in gamification (10) (1); the possibility of private communication between students and between teachers and students is also highly encouraged. [Community, Surprise]
- The points gained through success and/or effort should be interchangeable with virtual goods, be it additional features and options available in the LMS, higher

responsibilities in the community or even discounts on other courses' prices (10).
[Surprise, Innovation, Brand, Community]

On the other way, gamification has made use of learning and education theories in order to better understand its users and take them into account for designing better gamified systems:

- The concept of situational relevance states that is very difficult to design a goal engaging to the user without involving the user herself, as we are not aware of her context, preferences, or knowledge. So, the Organismic Integration Theory is a sub-theory out of the field of Education that states that external rewards unrelated to the activity are the least likely to be integrated, as the perception is that someone else is controlling the individuals behavior. When users can identify themselves with goals or groups that are meaningful to them, they are able to connect this goals to other values she already holds, thus producing autonomous behaviors and internalizing the activity as positive (12). This was also stated by Fabian Groh (6) with the first of his three principles that determine the intrinsic motivation for engaging users in the use of a gamified application: the principle of relatedness. By this principle, whatever you are doing with the application, it has to be meaningful: that is, the action you are trying to encourage must have some usefulness or purpose even without the gamified context. It must relate to the users' personal goals, or even let users customize its own goals within the application, so that they feel connected to its use.
- The theory of Universal Design for Learning is another theory from the field of education that can be applied to the gamification of a system. The concept is that, in education, different learners should be provided with different ways to learn and explore new contents, as well as different ways to demonstrate they have achieved mastery of those contents, and activities to reach that mastery. In gamification, this means that users will be more easily motivated and engaged into performing the gamified activity if they have different methods to reach the activity's goals and to demonstrate they have achieved them. This way, it will become easier for users to find some meaning in performing the task, as they can stick to those methods and systems best suited for their personality and

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personal objectives. However, it can be very challenging to design a gamified application so that every activity has different ways and tasks to reach its goals, and each of its ways and tasks can be meaningful for a certain kind of users (12). The principle of autonomy described, too, by Fabian Groh (6) relates to this theory, stating that games, and by extension the use of gamification application, must be a voluntary activity; users should have autonomy over their actions, and offering different ways for different kinds of users to engage in this activity is a good way to preserve it. Finally, Yongwen Xu (18) has also referred to the importance of taking into account that users come from different profiles, skills, and goals: different kind of users might play or engage with games for different reasons, each with different motivations but also with some space for common ground. Knowing or predicting which profiles your users will belong to could, and should, guide the design of the gamification elements of your application.

All of these theories have in common that the user is the center of the designing process. Meaningful gamification, thus, is the integration of user-centered game design elements into non-game contexts. Gamification must benefit the user. External rewards are not user-centered, and nor is considering the user's progress a simple, plain number attached to scoreboard. Information has to be transparent and, again, meaningful, as well as the rewards provided must relate to the task achieved. Then, if we have to benefit the user, generic solutions won't work: we have to take into consideration the user's needs and goals so that she feels connected to the activity (6) (12) (18).

2.3 Hypothesis, research questions and objectives

2.3.1 Hypothesis

The main objective of this research is to demonstrate through empirical means that applying gamification when building or upgrading an e-learning application or LMS can improve the students' participation, performance, and motivation.

2.3.2 Research questions

After this brief review, then, the research should be able to answer this questions:

2.3 Hypothesis, research questions and objectives

- Is gamification a good approach to increase e-learning students motivation and collaboration, and, thus, their performance?
- Does any previous approach to gamification exist within e-learning?
- Which other approaches have been devised within e-learning to confront and increase engagement? Are they compatible with gamification?
- How can we implement gamification within an existing e-learning tool and/or methodology?

2.3.3 Objectives

- First, a complete analysis of the gamification process and its methodology using the available literature of its theory and its application within different software and e-learning contexts. This analysis must argue, too, if it would be fit to apply this process in nowadays e-learning, what possible downfalls can carry, and whether or not e-learning has previously included gamification features in its methodologies -with or without success.
- Second, an in-depth study about the lack of engagement and collaboration problem found in e-learning: possible causes of the problem, which students are the most affected by it, and what kind of solutions have been devised in order to confront it. An specific e-learning literature review, then, will be required in order to fully comprehend e-learning, its downfalls, and its students. Still within this objective, the alternative solutions and methodologies found to have been used in e-learning to increase students' engagement and motivation should be compared to the principles of gamification, and it should be discussed to which extent are both pointing the same way.
- Third, a detailed e-learning gamification methodology should be devised from the previous knowledge gathered, taking into account what has been learnt about raising engagement in e-learning and with the use of gamification.
- Fourth, it should be performed a case study of the methodology devised before in order to point out its possible benefits and downfalls. The example design process should be described in detail, relating each step to the e-learning gamification

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process. The case study includes the development of an actual gamified e-learning application (or module for an existing LMS that allows it to include gamification feature), as it will be used in further steps of the research.

