Towards a justified choice of gamification framework when building an educational application

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Abstract - Gamification has been a leading global phenomenon since 2010 and represented in a variety of domains including education. Yet whether the application of game elements in non-entertaining contexts is effective, still sparkles an ongoing debate which aims to be solved by the application of gamification frameworks. A gamification framework analyses the core drives in human motivation in a system that can be easily applied to produce an effective strategy for successful implementation of gamification. On our journey to design and develop an educational application, implementing game design elements, that supports university students enrolled in a Web development course, we analyzed a variety of gamification frameworks in order to define the right one for our needs. In this paper, we present an in-depth analysis of the different gamification frameworks, leading towards a justified choice in the context of our research. Outcomes of our study and a work-in-progress implementation of the educational application are also summarized.

Keywords - Gamification framework, Gamification in education, Game design elements, Web design and development

I. INTRODUCTION

Games have been an integral part of human cultures and essential social interaction since the ancient past and represented in various forms. Later with the introduction of video games during the 20th century, mainstream popularity was gained and video gaming established itself as a preferred form of entertainment and a crucial part of modern culture. Yet with the evolution of the gaming industry supported by the adoption and usage of social media and mobile technologies, games are present in our everyday lives. That’s why it’s essential to identify the possibilities to use this environment or specific parts of it as a source for engaging experience in different contexts.

Gamification has been a leading global phenomenon since 2010 and represented in a variety of domains including education. Due to the broad area of applications, a common and popular definition is the usage of game design elements in non-game contexts [1]. However, due to the various and intertwined disciplines and vast adaptations and definitions that are framing gamification, recent researches suggest that the concept and its modern technological implementations are still young, evolving and adapting. In today’s digital world and emerging technologies, a gamification can have a complex entity and higher levels of abstraction in a way that it can be a process, a service, an experience, a product, a system or all at once [2].

From a marketing perspective, gamification has its roots in the past century with the introduction of the retailer loyalty programs, aiming to engage and motivate individuals, eventually turning them into loyal customers. Nowadays, it’s a common practice to gather a digital version of certain points on purchases and later redeem them for discounts on products or services, or other user-related benefits.

Apart from the various definitions, the implementation of gamification approaches in different domains has increased in the last years, becoming an emerging and promising trend. Yet whether the application of game elements in non-entertaining contexts is effective, still sparkles an ongoing debate as researches suggest that a clear design strategy is the key to successful gamification [3]. A gamification design and frameworks analyze the core drives in human motivation in a system that can be easily applied to produce an effective strategy for successful implementation of gamification.

The main goal of this paper is to identify the right gamification framework that can be applied when designing and developing an educational application that supports university students enrolled in a Web development course. Therefore, we decided to structure the paper as follows. First, we introduce some general concepts, key differences, and rules related to game design elements, gamification design elements, gamification of learning and game-based learning in Section II. In Section III, we focus on developing an in-depth analysis of the existing gamification frameworks as we reference recent studies, define methodologies and concentrate on the existing gamification design frameworks which can be applied in the context of our research. Finally, in Section IV, we propose an approach for implementing gamification design elements in an educational application, based on the researched frameworks and introduce a work-in-progress, together with summarized outcomes of our study.

II. GAME DESIGN VS. GAMIFICATION DESIGN - GENERAL CONCEPTS AND THEORETICAL BACKGROUND

A. General concepts

Game design is a popular concept in game studies and involves not only the process of creating the art, but also
defining the game system and applying the rules. It works as a system directed towards a gameplay, with entertaining outcomes. On the other hand, gamification design elements are game-like elements that are applied for the sole purpose of enhancing the engagement in different contexts. This outlines the main distinctive feature between the two concepts, namely that the first is designed for fun, and the second – to meet certain objectives.

The application of gamification in the domains of learning and education has a promising potential not only because it can enhance motivation and increase the retention levels but also shape desired behavioral objectives and performance metrics, and further deepen the engagement of the students with the subject matter. Gamification of learning, game-based learning and serious games, although similar etymologically, are distinctive concepts and approaches. In Section I we introduced the widespread and accepted definition of gamification but we also highlight the fact that it’s still a young and evolving concept. Yet in the context of our research, it’s important to differentiate the corresponding terms and enhance our overall understanding of the matter. While gamification uses elements from game design in non-game environments, serious games are often referred to as immersive learning simulations or gaming simulations [4]. They are games designed with the core purpose to improve learning while playing but their objective is not entertainment. In most scenarios, serious games describe and simulate real-life situations that when played and executed are preparing the players to handle that in reality. Serious games find application in the field of military training, healthcare, formal and corporate education, and many others. Game-based learning, on the other hand, is used to enhance the learning experience by implementing digital games in the learning process with the primary objective to achieve specific pedagogical goals and outcomes [5].

