GoRace: A Multi-Context and Narrative-Based Gamification Suite to Overcome Gamification Technological Challenges

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ABSTRACT Gamification is a potential approach to foster motivation and engagement in different contexts which popularity in recent years has encouraged its application in a diversity of domains, including health, education, business, society, or tourism. However, although all their promising benefits and rapidly developing, the gamification community should face a variety of theoretical, empirical, and technological challenges. Focusing on technological challenges, we can observe a need that claims for suitable gamification software tools that offer system-independence and flexibility, support the gamification design, implementation, and monitoring activities, and experiment with more game elements than only points, badges, and leaderboards. For that reason, this paper deals with the identified technological challenges by introducing a gamification software tool to cover the main lacks found. An analysis of the advances in gamification domain and their recent literature was conducted to identify the strengths and weaknesses of the most popular gamification software tools in order to design and develop a flexible system-independent gamification software solution that goes beyond the implementation of the classic game elements. As a result, we created GoRace, a multi-context and narrative-based gamification suite that supports the entire gamification process, provides flexible and system-independent gamification solutions, and allows the creation of tailored and reusable gamification solutions that go beyond the classic game elements to immerse participants in a fun, engaging, and challenging narrative-based gamification experience.

INDEX TERMS Flexibility, game elements, gamification, gamification process, gamification software tool, gamification technological challenges, multi-context, narrative, system-independence.

I. INTRODUCTION

Gamification, or "the use of game elements and game design techniques in non-game contexts" [1], emerged as a trending topic at the end of the first decade of the 21st century and has attracted the attention from both practitioners and researchers as a way to achieve a range of emotional, cognitive, and social benefits and guide human behavior for inducing innovation, productivity, or engagement [2] in different contexts, such as employee performance, customer engagement, and social loyalty, and in a diversity of domains, including marketing, human resources, healthcare, education, environmental protection and wellbeing [3].

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The recognition of the potential advantages of gamification has supported the exponential growth of its market, which is projected to grow from USD 9.1 billion in 2020 to USD 30.7 billion by 2025, at a Compound Annual Growth Rate (CAGR) of 27.4% during the forecast period [4], [5]. These promising benefits have also caused the rapidly increasing of gamification literature, as well as, its expansion and development in many directions, contexts, and domains [6]. However, "gamification is still a rather novel development that suffers from growing pains, and therefore, it is still found under significant conceptual chaos" [7], and their community should face a variety of theoretical, empirical, and technological challenges [6]–[10].

One of the main factors to success in gamification lies in the use of suitable resources, such as software-based

platforms, ad-hoc applications, or plug-ins, to support the entire gamification process [1], [8], [11]. In this paper, we use the term "gamification software tools" to refer to any digital tool used for supporting gamification process, including ad-hoc applications, platforms, or plug-ins.

Although in recent years, the promising benefits of gamification have caused the development of a high diversity of gamification software tools for conducting a variety of gamification experiences, we found that gamification still needs to deal with several technological challenges [8]. The majority of the gamification software tools are implemented as prepackaged and ad-hoc intrusive solutions that are integrated within the gamified domain impeding system-independence [11], [12]. Furthermore, the ad-hoc gamification solutions need also to face functional limitations, such as a limited range of available game elements and a frequently reduced operation regarding monitoring and control data of the gamification execution [13]. Additionally, the absence of general gamification software tools that implement gamification strategies independently of the gamified system also causes a lack of flexibility, since their specific functionalities to gamify a domain usually limit their reusability in others. Moreover, this lack of flexibility limits the possibility to integrate any domain resource within the gamification strategy, because it is usually the gamification software tool the one that is integrated into the domain and not vice versa. On the other hand, focusing on the gamification process and its activities, there exists a shortage of gamification software tools that efficiently support the design of gamification strategies, facilitate the monitoring and control activity by providing real-time analytics, and hide the implementation details through the automatic generation and deployment of gamification experiences [8], [13].

Hence, we can observe a need that claims for suitable gamification software tools that offer system-independence and flexibility, support the gamification design, implementation and monitoring activities, and experiment with more game elements than only points, badges and leaderboards. Considering this need, this paper introduces GoRace (https://gorace.uca.es), a multi-context and narrative-based gamification suite that:

a) supports the design of tailored gamification solutions and automatically implements and deploys them;

b) offers system-independence, and high flexibility regarding the different resources and domains that can be involved in a gamification experience, thanks to their architecture based on a REST API that deals with the external connections and integration with any domain resources;

c) facilitates the monitoring activity of gamification experiences by providing to gamification designers an easy to use and centralized application, GoRaceAdmin, to manage all their gamification experiences; and

d) experiments other less-explored game elements by providing participants with a centralized application, GoRaceGame. This application goes beyond the implementation of the classic game elements and immerses participants in a legendary Olympic race in which their progression is determined by their performance in the domain's real-life activities.

The structure of the paper is as follows: Section II describes the background of this work and provides an overview of the current gamification technological challenges. Section III identifies the works related to our proposal and compares them regarding the main technological challenges identified. Section IV introduces a detailed description of GoRace, our proposal. Section V briefly comments the GoRace's gamification experiences conducted and provides a preliminary user experience evaluation. Section VI discusses the limitations and threats to the validity of this work. Finally, Section VII summarizes the main contributions of this work, presents our conclusions, and draws our future work.

II. BACKGROUND

As we discussed in the introduction, many works claim that gamification success still requires the mature of several relevant factors for overcoming its theoretical, empirical, and technological challenges. Focusing on the technological ones, we can observe a need that claims for the development and use of suitable gamification software tools that: a) support the gamification design, implementation and monitoring activities, b) experiment with the wide variety of game elements, and c) offer flexibility and system-independence for providing adaptability, reusability, interoperability among different contexts and domains. The following sections provide further information.

A. GAMIFICATION PROCESS

As a new trend with promising benefits, the gamification literature has rapidly increased and spread in many directions [6], including the research efforts towards the development of numerous frameworks intended to support different aspects of the gamification process [8]. Regarding this issue, Mora *et al.* [14] conducted a systematic literature review in which the main gamification frameworks were analyzed. The Six Steps to Gamification framework proposed by Werbach and Hunter [1], the Complete Gamification Framework, Octalysis, proposed by Chou [15], the GAME framework proposed by Marczewski [16], or the gamification development framework proposed by Herzig [17], among others, are some of the well-known frameworks that define the different activities that the gamification process should follow.

Although several frameworks have been published and each of them provides a set of different activities for the gamification process, based on the outcomes of Mora *et al.* [14] and their analysis of the gamification proposals, the gamification process can be structured in the following four high-level activities:

1. **Analysis**, where the application context is analyzed, the objectives pursued by the gamification are established and the requirements are documented.

2. **Design**, where the gamification strategy is developed and playtested.
3. **Implementation**, where the design is implemented as software artifacts as well as functionally tested.
4. **Monitoring**, where the execution of the gamification strategy is measured in order to control the achievement of their objectives and subsequent design adaptations are conducted.

The success of gamification strategies requires suitable resources that support all the activities of the gamification process from the identification of the business objectives to the monitoring of the gamification strategies. However, regarding the resources to support the gamification process, some problems should be dealt with such as (a) the lack of user-friendly tools that can efficiently support the design of gamification strategies and implement them independently of the system, site, or process intended to be gamified, and (b) the necessity of highly-scalable monitoring tools that provide gamification analytics, that means, that provide not only participants immediate feedback [8], but also gamification designers with real-time analytics such as gamification elements analytics or KPI monitoring, that allow them to assess and adapt their gamification strategies [13], [18].

B. GAME ELEMENTS

According to [19], "the game elements are like building blocks that are needed for creating a game experience". In the context of game design, game elements have been listed and categorized in many occasions, being the most standardized approach the MDA framework, which describes the game elements as belonging to one of these categories: Mechanics, Dynamics and Aesthetics [20]. Gamification motivates by bringing game elements that are considered fun and engaging into tasks that do not have such qualities [21]. In the literature, we can also find many different ways to characterize the game elements used in gamification [11], [22], [23]. Therefore, according to these authors, there is not yet a standard classification of game elements. Nevertheless, one of the most used approaches [21] is the adaptation of the MDA framework proposed by Werbach and Hunter which classifies game elements into three relevant categories: dynamics, mechanics and components [1].

Dynamics are the big-picture aspects of the gamified system that have to be considered and managed, but which can never directly enter into the game. In other words, dynamics are the experience of how the user interacts and creates expectations in the gamified system. Sense of competence, satisfaction, social rank and narrative are examples of game elements belong to dynamics. Mechanics are the basic processes that drive the action forward and generate player engagement. For instance, time counting, behavior, preference, surprise, fun or participation are game elements belong to this category. Components are more specific instantiations of mechanics and dynamics, such as classification, avatar, points, rankings, nicknames or exploration game elements. Each mechanic is

tied to one or more dynamics, and each component is tied to one or more higher-level elements [1], [21].