- Finally, an experiment should be carried using the gamified application that demonstrates empirically if gamification really improves the e-learning experience and its results on the student's performance and participation over non-gamified e-learning.

2.4 Research methodology

The proposal of this research is focused in creating a new model, methodology and/or set of guidelines for the future development of e-learning tools based on the gamification unique characteristics. Among the different research strategies, then, it is obvious that this one falls within the range of the Design and Creation, as the product it aims to generate is an IT artifact other researchers and developers will be able to use in the future. However, some measure of the case study strategy will be used, too: the gamification concept and methodology will be analysed and studies for this research, and compared to other existing theories within e-learning. Experiments are also conducted in the research last planned objective in order to proof (or disproof) whether a gamified e-learning system is more effective than a non-gamified one.

But, although the design and creation strategy usually is considered to belong to the positivist paradigm (a final product is achieved or not), I consider this research to have a strong interpretivist point of view: gamification and e-learning themselves rely on some kind of subjectivity, after all, because what a person considers well-represented and engaging may not be the same for another different person. Learning and engagement are, to some point, personal points of view that can only be generalized to a certain degree -and it's because of that most of the modern e-learning methodologies and theories are user-centered taking into account that each user is a different learner with different learning needs.

Documentation will be the main method for obtaining data through the first objectives of the research, as it will consist mostly on investigating the existing literature, theory, and methodologies both in e-learning and gamification. Documents, in the form of logs and code documentation, will also be generated during the development, testing,

and debugging of the planned, gamificated e-learning system; the system logs will also be used during the experiments planned for the last step as side documentation and as a method to collect quantitative and qualitative data about the application usage and problems. Finally, questionnaires will be devised both for the application development and the final experiments with students; the first questionnaires will be oriented towards the better design of possible user profiles and what those users will expect from an application oriented to their engagement with gamification; the latter ones are thought to provide data in order to value the results and status of the experiments at different times, as well as to obtain feedback and opinions from the users themselves about the application.

2.5 Scheduling

The final goal of this research is to proof that gamification is a good solution to cope with some of the e-learning's most important problems, helping students increase their motivation, engagement, and performance, as stated in this document and the previous ones. For that purpose, there are some milestones the research must reach: some of them in a certain order so it is possible to progress to the next one, some others because they are academical mandatory deadlines that every thesis research has to accomplish. The partial objectives section in this document offers a good starting point for establishing research work milestones and activities needed to achieve them through the next years; in addition to some mandatory activities as mentioned before (such as redaction of the research memory or defending the thesis against an academical jury), those objectives will be the skeleton from which to build the research plan.

The research plan will be organized in the following phases, each one with one or more related activities that either they have to be performed together in a certain order or they synergize enough so that they can benefit from being done at the same time. It also takes this year's August as research work starting month:

2.5.1 State of the art (from 2014, August to 2014, December)

The first phase will consist on achieving the first two partial objectives of the research: a complete analysis of the gamification process and its methodology and its application within different software and e-learning contexts, and an in-depth study about the lack

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of engagement and collaboration problem found in e-learning. Although a preliminary research about those subjects has already been done in previous documents, an in-depth one has to be done with a more extensive literature analysis in order to support a thesis-size research work:

- *(2014, August - 2014, September)*: Search for enough literature resources that can support the thesis theory, as well of any that can disprove it. Redaction of a first draft.
- *(2014, September)*: Revision of the first draft with the thesis' tutor.
- *(2014, October - 2014, November)*: Second iteration on the state of the art research, focusing on researching more literature for those fields and cases that aren't proven enough, and on polishing and extending the text for those that do have extensive literature. The second draft is redacted.
- *(2014, November)*: Revision of the second draft with the thesis' tutor.
- *(2014, December)*: Redaction of the final state of the art document, structuring the literature found in order to achieve the two first partial objectives. Final short reviews with the thesis' tutor for any last revision of the document before submitting it.

2.5.2 E-learning gamification methodology (from 2015, January to 2015, April)

The second phase will consist on developing a gamification methodology adapted to the modern e-learning applications, using what it has been learnt about both subjects during the redaction of the state of the art as a base for it.

- *(2015, January)*: Revision of the state of the art literature for gamification and e-learning theories and methodologies; additional research on these literature sources and any possible new literature about the subjects in order to gain additional understanding for applying gamification into e-learning.
- *(2015, February - 2015, March)*: Design and redaction of the e-learning gamification methodology's first draft.

- *(2015, March)*: Revision of the first draft with the thesis' tutor.
- *(2015, April)*: Redaction of the e-learning gamification methodology's final document, with minor review iterations with the thesis' tutor during the process to polish any details and add any pertinent new literature to it.

2.5.3 Gamification methodology case study (from 2015, May to 2017, January)

During the third phase, the research will focus on designing and developing a gamified e-learning application using the gamification methodology from the previous phase, as well as on detailing and describing the process as a case study for the research.