B. Theoretical background

When it comes to designing a game, although there are different approaches shared in literature from a theoretical perspective, a set of game design fundamental principles is proposed by Salen and Zimmerman (2014) which suggests that the process should follow an iterative design methodology as shown in Figure 1 and described below [6]:

- Understanding design, systems, and interactivity, as well as player choice, action, and outcome.
- Including a study of rule-making and rule-breaking, complexity and emergence, game experience, game representation, and social game interaction.
- Adding the powerful connection between the rules of a game and the play that the rules engender, the pleasures games invoke, the meanings they construct, the ideologies they embody, and the stories they tell.

Game design should also be approached in a way to identify the smallest parts of a game, often referred to as atoms, and it’s necessary to set an understanding of what these parts are and how they interact in order to design or analyze a complete game [7]. This necessity leads to the development of Mechanics – Dynamics – Aesthetics model, which later turn to become one of the very first formal frameworks trying to conceptualize the approach to understand games and attempting to bridge the gap between game design and development, game criticism, and technical game research [8]. The framework would be presented in details later in Section III.

On our journey to design and develop an educational application, implementing game design elements, that supports university students enrolled in Web development course, we also stumbled upon a similar approach. In the context of designing and developing a web, mobile or universal application, the concept of atomic design or atomic approach is often used as a way of creating and maintaining effective coherent design systems. Atomic design is a methodology composed of five distinct stages working together to create interface design systems in a more deliberate and hierarchical manner [9].

![Figure 2. Five stages of atomic design methodology](image)

Another popular process that is often suggested when approaching or implementing gamification is the usage of user-centered design philosophy.

Some sources suggest that there’s a difference between the user-centered and human-centered approach in the scope of human-computer interaction (HCI) and the design of information systems (IS). Yet in the context of this paper we would refer to the human-centered approach as a philosophy that puts the users (players) and their goals, at the center of the design and development process, in comparison to function-focused or data-driven which refer to efficient and result-oriented activities [10]. The human-centered approach is opposed to the traditional, technology-oriented approach, which prioritizes computer-based information processing and technology-

III. GAMIFICATION FRAMEWORKS

In Section II, we introduced some general concepts and key differences between game design elements and gamification. We can conclude that gamification as a concept has a complex definition and gathers various and intertwined disciplines under one hat, including game design and theory, user interface and system design, computer and software engineering, psychology and more.

In order to understand better the concept of a gamification framework, namely in the way that it analyses the core drives in human motivation in a system that can be easily applied to produce an effective strategy for successful implementation of gamification, our research would focus on the established gamification frameworks existing in literature with focus on their main features.

A. MDA framework

The MDA framework is one of the first basic formal frameworks trying to conceptualize the approach to understand games. It puts emphasis on the fact that games, in comparison to other entertainment activities, have relatively unpredictable consumption, which makes them a preferred medium. It suggests that games can be broken down into three levels of abstractions main components – mechanics (rules), dynamics (system) and aesthetics (fun), as [8]:

- Mechanics are the particular components of the game, at the level of data representation and algorithms.
- Dynamics are the run-time behavior of the mechanics acting on player inputs and each other outputs over time.
- Aesthetics are the desirable emotional responses evoked in the player when they interact with the game system.

The MDA framework also shapes the one-way connection between the three abstractions, approached both from the game creator’s and player’s perspective as shown in Figure 3:

![MDA framework abstractions](image)

**Figure 3. MDA framework abstractions**

As is seen on the figure, the creator constructs the functions and develops the features (mechanics) of the game, which produce different types of interaction and behavior (dynamics), and this leads to particular player emotions and experiences (aesthetics). The player, on the other hand, formulates their experiences based on the aesthetics and they engage in specific activities based on that [12].

B. MDE framework

Being one of the first frameworks for gamification puts the MDA framework at a starting point of a gamification research. Through the years, the framework has been modified by different authors and it was grounding the foundations of either adaptations or extensions, in order to fit different contexts.

One of the modifications was the MDE framework. The MDE stands for Mechanics – Dynamics – Emotion model. As obvious from the title the aesthetics abstraction was replaced with emotions. Robson et al. (2015) suggest that aesthetics describes the desirable emotional responses (as fantasy, fellowship, or other) evoked in game players when they interact with the game, which makes them more relevant to specific game context but not for gamification design as gamification is not a game [13]. In that context, emotions as an abstraction are more related to the engagement outcomes.

![MDE framework abstractions](image)

**Figure 4. MDE framework abstractions by Robson et al. (2015)**

To summarize, the MDE framework outlines the interdependent relationship of the gamification principles of mechanics, dynamics, and emotions, and how these principles relate to one another as the key for successfully gamifying an experience [13]. This is also one of the distinct features that differentiate the MDE framework from the MDA framework that has a one-way relationship and the different components don’t affect each other as shown in Figure 4.