Several authors have conducted different studies in order to identify and define the set of suitable game elements to be integrated into different gamification contexts [24]–[26]. However, despite the diversity of existing game elements, the vast majority of gamification experiences are based on the so called PBL triad or "pointsification" [27], the application of points, badges, and leaderboards as the main game elements in a gamification experience [11, 28]. This approach "takes the thing that is least essential from games and represents it as the core of the experience" [28], ignoring the part that makes games wonderful and attractive, which is, at the same time, the part that allows achieving the commitment, loyalty, enthusiasm, and fun of the participants [1], [28]. Therefore, although the use of "pointsification" can be effective and achieve good results in the short term, it can lead to the failure of gamification experiences in the long term since points, badges, and leaderboards are not proved useful to provide involving experience for participants [12], and also can create situations where users simply collect points and rewards, which result in voiding the user experience [12], [28]. In addition, "pointsification" limits the design of gamification experiences, and the limited perceptions of gamification design signal a limited perception of gameful experiences in general [6].

Gamification is a wider field in which many mechanics exist, but, most importantly, it is a field in which there are suitable dynamics for taking advantage of those mechanics to engage and motivate participants in the best way [29]. Hence, gamification designers should be aware of the risk of adopting gamification as a simple "pointsification system", as the approach has more to offer [1]. One of these underused elements is the narrative [1], [24]. Gamification narratives are a fundamental dynamic in a gamified process and one of the keys for engaging participants [1]. The narrative game element can be understood as the process in which the user builds his own experience through a given content, exercising their freedom of choice in a given space and period of time, bounded by the system's logic [30]. Incorporating a semantic layer, either adding a scenario, a theme or a story to a gamification experience, helps to give coherence and could have a major impact on the other elements of the whole of the gamification experience [31]. Most remarkable, it makes participants' engagement easier and longer-lasting [32]. However, despite its advantages, there is an absence of a high number of gamification experiences that implement the narrative game elements instead of focusing mainly on the PBL triad [24], [33].

C. GAMIFICATION SOFTWARE

Gamification software refers to any tool or platform used for applying game elements and game design techniques to non-game contexts in order to boost engagement, motivation, and successful end-results according to the business goals. One of the main factors to success in the design of

gamification and apply it correctly lies on the use of suitable resources, such as software-based tools or platforms, for supporting the entire gamification process. Bearing in mind the literature, we found that software gamification solutions are mainly implemented by two different ways: (a) using general-purpose gamification platforms, or (b) creating self-built solutions [8].

Using a general-purpose gamification platform can be an easy solution in the absence of a gamification designer, or in any context where there is a lack of the knowledge, resources, or experience to develop a gamification strategy or create a self-built solution. Well-known examples of general-purpose gamification platforms are Bunchball Nitro, SAP, Badgeville, among others, that provide general gamification solutions for enterprises in order to boost customer loyalty, performance management, employee engagement, or e-learning, as shown in [34]–[36]. However, using a generic gamification platform can limit the gamification experience and their customization according to the needs of the participants, and therefore reducing the flexibility and interoperability with the system, and the control and processing of the data generated along the experience [8], [13].

On the other hand, the creation of self-built solutions for supporting gamification allows gamification designers to design specific tools that fit with their business goals and their participants' needs, having the full control over the entire gamification engine and the data generated along the experience. This type of gamification solutions requires a high level of knowledge and understanding of gamification design and technologies to implement the necessary tools, but provide more flexibility and interoperability than using a general-purpose gamification platform, since gamification designers can adjust to their needs all the aspects of the systems without being limited by the functionality of a generic gamification platform [8]. Some examples of this type of self-built gamification solutions are the tool created by [37] to promote participation in online discussions, the gamification platform implemented by [38] based on a question board with the goal to engage learners in online post-lecture questions, or the gamification solutions implemented by well-known enterprises such as Starbucks to increase customer loyalty with their reward-based system, and Nike to promote sports habits and announce their products through the Nike+ Fuel-band and application, among others [39]. One of the main problems of self-built solutions is their specific character, which does not usually allow being reused, challenging or impeding a multi-context use.

III. RELATED WORKS

In recent years, several studies have analyzed the gamification field from different perspectives, contexts, and domains, identifying their strengths and weaknesses, as well as the advantages and disadvantages of the gamification solutions implemented. Some of them have reviewed the design of gamification solutions focusing on the game elements used [6], [12], [26], [40], concluding that the majority of

the empirical gamification experiences analyzed are based on points, badges, and leaderboards. This is an issue that authors highlighted that must change since it eclipses the wide variety of existing game elements while limiting the design and potential of gamification experiences [6], [29]. Other studies have analyzed the gamification implementation activity identifying the way as the gamification solutions are implemented and classifying them according to their ability to be applied in general or specific contexts, or the technology under they are developed [8], [11], [13], [40]. As a conclusion, authors agree on the lack of flexible and system-independent general-purpose solutions that provide adaptability, reusability, interoperability among different contexts and domains [8]. Other authors have centered their attention on the gamification monitoring activity analyzing the capability of the gamification solutions to provide real-time analytics and participants' feedback [8], [13], [14]. A topic that is considered as a crucial aspect for the gamification experiences' life since the collection, processing and control of the generated data within a gamification experience depends on these features of the gamification solutions [14].

From these studies, we have retrieved well-known gamification software solutions such as FourSquare [12], Bunch-Ball [13], ClassDojo [40], other less-known such as Medit4CEP-Gam [8], and we have also completed the retrieved list with some manual searches on the grey literature based on the list of references of these studies. All the identified gamification software solutions are shown in Table 1. In this table, gamification software solutions have been classified according to six features:

F1. The main game elements that they implement. A gamification software solution is classified as "classic", if its design is mainly based on classic game elements (points, badges, and leaderboards), or as "non-classic", if its design is based on more game elements rather than the classic ones.

F2. The purpose of the solution. Gamification software solutions can be classified as "general", if they have been created as a general-purpose gamification solution to be integrated with any context, or "specific" if they are self-built solutions to cover the specific needs of a domain.

F3. The reusability of the solutions, that is, if the gamification software solution enables its application in more than one particular context.

F4. The interoperability of the solutions, that is, if the gamification software solution is able to integrate several tools, systems, and actions within the gamification strategy.

F5. The system-independence of the solutions, that is, if the gamification software solution is not implemented as a prepacked or ad-hoc intrusive solution that should be integrated within the systems or tools to gamify.

F6. Support the gamification monitoring activity, that is, if the gamification software solution provides features for supporting the gamification monitoring activity

TABLE 1. Gamification software solutions.

Gamification software solution	Game elements (F1)	Purpose (F2)	Reusability (F3)	Interoperability (F4)	System-independence (F5)	Support gamification monitoring activity (F6)
Badgeville [8, 13]	Classic	General	x			
BunchBall [8, 13]	Classic	General	x	x		x
SAP(Gigya) [8, 13]	Classic	General	x			x
Medit4CEP-Gam [8]	Classic	General	x	x	x	x
ClassDojo [40]	Classic	General	x[*]		x	
Kahoot [40]	Classic	General	x		x	
ClassBadge [40]	Classic	General	x[*]		x	
FourSquare [12]	Classic	Specific				
Nike+ [12]	Classic	Specific				
Getglue [12]	Classic	Specific				
PRIME (bluewolf) [8]	Classic	Specific				
Starbucks [8]	Classic	Specific				
Duolingo [40]	Classic	Specific				
Ribbonhero of Microsoft [40]	Classic	Specific				
GAMESIT [45]	Non-classic	Specific				
Unicraft [46]	Non-classic	Specific	x		x	
Classcraft [47, 48, 49]	Non-classic	Specific	x[*]		x	
Gamfi[**]	Non-classic	General				

[*] They provide reusability but only in educational contexts.

[**] https://www.gamfi.com

by implementing gamification elements analytics (see Section IV-G).

As Table 1 shows, we can find numerous works that implement gamification solutions based mainly on points, badges, and leaderboards, but if we focus on both, general and specific, solutions we found that less than 25% of the identified gamification software solutions are based on more game elements than classic ones such as narrative, avatar, or storytelling. Moreover, only one of this last group is a general-purpose gamification solution.