- *(2015, May)*: Analysis of the existing open-source e-learning applications as well as the most suitable programming languages for them, in order to decide whether the case-study application will be developed from scratch or in as a module for an existing e-learning system. Redaction of the decision taken, properly argued, for the future research memory and case-study document.
- *(2015, June - 2016, February)*: Software engineering design process of the application using the methodology previously developed as a guide for designing its gamification features. It includes the redaction of the software design documentation and a monthly review with the thesis' tutor to check, discuss, and guide the design process. It also includes taking notes for the case study and a first draft of it. It also includes the design of questionnaires for students about e-learning tools, as well as giving them to a proper segment of students and its posterior result analysis.
- *(2016, March - 2016, September)*: Software programming and development process. Includes testing and debugging of the individual functionalities.
- *(2016, October)*: Final but thorough testing of the application as a whole and debugging of any error found.
- *(2016, November)*: Redaction of the software development process description for the future research memory.

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- *(2016, December)*: Redaction of the case study document first draft and review of it with the thesis' tutor.
- *(2017, January)*: Redaction of the case study final document, including any minor reviews with the thesis' tutor in order to properly polish it.

2.5.4 Experiments and final defense (from 2017, February to 2018, May)

After developing the gamificated e-learning application and using it as a case study for the research, all that is left is to prepare the experiments with real students, perform them, analyse its results, write the research memory, and defend the thesis against an academical jury.

- *(2017, February - 2017, March)*: Recollection, review, and redaction of the research memory so far using the previous documents redacted and gathered until this moment.
- *(2017, March)*: Revision of the redacted research memory so far with the thesis' tutor.
- *(2017, April)*: Redaction of the research memory so far. Analysis of the research in order to refresh its contents for the experiments.
- *(2017, May)*: Analysis of what students would be the best target for the experiments. Design and redaction of the experiments first draft.
- *(2017, May - 2017, July)*: Contact suitable learning centres for the experiments, and agree with one of them to perform them during the next semester (using the experiments' first draft and the research memory so far to explain them).
- *(2017, June)*: Revision of the experiments' first draft with the thesis' tutor.
- *(2017, July - 2017, August)*: Redaction of the final experiments document; design and redaction of the questionnaires for the experiment.
- *(2017, September)*: Set up the experiments, print the questionnaires, and make any arrangements needed with the students tutor and teachers.

- *(2017, September - 2017, October)*: Initiate the experiments with the gamified application. Give the initial questionnaire to the students and collect their answers.
- *(2017, October - 2017, November)*: Analysis and redaction of the first questionnaire's results.
- *(2017, November)*: Give the intermediate questionnaire to the students and collect their answers.
- *(2017, November - 2017, December)*: Analysis and redaction of the second questionnaire's results.
- *(2017, December)*: Give the final questionnaire to the students and collect their answers.
- *(2017, December - 2018 January)*: Analysis and redaction of the final questionnaire results. Redaction of the combined document about the questionnaires. Collect the application logs.
- *(2018, January)*: Collect the students academic results.
- *(2018, February)*: Analysis of the application logs and the academic results of the students, and compare them to the questionnaire results.
- *(2018, February - 2018, March)*: Redaction of the experiments results and conclusions final document. Redaction of the research memory final document by adding the experiments' results document.
- *(2018, March)*: Review of the research memory final document with thesis' tutor.
- *(2018, April)*: Submit research memory final document. Prepare oral defense of the thesis.
- *(2018, May)*: Thesis defense against academic jury.

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Thesis' directors

3.1 Director proposal

Enric Guaus Termens. Music Technology Group, Universitat Pompeu Fabra (UPF);
Sonology Department, Escola Superior de Musica de Catalunya (ESMUC)

Music Technology Group (UPF):

- Office hours: monday 15:30-19:30
- Contact: name.surname -at- upf -dot- edu
- Postal address: c/ Tanger 122-140, office 318; 08018 Barcelona, Spain
- Web: <http://mtg.upf.edu/> Sonology Department (ESMUC):

- Office hours: tuesday to friday 10:00-13:00

- Contact: name.surname -at- esmuc -dot- cat

- Postal address: c/ Padilla 155, Edifici l'Auditori, office B-215; 08013 Barcelona, Spain

- Web: <http://www.esmuc.cat/Departaments/Sonologia>

3.2 Relation to UOC

Enric Guaus (Barcelona, 1974) is a researcher in sound and music computing at the Music Technology Group, Universitat Pompeu Fabra (UPF), and professor at the Sonology

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Department, at the Escola Superior de Musica de Catalunya (ESMUC). He obtained a PhD in Computer Science and Digital Communications (UPF), in 2009, with a dissertation on automatic music genre classification. His research interests cover music information retrieval and human interfaces for musical instruments. He is assistant professor in acoustic engineering at the Universitat Pompeu Fabra (UPF) and lecturer in maths, electronics and computer science at the Escola Superior de Musica de Catalunya (ESMUC). He is also a consultant professor at Universitat Oberta de Catalunya (UOC) and collaborator at different master programs. He is member of the Observatori de Prevenció Auditiva per als Músics (OPAM) i de la Barcelona Laptop Orchestra (BLO).

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