C. 6D framework

The 6D gamification framework has a business background and conceives the following approach to gamification [14][15]:

- Define business objectives – this step puts emphasis on the fact that the specific application goals have to be well-defined, for example: “Teach the concept of a basic HTML structure”;
- Delineate target behavior - specify the tasks that the users must perform and metrics to assess these tasks, for example: “Increase students’ motivation through exercise”;
- Describe your players - define the known characteristics about the players, demographic, age groups or behavior types, for example: “Students, no previous experience in Web development”;
• Devise activity loop - specify the tasks that students should repeat to keep them engaged and to progress their skill level;

• Don’t forget the fun - after specifying goals, the tasks, the players and their behaviors, the authors recommend to review the application and see if the goals of creating something fun is still on focus;

• Deploy appropriate tools - based on the previous steps apply the necessary mechanics, metrics, and tools that focus on the target player and the application goals, for example – what Point-Badge-Leaderboard (PBL) systems would be integrated, what and how achievements would be unlocked, how the avatars would be customized and other;

D. GAME framework

GAME framework is a simpler framework for gamification design process [16]. The name of the framework is an abbreviation of the four main stages proposed:

• Gather information by asking – at this stage the following questions should be answered: "What are you gamifying?", "Why are you gamifying it?", "Who are you gamifying it for?", "How is success measured?", etc.;

• Act – After the information from the first step is collected actions towards design should be made, depending on the goals, engagement, experience of the users, and then everything should be tested;

• Measure – Measure the users’ performance and the outcomes, and how they relate to the goals from the previous step. This feedback should be used for iteration and improvements;

• Enrich - the system should be enriched over time, following an iterative path (new challenges, engaging content).

E. Octalysis framework

Octalysis framework is a complete gamification framework, proposed by Yu-kai Chou [17]. From the author’s perspective, the gamification is a design that places the most emphasis on human motivation in the process.

The framework itself focuses on a Human-focused design, instead of Function-focused design to achieve results quickly. The author, having a strong background in game mechanics, suggests that there are eight different types of core drives that motivate us to engage in certain activities. The approach he proposes is based on an octagon shape with eight core drives represented on each side: epic meaning and calling, development and accomplishment, creativity and feedback, ownership and possession, social influence and relatedness, scarcity and impatience, unpredictability and curiosity and loss and avoidance. The core drives push us in different directions as not everybody is motivated by the same drive.

Visually, the Octalysis framework has a shape of an octagon where the core drives are represented in each corner as shown in Figure 5.

![Figure 5. Octalysis framework as proposed by Yu-kai Chou](image)

He also suggests other approaches to understanding the framework, namely dividing the drives, as these on the right side represents the creative, artistic and social aspects, while these on the left side represents the logical and intellectual aspects. Moreover, he emphasizes the importance of understanding that these drives favor either extrinsic or intrinsic motivation. The key point in this framework is that it’s not necessary for an application to possess all core drives to be successful.

F. Other frameworks

In recent systematic research on gamification design frameworks, out of 2314 unique works initially, Mora et al. (2017) analyze a definitive list of 40 works, after applying a systematic filtering process [18]. Apart from the fact that some frameworks are based on or extend the proposed ones, the research also introduces hybrid versions. Some key outcomes from that research are:

• A clear predominance of gamification design frameworks in a business context, with less available research concerning generic, learning and health frameworks;

• Most of them are conceived as user-centered designs;

• From a logical point of view - extensive importance is given to the engagement loop;

• Measuring also seems to be a critical issue for gamification and the majority of the frameworks explicitly refer to the use of analytics and the importance of data collection;

• The psychological perspective presents a high relevance in almost all of the frameworks, as a key element that must be present in the design process;
• Interaction fundamentals are also extensively referred to, emphasizing gamification as user experience in itself. The need or desirability of developing software taking into account the possibilities provided by digital environments is also extensively referenced;

• Additionally, a closer relationship between the principles and elements of game design and gamification has been shown. Moreover, the results have revealed the heterogeneity of the analyzed frameworks, from a highly theoretical objective through to conceptualization, including the perception of gamification from different contexts and areas of interest;

Considering the above, we would propose an implementation of gamification design elements in an educational application in the next section, based on the background in Section II and the analysis in Section III.

IV. IMPLEMENTATION OF GAMIFICATION DESIGN ELEMENTS IN AN EDUCATIONAL APPLICATION

A. Why should we use gamification in web development course?

In order to answer this question, it’s important to understand the current state of the World Wide Web or the Web. Today’s web pages have nothing to do with the 1989 version of Tim Berners-Lee invention. And not because drastically changed, web pages are still documents supported by other web resources, interlinked by hypertext links and accessed via the Internet. But the web pages built back then served one basic purpose – to provide a simple and yet effective way of creating, sharing and connecting documents with information together.