Regarding the flexibility in terms of reusability, interoperability, and system-independence, we can observe that the majority of the identified general-purpose gamification software solutions provide reusability in some way, but they fail to provide interoperability, being only two of them able to integrate several tools, systems, and actions within the gamification strategy. In addition, although they are general-purpose solutions, not all of them (50%) offer system-independence so it usually difficult their implementation since they need to modify the system for including the gamification layer that, at the same time, usually requires the work of a system expert. On the other hand, although the specific-purpose gamification software solutions do not usually provide reusability, we can observe that two out of the ten identified solutions are able to provide it, mainly thanks to they also provide system-independence, a crucial feature to easily adapt and integrate the solution to other contexts. Finally, as we have previously commented, one of the gamification technological challenges highlights the necessity of gamification software solutions that support the gamification monitoring activity. The majority of the identified solutions provide, in a certain way, features for supporting the monitoring of the participants and providing them with real-time feedback, but if we focus on monitoring the entire gamification strategy that requires real-time feedback for gamification experts and more specific analytics such as game elements statistics or feedback and tracking measures [8], [13], [18], we found that only three of them support the gamification monitoring activity by implementing gamification elements analytics.

Bearing in mind the strengths and weaknesses of the identified gamification software solutions, we have created GoRace, a multi-context and narrative-based gamification suite, designed to motivate and engage participants for achieving the business goals of any domain, immersing them in a fantasy virtual world inspired in the game elements of successful video games such as Mario Kart [41], God of War [42], and World of Warcraft [43], [44]. A suite that aims to contribute to the gamification scope by dealing with the existing gamification technological challenges.

IV. DESCRIPTION OF GORACE

GoRace is a suite of web applications that allows to automatically create a tailored web solution to gamify any domain. It easily integrates with the systems, tools, or sites of a company, business, educational setting, etc. and takes advantage of the activities that participants perform to provide them with a unique experience that boosts engagement, motivation, and successful end-results according to the business goals. Inspired by game dynamics, mechanics, and components of well-known video games, GoRace involves participants in a narrative-based gamification experience. In a GoRace experience, participants are transferred to a virtual world based on the age of Greek mythology, where they will participate in a legendary Olympic race. The objective of the race is to reach immortality by arriving first to the finish line. For

that, participants should accomplish their real-life activities to get different game rewards, such as distance points and virtual coins, and interact with other game elements of the virtual world, such as a virtual shop, to buy and decide when and how use a wide variety of fantasy items that may have positive or negative effects on the progress of a particular or all participants that allow participants to advance in the race.

A. TERMS AND DEFINITIONS

For the purposes of this work, Table 2 provides the terms and definitions used in the context of GoRace.

B. GORACE GAMIFICATION PROCESS

A GoRace gamified domain is characterized by the gamification experience that connects the domain resources with the tailored solution involving gamification masters and participants in a specific gamification strategy with the objective to cover the domain's business needs and goals. As Fig. 1 shows, GoRace follows a three-stage process to gamify a domain. Starting from the domain to gamify and their business goals, interests, and needs, the GoRace gamification process is composed of Analysis and Design (AD), Implementation, and Execution, Monitoring and Control (EMC) stages that integrate the four high-level activities of the gamification process commented in Section II-A. A further description of the aims and activities of each stage follows.

1) ANALYSIS AND DESIGN (AD)

Previous to the use of the GoRace suite, in the Analysis and Design stage, the domain to gamify is analyzed and their gamification strategy is designed in order to use GoRace for implementing the gamification tailored solution.

Two main activities take place in this stage:

1. *Domain description*. This activity is the first step of the GoRace gamification process and involves gamification designers and gamification masters in the description and analysis of the domain to gamify. Its objective is to plan the gamification experience by identifying all the domain resources that will take part into the gamification experience, as well as, all the activities that will be involved into the gamification strategy. In addition, the relevance and specific features of each activity within the domain are documented in order to design a specific gamification strategy according to the business goals, interests, and needs of the domain. As Fig. 1 shows, this activity receives the domain to gamify and their objectives as input, and ends with the gamification experience plan as output.

2. *Gamification strategy design*. In this step, gamification designers design the particular gamification strategy for the gamification experience previously planned. For that, they take into account all the particularities of the domain resources and activities to design a tailored

TABLE 2. Terms and definitions.

Term	Definition
Activity	Any action performed by the participant in the gamified domain that results on an outcome in the GoRace virtual world.
Domain	Any business, company, educational setting, etc. to be gamified.
Domain resources	Set of software tools, websites, systems etc. of a particular domain that the participants in a gamified GoRace experience used. For example, in a particular educational setting, the domain resource can be the learning platform used to perform the activities of the educational course.
Gamification designer	Users that design and implement the gamification strategy using GoRace. They are specialized in GoRace and the game elements that can be used to design engaging and fun experiences in non-game contexts.
Gamification experience	Experience created by gamifying a domain with GoRace. This involves the particular domain resources, the tailored solution, and their joint integration for implementing the gamification strategy designed for such domain.
Gamification experience plan	It describes and documents all the information needed (participants, activities, domain resources, how participants interact with the domain resources, the relevance of the different activities,…) to design the gamification strategy of a domain.
Gamification master	Users who use GoRaceAdmin to manage and dynamize the gamification experience. They have expertise in the domain intended to be gamified. For example, in an educational setting, the gamification master would be the teacher conducting the gamification experience.
Gamification strategy	It establishes how the gamification experience of a domain will be carried out. It identifies all the activities, actions, events, and resources of the domain that will take part in the gamification experience, as well as, their role in such experience.
Gamified domain	The particular company, business, educational setting, etc. that is being gamified with GoRace.
GoRace	Suite of gamification web applications.
GoRaceAdmin	An administration application that allows gamification masters to manage the GoRace gamification experiences
GoRaceGame	A game application that allows participants to be involved in the GoRace gamification experiences.
Participants	End-users who participate in the GoRace gamification experience, also known as players.
Tailored solution	Set of GoRace applications that implement a specific gamification strategy to gamify a particular domain. It is composed of two applications: GoRaceAdmin and GoRaceGame.
Variable	Any measure that assesses the outcome of an activity in a gamified domain.

solution that includes the tailoring of the elements of the virtual world to achieve the specific goals of the domain, and the necessary mechanisms to transfer the progress that participants achieve in the real-life activities of the domain to the GoRace virtual world. These mechanisms involve, among others, the definition of the variables that will measured the performance of the real-life activities, the definition of the equations to automatically transform the results of these activities in game elements that will allow participants to progress in the narrative provided by GoRace, and the adaptation of all the game elements of the narrative such as the start and end points of the race, to the particular domain. As a result of this activity, the gamification strategy of the domain is designed and documented in order to proceed with their implementation (see Fig. 1).

Although the suite does not directly support this activity of the GoRace gamification process, guiding it or suggesting ideas, GoRace's features and its game elements have an important role in the analysis of the activities and resources of the domain to gamify, and the design of the gamification strategy, as well as, in the transformation and connection of both worlds, the real and the fantasy.

2) IMPLEMENTATION

Once the gamification strategy has been designed, the next stage of the GoRace gamification process is its implementation by creating the tailored solution. Hence, in the Implementation stage of GoRace the design is implemented as software artifacts and functionally tested. In this stage, two activities are carried out:

3. *Gamification Strategy Implementation.* In this activity, gamification designers use the gamification strategy designed to automatically implement the GoRace tailored solution. Gamification designers using GoRace define all the information related to the gamification strategy and adapt the game elements involved in the specific gamification experience, such as the race's features or the virtual shop, according to the gamification strategy designed. As a result, based on the activities, variables, equations, adapted game elements, and particularities of the gamification strategy, GoRace automatically generates a tailored solution. As Fig. 1 shows, this tailored solution consists of two specific web applications: GoRaceAdmin that allows gamification masters to manage the gamification experience, and GoRaceGame that allows participants to take part into
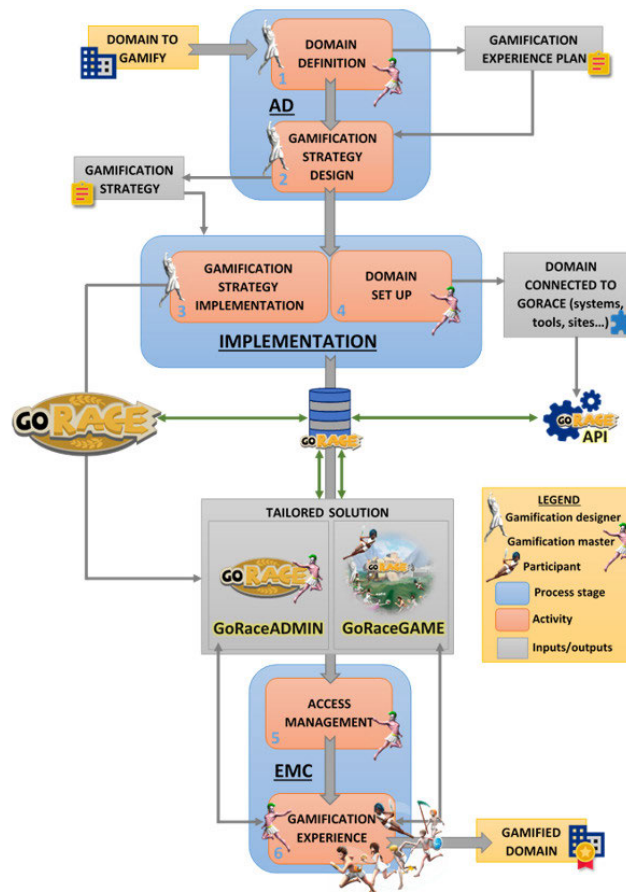

FIGURE 1. GoRace gamification process.

the specific legendary Olympic race that gamifies their particular domain. Moreover, in this activity gamification designers test the tailored solution to ensure its functionality and change or adjust any identified issue before the gamification experience is executed.

4. *Domain Set up*. Considering the gamification strategy designed, the domain resources should be set up to connect them with GoRace by using its Application Programming Interface (API) (see Fig. 1). Gamification masters need to adapt their domain resources for sending via GoRaceAPI the information related to their participants' activities according to the gamification strategy. Through this configuration, GoRace is integrated with the domain resources, and therefore, the domain is connected to GoRace allowing the automatic sending and processing of the participants' accomplishments in their real-life activities.

3) EXECUTION, MONITORING AND CONTROL (EMC)

Finally, in the EMC stage, the gamification experience is executed and its monitoring and control is performed. As Fig. 1 shows, this stage consists of two activities:

5. *Access Management*. Once the GoRace tailored solution has been generated and the necessary mechanisms to communicate the domain resources with GoRaceAPI have been implemented, the next step requires that gamification masters manage the access to GoRace by using GoRaceAdmin. Through this application, gamification designers should set up the access credentials to enable and test the connection of the domain resources with GoRace to ensure that GoRace successfully receives correctly the data sent by the domain resources before starting the execution of the gamification experience. Moreover, in this activity, gamification masters should also register all the participants that will be involved in the gamification experience by allowing the creation of their GoRace accounts.

6. *Gamification Experience*. After completing the setting up of the connection and the registration of the participants, the gamification experience can be executed. By using GoRaceGame, participants can log in the GoRace virtual world to participate in a legendary Olympic race aimed at achieving immortality. For that, they need to perform their real-life activities supported by the domain resources. Their outcomes will be automatically transferred to the virtual world, at the same time that their race's progress will be notified in real-time. On the other hand, by using GoRaceAdmin, gamification masters are able to manage the participants in the gamification experience, as well as measuring, analyzing, and tracking their progression and outcomes. Moreover, gamification masters are also able to deploy strategies to establish new challenges to encourage participants' participation and improve their motivation whenever they want. Hence, GoRaceAdmin allows gamification masters to observe at any time the

progress of the gamification experience and make decisions such as send notifications to participants, reward or punish players' behavior, among others, to control, improve, and adapt it in real-time. As a result, participants and gamification masters are involved in a gamification experience designed to gamify their domain according to their specific business needs and goals.

C. GORACE ARCHITECTURE

GoRace has been developed as a suite of web applications using well-known web technologies to provide operability and support the design, implementation, execution, control, and monitoring of gamification experiences in an easy and user-friendly way. As we can see in Fig. 2, GoRace is composed of the following elements:

a) A main application that allows gamification designers to design and implement the GoRace tailored solutions for gamifying any domain according to its interests and needs, as well as managing the rest of the elements of the suite, such as the access to the tailored solutions, the information of the website, or the way in that external services and domain resources are integrated.

b) Tailored solutions. Each tailored solution is composed of two web applications that are automatically generated by using GoRace suite to gamify each domain with its defined gamification strategy: GoRaceAdmin and GoRaceGame.

c) A centralized database managed by MariaDB that deals with the data persistence of GoRace.

d) An API that allows and facilitates the connection of any tool, site, or system with GoRace.

e) A website, https://gorace.uca.es, that allows accessing to the tailored solutions and provides general information of the GoRace suite to the public.

GoRaceGame has been developed as Progressive Web Apps (PWAs). A PWA was initially defined by [50] as a set of concepts and keywords including progressive, responsive, connectivity, independent, app-like, fresh, safe, discoverable,
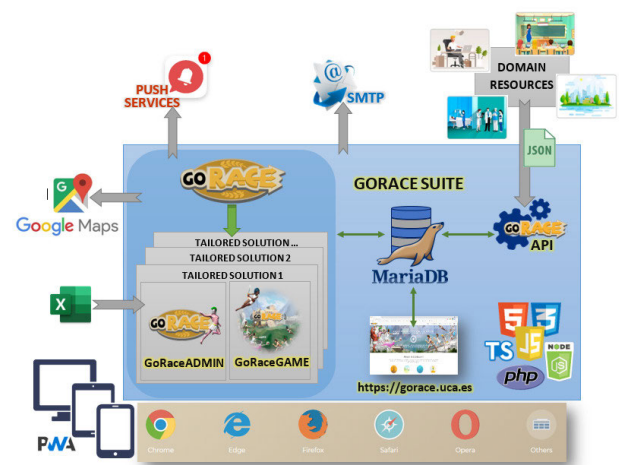

FIGURE 2. **GoRace architecture.**

re-engageable, installable, and linkable [51]. Summarizing, a PWA is a website that looks and behaves as if it were a mobile app, and therefore it takes advantage of its native features such as the capability to be installed and distributed without app marketplaces or to receive push notifications. The development of GoRaceGame as PWA facilitates its flexibility in terms of use and access and its portability since it makes it compatible with all current web browsers. Furthermore, it can be installed on Android devices as if it were a native application, which helps provide a gamification software tool that can be run on mobile devices such as smartphones and tablets as well as on desktops and laptops. These website features also contribute to the system-independence of GoRaceGame, since it does not require to be implemented within the system to be gamified and also allows GoRaceGame to integrate and benefit from the multiple web services as a way to provide a better user experience. In addition, its behavior as a native app allows GoRaceGame to take advantage of the push notifications to implement automatic and immediate feedback to the participants as a result of the activities of the gamification monitoring activity. Hence, the features of GoRaceGame as PWA allow us to get a gamification software solution for contributing to overcome some of the main gamification technological challenges identified in Section II-C.

The GoRaceAPI provides a set of integrated functionalities to communicate the resources of the gamified domain with GoRaceGame. By using this API, the domain resources are able to register and check the access of the participants involved in the gamification experience, as well as to send the information of their gamified real-life activities to GoRaceGame, which will automatically process this information and transform it into game elements within the fantasy world. As Fig. 2 shows, the communication with the API is carried out through JSON files that must contain the data according to the measurement variables established in the gamification strategy. In this communication, domain resources are responsible for connecting and sending information to GoRaceGame via the GoRaceAPI when necessary. Being a non-intrusive solution, GoRace does not access or connect to them. This feature makes GoRace a system-independent software solution since the gamification layer is not implemented as a prepacked or ad-hoc intrusive solution that should be integrated within the domain to gamify. Moreover, thanks to the connection via API, GoRace offers high interoperability since gamification masters can connect any desired tool, system, or site of the domain to GoRaceGame, and therefore, involves them in the gamification strategy.

We have mentioned above that GoRaceGame automatically receives the progress of participants' real-life activities through its API. Nevertheless, GoRaceGame also allows the incorporation of non-automatic activities results by importing them through Excel files via GoRaceAdmin. This feature helps to enrich the design of gamification strategy since it is not only limited by the automatic activities of the domain
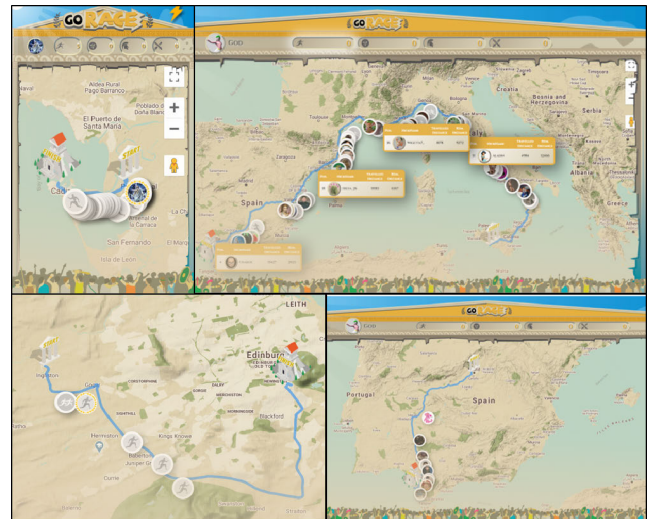

FIGURE 3. Examples of maps and routes for several races in different gamification experiences.

resources connected but allowing the integration of a huge diversity of activities that due to their features cannot be automated such as those related to good behavior of students in a classroom, the participation of employees in activities within a company, or simply any activity that does not involve the use of technology.