Yet with the expansion of the Internet, together with the hardware advancements, rise of social media and content creation, the Web also evolves rapidly. This fact affects not only the coding techniques and web development approaches, but it also forces the introduction of new concepts as "grids", "responsive design", "mobile-first", "CSS pre-processors", "progressive enhancement", "unobtrusive JavaScript" and many more. This progress puts a lot of challenges in terms of how to teach effectively web technologies to the students and constantly adapt the classes when introducing new techniques in the curriculum.

That’s why we consider that the presence of a tool that can enhance the learning process in a non-obtrusive way, and even better – possessing and implementing a gamification approach would be beneficial.

B. Current generation

Current Generation Z (Gen Z) is perfect to conduct our research as it refers to the students born in the early to mid-1990s up through 2010, that grow up in an environment exposed to technological progress, Internet and the rise of social media. In order to plan and implement creative and engaging teaching strategies that maximize the retention of the students, it’s important to understand how Gen Z perceives and processes information.

Some distinctive characteristics of Gen Z in terms of socialization and learning are [19]:

• They prefer interactive environments and consume most of the information on mobile devices.
• They like to be instantly connected and express themselves via different social media channels.
• They have increased visual learning ability which is enhanced by complex video games and digital images.
• They are described as growing up too fast with vast exposure to news, media, video games which foster a desire to keep up with the game lifestyle and therefore expect school and work to be fun.
• 43% prefer a digital approach to learning and find it easiest to learn from the Internet.
• They like to have random access to information, love to explore using their own routes, rely on visual content, and require positive outcome and rewards, and instant feedback.
• They are multi-taskers that read less than 20% of text and spend only 4.4 seconds for every 100 words on the page. Thus, they need guidance how to focus their attention on a single task that has depth and complexity.

C. What gamification design elements should we choose?

In Table 1, we specify different elements that can be applied when we approach the design and development process of the application.

For every gamification application, a set of design mechanisms has to be outlined before its development. These are the elements which combine and interact to create a gameplay. The overall experience of gameplay depends on how well the system design elements are kept in mind to enhance user experience [20].

If we refer to the analysis we conducted in Section III, we can conclude that the approach we’ve taken in this section is quite similar to the stages proposed by the 6D framework in terms that we define our goal and expected outcomes in Subsection A. Then in Subsection B, we describe our player persona, and later in subsection C we focus on the fun, mechanics, system and desired behavior.

Although the defined gamification elements in subsection C are not described in the context of a game loop, the proposed mechanics would still be organized in a system and evoke certain emotions when adopted by the students. In that way, the proposed approach is also similar to the fundamental gamification design frameworks as MDA and MDE.
<table>
<thead>
<tr>
<th>Gamification design element</th>
<th>Adaptation in the educational application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levels/ Milestones</td>
<td>Section/topic in the course should be split into separate levels and each level should contain specific information about the topic.</td>
</tr>
<tr>
<td>Rewards / Points / XP</td>
<td>A reward system should be present in the form of points/XP that the students gather when they complete a level/task successfully, as well as if they participate in activities to better their coding skills such as challenges, unlocking badges, etc.</td>
</tr>
<tr>
<td>Hints</td>
<td>Students could use hints if they are stuck at a certain task. In order to obtain a hint, a student would have to exchange his/her previously collected reward points.</td>
</tr>
<tr>
<td>Badges</td>
<td>Students should be able to unlock a badge depending on their activity within the application.</td>
</tr>
<tr>
<td>Challenges</td>
<td>A challenge could be like problem-solving but providing specific goals and outcomes. For example, in doubling the current points or boosting the performance.</td>
</tr>
<tr>
<td>Goal setting</td>
<td>A goal setting should provide students with a possibility to set certain goals (how often they want to play or to gain a certain number of points each day). A notification system has to be utilized to serve this functionality.</td>
</tr>
<tr>
<td>Progress/Story</td>
<td>Course progress.</td>
</tr>
<tr>
<td>Time frame</td>
<td>Time pressure mechanism could be applied when dealing with challenges.</td>
</tr>
<tr>
<td>Immediate feedback</td>
<td>After a level/challenge is complete.</td>
</tr>
</tbody>
</table>

V. CONCLUSION - DISCUSSIONS AND FUTURE WORKS

In this paper, we have conducted a research and analysis of some of the existing gamification frameworks in the scope of our study, namely developing an educational application that utilizes gamification to support university students enrolled in a Web development course. Although our initial intention was to choose only one framework, due to the possibilities of adaptation depending on the content and domain, we opted for a justified hybrid approach.

The actual implementation of the application is going to be tested with several groups of students, as we plan to use experiments to assess the effects of these system design elements on learner engagement and learning achievement and wrap the results in subsequent and follow-up research.

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