On the other hand, GoRace makes use of different services for providing particular gamification solutions to gamification masters and real-time feedback to participants (see Fig. 2). As we have commented, by using the main application of GoRace gamification designers are able to automatically create tailored solutions to deploy specific gamification strategies. These gamification strategies are managed by gamification masters using GoRaceAdmin, and involved participants in a fantasy world where they participate in an Olympic race by using GoRaceGame. In order to provide an exclusive gamification experience, the route of the race is also adapted and customized for each experience according to their designed gamification strategies. To provide these routes, GoRace makes use of services of Google Maps such as the Geocoding, Directions and the Maps JavaScript APIs to display the progress of the race on a customized map that integrates the game elements of the fantasy world. Fig. 3 shows some examples of maps and routes designed for different gamification experiences.

A crucial factor for keeping alive a gamification experience is that participants get immediate feedback that informs them about their performance, progress, and achievements in real time [1], [14]. For that, GoRace makes use of PUSH and SMTP services to send notifications and emails, respectively. Through these services, GoRace informs participants about their progress in the race providing information related to the influence of their real-life activities in the race or the different events that can occur within the fantasy world during the execution of the race.

FIGURE 4. GoRaceGame screenshots.

D. GORACEGAME

GoRace gamifies domains by immersing their participants in a narrative-based gamification experience. Narratives consist of using stories that place participants in a process in which they build their own experience by exercising their freedom of choice in a given space and period of time, limited by the system's logic [30], [52]. For that, all the game elements implemented in GoRaceGame are designed around a story that brings the age of Greek mythology to the present day for involving participants in a legendary Olympic race in which their progress is determined by their performance in the domain's real-life activities. The aim of the race is to achieve immortality and turn into an Olympic God by reaching first at the finishing line. Hence, participants should give the best of themselves in real-life, as well as managing their in-game strategy to progress and achieve the goal. A video trailer helps immerse the participants into the story, giving context to the narrative-based gamification experience. This trailer can be seen at https://youtu.be/KI8Qh8mCpkg.

Participants need to complete their registration in GoRaceGame and turn into players by choosing their nicknames. Once players have set their name and their avatar, GoRaceGame transfers them to an ancient Greek environment where the legendary race takes place and the Olympic gods are the main spectators who are waiting to offer players their help. Fig. 4 shows the login and some of the screens of the GoRaceGame application running in a smartphone device.

The first time that players access to GoRaceGame, the trailer is displayed to immerse them in the story and an interactive tutorial tour is provided to explain them how-to-use the environment and play with it, then they are placed in the home screen of the application where the map and the route of the legendary race are presented (see the second image of Fig. 4 or Fig. 5).

Players can move along the different screens of the application by using the navigation bar, which is located at the bottom of the application (see Fig. 4 and Fig. 5). These screens are:

1) **Home.** This is the main screen of GoRaceGame and it serves as the eyes of players within the narrative since it summarizes the relevant aspects of the race in a visual way.

FIGURE 5. Home screen.

2) **Backpack.** This screen allows players to observe their relics, powerful items that they can obtain during their progress in the race, and apply them to get their benefits.

3) **Shop.** This screen is the virtual shop of the game. It provides players with a catalog of fantasy relics that they can buy to obtain powers that may help them implement their in-game strategy.

4) **Ranking.** This screen provides players with a traditional ranking-like view of the current situation of the race.

5) **Profile.** This screen allows players to customize their avatars, as well as to access different functionalities and information of GoRaceGame.

Moreover, through this navigation bar, players can access to the exit functionalities that gives them two options: (i) log out the GoRaceGame application, and (ii) change among the different races in which they may be involved. This last functionality is a key factor of GoRace's reusability since players can access to all their gamification experiences, play their different races, and manage their game's strategies by using a centralized application, without any necessity of having multiple accounts in GoRace and having the possibility of changing among the gamification experiences they are participating in, and therefore, among the gamified domain they are involved at the reach of a single click.

A more in-depth description of the screens of GoRace follows:

1) HOME SCREEN

The main element of the home screen is the visual map of the race. This map shows the route of the legendary race and the position of each player by placing their avatar along the route of the race. The position of the player that occupies the first position in the race is highlighted by showing its avatar encircled with a golden laurel wreath. At the top of the home screen, the main data and statistics of the player's avatar are provided. These elements, labelled as A-E in Fig. 5, are the following:

A. The player's name (nickname) and the image of their avatar.

B. *Distance points*. These points show the current travelled distance in the race and they are obtained by the players' accomplishments in their real-life activities. All the GoRace gamification experiences are guided by the Distance points since the maximum amount of Distance points that can be obtained in a race, determines the length of the race.

C. *Divine points*. These points map to virtual coins that players use to buy relics in the shop. Relics are powerful items that provides players individual or collective positive/negative effects such as the ability to advance faster in the race or to reduce their opponents' advance, among others. These points are also obtained by the players' accomplishments in their real-life activities.

D. *Protection degree*. The amount of protection degree of a player indicates how many times the player can be protected against a negative effect that other players may apply to them as a result of using a particular relic. Given the situation, this benefit is applied to the player automatically as long as they still have some protection degree available. After this application, the amount of protection degree used is removed from the available protection degree.

E. *Reflection degree*. The amount of reflection degree does not only protect players against the negative effect of another player's attack. It allows them to return the negative effect of the attack to the attacking player. The amount of reflection degree of a player indicates how many times the player can benefit from this feature. The use of this benefit is also performed automatically when the player is attacked and has some reflection degree available. After this application, the amount of reflection degree used is removed from the available protection degree.

2) HISTORY SCREEN

In the upper right corner of the home screen, players can find the lightning button that gives them access to the player's history screen. This screen contains all the information available about the player's performance and helps them analyze all the events that have occurred in the race. Moreover, this lightning symbol acts as an in-game notification since it starts moving and shining each time that something that affects them has occurred in the race. Concretely, the history screen provides information related to four different race events (see Fig. 6):

1) *Assignments done*. This section of the history screen provides information related to all the player's real-life activities that have influenced their progress in the race, showing their impact in the distance and divine points.

2) *Relics used by the player*. This section provides information about all the benefits obtained by the relics that the player has used.

3) *Relics used against the player*. This section provides information related to all the positive and negative effects that have been applied against the player, showing the names of the attacking players who applied

them and how the different kinds of the player's points have been affected.

4) *Used Codes*. This section shows the information related to all the codes redeemed by the player. These codes are special rewards provided by gamification masters that allow players to obtain extra benefits during the gamification experience.

3) RANKING

Players can also access to their race's history through the information button located in the upper left corner of the ranking screen (see Fig. 7). The ranking screen, as its name indicates, provides players with another way to observe and analyze their progress in the race by displaying the different players' positions in a ranking. In this ranking, each player sees their own position highlighted with a different background. Hence, the political activity of GoRace virtual world takes place among the home and ranking screens in whereby considering the race's information and history, players plan their play strategies, identifying their allies and opponents.

Additionally, each race has an initial and end date. A timer, that is visible in different screens of GoRaceGame, shows a countdown of the time remaining to finish the race, and therefore, to finish the gamification experience.
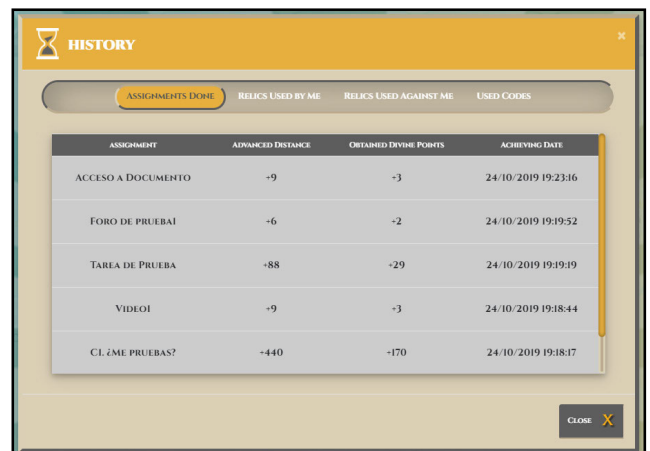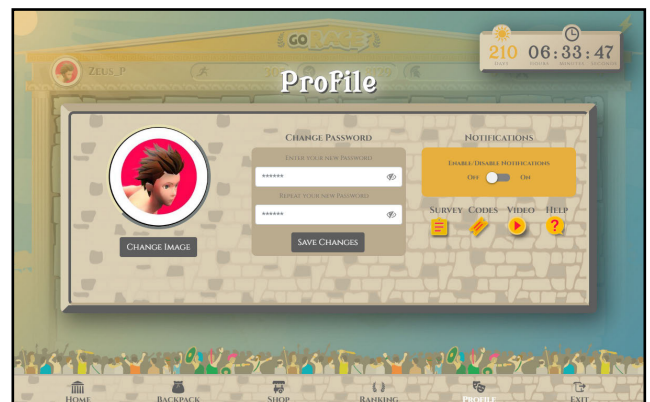

FIGURE 6. History screen.

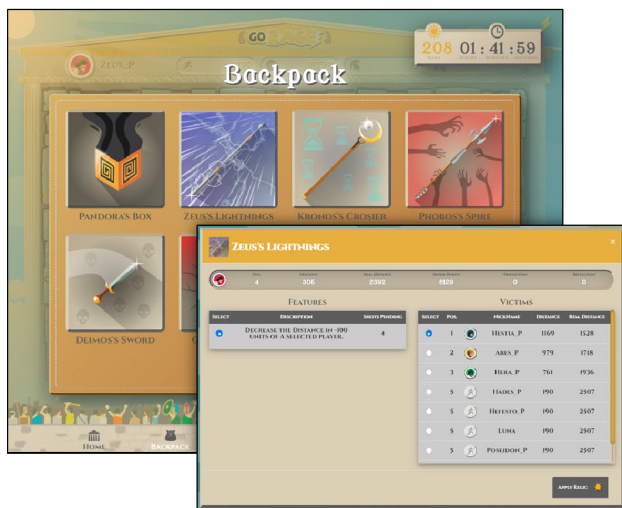**FIGURE 7.** Ranking screen.

FIGURE 8. Shop screen.

FIGURE 9. Backpack screen.

4) SHOP SCREEN

The economy of the virtual world of GoRace is based on the divine points that players can obtain by performing their real-life activities within the gamified domain. These points are used to buy a wide variety of relics that provides players individual or collective positive/negative effects such as the ability to advance faster in the race, reducing their opponents' advance by attacking them with the Olympic weapons, or supporting their colleagues by acquiring the gods' powers. The catalog of available relics is available at the shop screen (see Fig. 8). Through this screen, players can check their current amount of divine points, and they can explore the different available relics, analyze their benefits, and check their price to decide what relics to buy according to their own play strategy.

All the acquired relics are stored in the backpack of the player. Through the backpack screen, players can check all the information related to the benefits of their relics, and by selecting them, they can analyze and manage their abilities and features, apply them and get their benefits (see Fig. 9).

FIGURE 10. Profile screen.

FIGURE 11. Winner screen (left) and GoRace's night environment (right).

5) PROFILE SCREEN

The profile screen allows players to change their avatar and edit their account's options. Through this screen, players can change their avatar, change their password, and enable or disable the GoRace game notifications. These notifications are push notifications that GoRaceGame automatically sends to players' devices for providing real-time feedback about the relevant events that occur during the race. It is important to remark that this option only sets up the push notifications, since GoRace also provides notifications via email for maintaining, at any moment, their players informed and providing them real-time feedback about their progress.

As we can observe in Fig. 10, the profile screen also allows players to access some extra functionalities such as completing an in-game survey to assess the players experience with GoRaceGame, giving access to both the game trailer and tutorial tour, and getting extra rewards by exchanging special codes that may have been provided by their gamification masters.

In addition, to help its users, GoRaceGame includes tooltips and success/failure temporal messages for giving players information about the different elements and functionalities of the game, and the results of the in-game actions, respectively. Both kinds of messages are customized according to the narrative, being the different Olympic gods the ones who provide the information. For example, the timer displays the message "Hurry up! Time runs against you. The sun god Helios, and the goddess of the moon, Selene, will show the time remaining to finish the race." or when an error occurs when applying a relic, the message displayed is "Oops! It

seems that Hades is up to something! Please, access to the relic and try to apply again.''

GoRaceGame also includes several audiovisual effects to alert players about important events during the race. Examples of these effects are the shining and movement effect of the lightning symbol, and others to improve the narrative experience such as the play of epic music and confetti animation when a player arrives at the finishing line or the adaptation of the screens according to the time of the day the player is using GoRaceGame, showing a sunny environment during the day and a dark one during the night (see Fig. 11).

E. GORACEADMIN

Similar to GoRaceGame, GoRaceAdmin provides gamification masters with a centralized application that allows them to manage all the gamification experiences in which they are involved. Through GoRaceAdmin (see Fig. 12), gamification masters are able to manage their gamification experiences by performing the following activities:

a) Access and set up their profile.
b) Manage the participants who take part into in the GoRace experience.
c) Manage the access and connection credentials of the domain resources involved in the GoRace gamification experience.
d) Import the outcomes of non-automatic activities performed in the gamified domain.
e) Manage different gamification experiences.
f) Access relevant information of their gamification experiences such as their number of participants, their starting and end dates, the variables that measured the results of the gamified activities of their respective domains, etc. to monitor and control them.
g) Access to the documentation of GoRace such as tutorials and materials to get the maximum performance of the applications.
h) Contact GoRace team to communicate any incident that may occur during the development of the GoRace gamification experiences.

On the other hand, gamification masters make use of all the functionalities that GoRaceAdmin offers to create a unique experience for their participants that is limited only by their imagination. For that, GoRaceAdmin provides extra functionalities that allow gamification masters to:

a) Manage and send notifications to their players. As we have previously commented, GoRace automatically sends emails and push notifications to the players to maintain them informed of any event that occurred during the race. In addition, the gamification masters can manually create new notifications that can be scheduled or directly sent to the players about new events, challenges, activities, or important dates related to the gamification experiences.
b) Manage rewards for their players to change the gamification strategies in real-time. These rewards are
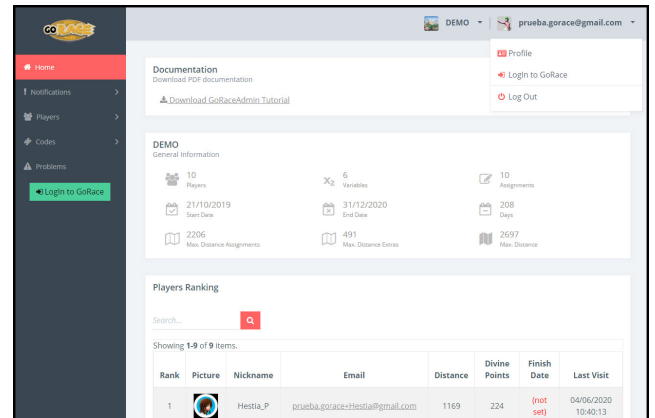

FIGURE 12. GoRaceAdmin screenshot.

materialized as alphanumeric codes that players can redeem via GoRaceGame. Through this functionality, gamification masters can create codes that influence the progress of the race by rewarding players with extra points or relics. They can be used to reward individual or collective behaviors within the domain, allowing gamification masters to expand the gamification experience.
c) Access GoRaceGame as an Olympic god that can move freely around the race and uses their powers to reward or punish players' behavior. As an Olympic god, gamification masters have specific functionalities that give them the control of all the race such as accessing to all the relics of the shop, creating their own relics for applying any negative or positive effects they want, establishing their position in the race to apply specific effects to certain players, and monitoring and analyzing all the actions that they have performed as a god by observing the race's history.

Hence, GoRaceAdmin, not only allows gamification masters to manage, analyze, monitor, and control the gamification experience but also provides them with different mechanisms to improve and add dynamism to the story, involving them in the experience and allowing them to influence of the narrative itself.

F. GORACE FLOW

During the execution of a gamification experience, the flow of interactions between gamification masters, participants, domain resources, and GoRace can be summarized into a four-step process which takes place each time a new activity is performed in the gamified domain (see Fig. 13):

1. *Real-life activities*. First, participants perform their daily activities of the gamified domain. These activities can involve the use of the domain resources, which are connected with GoRaceGame via its API, or can be done by using other resources that either are not connected to GoRaceGame or do not make the use of any technology. The outcomes of the activities performed by using the domain resources are
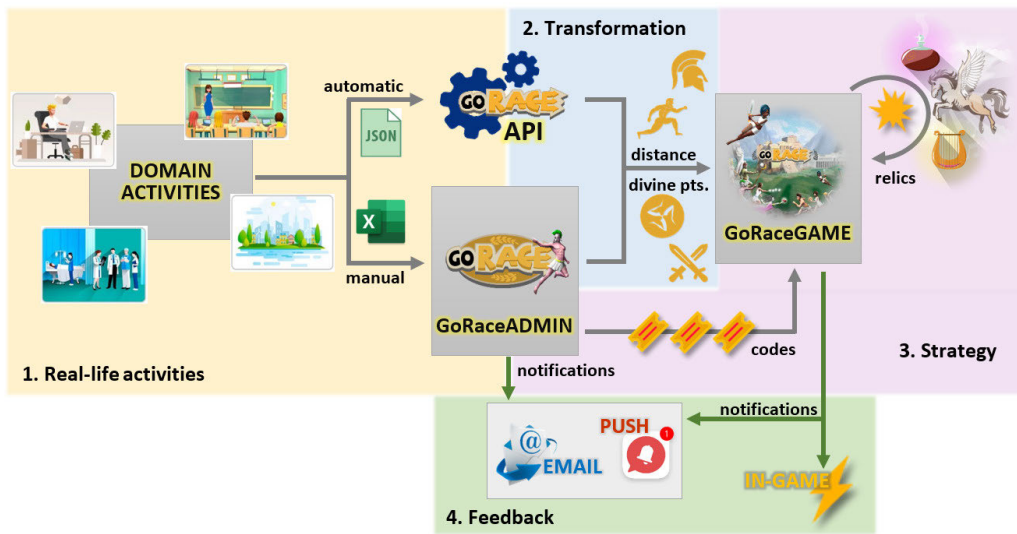
FIGURE 13. Gorace flow.

automatically sent to GoRaceGame, while the outcomes of the non-automatic activities are manually imported to GoRaceGame by the gamification masters using GoRaceAdmin.

2. *Transformation*. As soon as the outcomes of both domain resources and non-automatic activities reach GoRaceGame, the information is transformed into distance and divine points. The distance points allow participants to advance in the race, while the divine points allow them to purchase the god relics in the virtual shop and get their benefits.

3. *Strategy*. As the outcomes of the real-life activities performed by the participants influence their progress in the race, both participants and gamification masters are able to analyze such progress in order to make their own strategies within the narrative of GoRace. Participants, according to their preferences of game, will be able to interact with the functionalities of GoRaceGame to reach the finishing line in first position and with it, immortality. To do so, they will need to manage their divine points to purchase the god relics that offer the required benefits for themselves or that help support or attack other players. On the other hand, gamification masters, by using the functionalities of GoRaceAdmin, such as the possibility of creating extra rewards via codes, will influence and dynamize the progression of the race by creating new interactive experiences and challenges according to their needs and goals.

4. *Feedback*. Finally, every new event or action that influences the progress of the race is notified to participants via in-game notifications (lightning symbol), and external ones (emails and push notifications), providing real-time feedback at any time.

G. GORACE MONITORING

Monitoring a gamified domain not only implies the analysis of the progress of the gamification experience in order to

control that everything progresses successfully according to the implemented gamification strategies, but also implies a constant and detailed real-time tracking of the participants' activity. This real-time tracking is used to provide players with immediate feedback about their performance and to support gamification masters to assess, control, improve, and adapt the gamification experiences. Hence, the capability of gamification solutions to support the gamification monitoring and adaptation activity is an important factor to provide real-time analytics and immediate participants' feedback, and therefore, for assuring the success of gamification experiences.

Considering the functionalities of GoRace, we can observe how the tailored solutions provide two different ways, internal and external way, to keep participants informed of their activity at all times. In an internal way, GoRace provides real-time feedback about the progression of participants via GoRaceGame where they can explore the different screens to know the state of the race at any time, as well as, they can access to their race's history to observe the logs of their performance and track by themselves all the events occurred. Moreover, GoRaceGame provides in-game notifications by the animated lightning that allows participants to know when something has influenced their race's progression each time they access GoRaceGame, being, in that way, informed anytime. On the other hand, in an external way, GoRace provides real-time feedback about the race's progression by notifying participants via email and push notifications, so they can be informed at any time while they are not connected to GoRaceGame. These notifications come from two different sources: the automatic notifications that GoRace integrates to inform about crucial changes in the race's progression of participants such as the influence of their real-life activities or changes in their positions, and the manual notifications that are created by gamification masters through GoRaceAdmin as a mechanism to maintain participants immersing in the gamification experience (see Fig. 13).
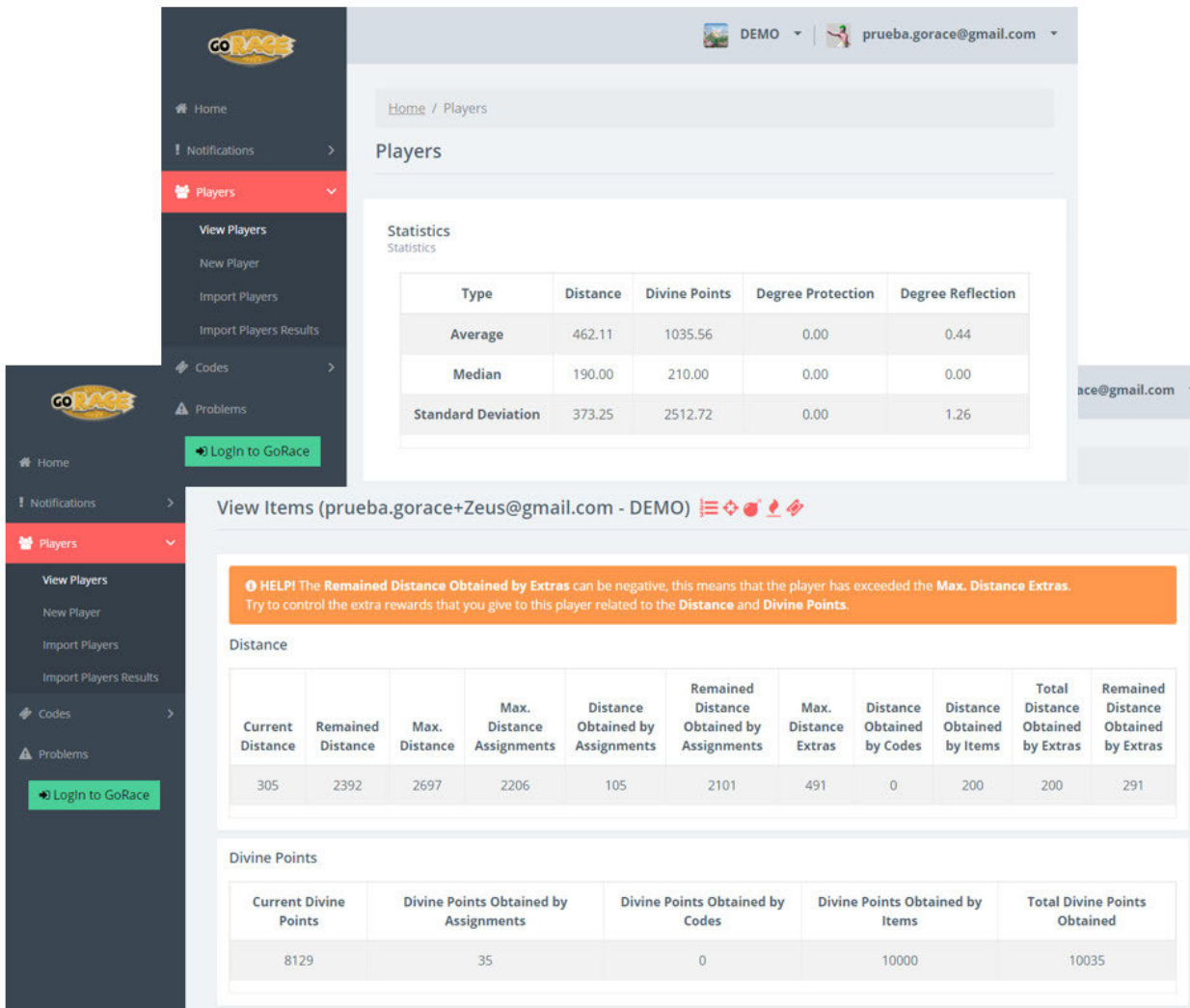
FIGURE 14. GoRace's statistics.

On the other hand, GoRace allows gamification masters to monitor and control their gamification experiences by providing several functionalities for analyzing and evaluating their participants' progression and engagement through GoRaceAdmin. For that, GoRaceAdmin provides several information screens where gamification masters can obtain general information about the gamification experiences, statistics about the progression of their gamification experiences, as well as, specific measures to analyze and evaluate the individual progression of each participant and their relation with the game elements of GoRaceGame (see Fig. 14).

Regarding the mechanisms for measuring the progression of gamification experiences, as Fig. 14 shows, GoRace provides general statistics (average, median, standard deviation) for supporting gamification masters the analysis of the general progression of participants in terms of the main points of the narrative, distance and divine points. Moreover, it individually measures the relation of each participant with all the achievable elements of the experience and categorizes them according to their source through players achieved them. Concretely, this source has two different origins: assignments and extras. Assignments include all the activities, actions, or events, manual or automatic, describe in the gamification strategy, and extras includes the influence of codes and relics that are dynamically used or created during the execution of the gamification experience as a result of the participants' strategy to progress in the narrative or gamification masters' mechanisms to dynamize the experience. The evolution of these measures will allow gamification masters to analyze the progression of each participant, as well as, to make decisions to enrich their individual and global experience, playing and designing own strategies through the functionalities offered by GoRaceAdmin. On the other hand, GoRaceAdmin also allows gamification masters to know at any time all the events and actions occurred during the race of each user such as the relics acquired or the rewards obtained by the codes, providing enough information to analyze the game's preferences of each user, and to improve the future gamification experiences.

Bearing in mind the eight requirements for gamification elements analytics provided by [18], GoRaceAdmin is able to:

a) Mostly fulfill the feedback rate requirement that is accomplished when ''a tool allows to measure the amount gamification feedback events per time in which the participants actively work with the gamified system, and offers descriptive statistics and annotations to measure the feedback rate'' [18]. GoRace allows gamification masters to inspect the gamification feedback events per time that participants have completed within the gamified domain, and also allows them to obtain indirectly statistics about the amount of gamification events in which participants have been involved, but does not offer direct metrics for analyzing the feedback rate.

b) Fulfill the points distributions requirement that is accomplished when ''a tool provides insight into the distribution of points over users'' [18]. Gamification masters are able to observe and analyze the distribution of the different kinds of points of GoRace over participants.

c) Fulfill the achievable game elements statistical overview requirement that is accomplished when ''a tool provides insight into the overall statistics of badges, levels, missions, and other achievable game elements'' [18]. GoRace not only provides gamification masters insight into the distribution of the different points but also provides insight into the overall statistics of all the achievable game elements of the experience such as the different relics.

d) Fulfill the user distribution on game elements state requirement that is accomplished when ''a tool provides a detail view on the state and progress of participants with regards to a particular game element'' [18]. GoRace is able to provide a detailed view on the state and progress of users with regards to a particular game element such as the different relics, the codes, or the points.

e) Fulfill the temporal statistics requirement that is accomplished when ''a tool provides temporal statistics on the progression of participants with regards to a particular game element'' [18]. GoRace provides general temporal statistics of the progression of participants regarding the particular game elements of the gamification experience.

f) Partially fulfill the user characteristics requirement that is accomplished when ''a tool allows an exploration of the correlation between participants' properties and participants game state'' [18]. GoRace does not collect any information about the participants' features. Nevertheless, regarding the progression and race's history of participants, gamification masters are able to infer user properties by analyzing their game state.

g) Partially fulfill the alerting requirement that is accomplished when ''a tool provides mechanisms to define goal values and goal ranges for game element metrics'' [18]. GoRace provides mechanisms to indicate gamification masters when game element boundaries exceed, but does not allow them to define their own goal values or ranges.

h) Fulfill the user interaction tracking that is accomplished when ''a tool allows experts to track and investigate how much attention users draw to particular game elements and how this influences their behavior with regards to application KPIs'' [18]. GoRace allows gamification masters to track and investigate all the interactions among participants and game elements, as well as, how the particular game elements influence the participants' behavior.

As a conclusion, the functionalities and information that GoRaceAdmin provides to gamification masters for analyzing, monitoring, and making decisions to control, change and adapt the gamification strategies in real-time, allow GoRace to fulfill, at least partially, the eight gamification elements analytics requirements defined for assessing the quality of gamification monitoring support tools. We have compared this result with the gamification software tools that provide features for supporting the gamification monitoring activity identified in Table 1. The evaluation of the ability of these tools for gamification analytics was evaluated under the same requirements by [8] and [13], whose studies also compared these tools with other tools for game analytics. In Table 3,

TABLE 3. Summary of the requirements covered by GoRace.

Game Element Analytics Requirements	GORACE	MEdit4CEP-Gam	BUNCHBALL	GIGYA	DELTADNA*	GAMEANALYTICS*	GAMEHUD*	HONEYTRACKS*	UPSIGHT*
Feedback Rate	↗	↗	↓	↓	↗	↘	↘	↘	↘
Point Distributions	↑	↗	↑	↓	↑	↓	↓	↓	↓
Achievable Game Elements Statistical Overview	↑	↗	↓	↘	↗	↘	↘	↘	↘
User Distribution on Game Element State	↑	↗	↓	↓	↓	↓	↓	↓	↓
Temporal Statistics	↑	↗	↓	↓	↓	↓	↓	↓	↓
User Characteristics	↘	↓	↓	↓	↓	↓	↓	↓	↓
User Interaction Tracking	↑	↓	↓	↓	↓	↓	↓	↓	↓
Alerting	↘	↗	↓	↓	↓	↓	↓	↓	↓
Number of Supported Requirement	**8**	**6**	**1**	**1**	**3**	**2**	**2**	**2**	**2**

↓ **Not fulfilled,** ↘ **Partially fulfilled,** ↗ **Mostly fulfilled,** ↑ **Fulfilled**

*Tools for game analytics retrieved from [12].

we provide their results with the results of the evaluation of our tool, concluding that our tool reaches the highest coverage of the gamification elements analytics category.

H. MULTI-CONTEXT AND NARRATIVE-BASED GAMIFICATION SUITE

As we have observed along this section, GoRace implements a wide variety of game elements. The review of Peixoto and Silva [21] provided a catalog of game elements in which they identified 229 elements divided into three levels. The first level classified the game elements according the categories proposed by [1]: dynamics, mechanics and components. The second level presents the game elements itself. And, the third level categorizes the game elements according to the personality types of Bartle's types of players [53]: achievers (A), socializers (S), killers (K) and explorers (E). Taking into account this catalog, we have used it to provide an overview of the variety of game elements implemented in GoRace. Table 4 shows all the game elements identified in the Peixoto and Silva catalog, being the GoRace's game elements those cells highlighted in grey shadow.

All the game elements implemented have been carefully developed around the main element of the narrative, allowing, as we can observe in Table 4, the existence of multiple scenarios according to the different types of players of the participants involved. This not only allows participants to build their own experience in the GoRace narrative, but also allows gamification masters to get involved as game masters enriching the GoRace narrative with the only limitation of their imagination. In addition, the wide variety of game elements of GoRace also allows to avoid "pointsification" such as we have commented along this section, the gamification experience required more than collect points or badges. Hence, GoRace goes beyond the classic game elements to immerse participants in a fun, engagement, and challenging narrative-based gamification experience.

On the other hand, the capability of GoRace to create solutions for deploying particular gamification strategies and their portability, interoperability, system-independence and centralized features provide it with high adaptability and reusability. GoRace is able to be applied in any domain by the adaptation of its applications and game elements according to the designed gamification strategy. These features turn GoRace into a multi-context powerful gamification suite that is not limited by a specific domain or a particular tool, system, or site of the domain, but that it can be applied to gamify different domain resources and even resources from different domains.

Hence, we can take advantages of GoRace's features to apply it in any domain that needs to achieve a goal such as for instance:

a) In a business domain, where GoRace can be connected with its applications to motivate employees, attract and retain customers by providing a unique a different experience, and help to make decisions within the personnel selection processes.

b) In a society domain, where GoRace can be applied to transform social innovation processes into a fun, social and interactive experience for promoting the participation of citizens in the development of public solutions or encouraging their commitment to energy saving and reduction of pollution measures.

c) In a health domain, where GoRace can be incorporated into the daily patients' activities to stimulate their recovery process, promote healthy habits, and dynamize disease prevention campaigns through a fun experience in which interaction with other people is possible.

d) In the tourism domain, where GoRace can be used to offer a unique, interactive, social, and fun experience suitable for all audiences through which tourists can explore a locality, its history, and traditions.

e) In education, where GoRace can be integrated within the educational activities for gamifying the learning process, at the same time that helps to motivate students, encourage their participation in and out the classroom, and increase their interest and performance.

As a specific example, GoRace can be applied to gamify an educational course that uses a Learning Management System (LMS), for example, based on Moodle, as the main domain resource. We can connect, via GoRaceAPI, the results of the different activities that students perform on the LMS (quizzes, tasks, viewed resources, etc.) in order to automatically influence the GoRace narrative, or we can use other features of GoRace as the codes or the God mode, to gamify non-LMS activities such as the attendance to the lessons, the active participation during the learning process, or activities to put into practice several cross-curricular competencies that give gamification masters more freedom to address the gamification experience.

GoRace can also be applied to gamify the daily physical activity of people, for instance in an illness recovery or a weight-loss process, by integrating within the gamification strategy activities whose results can be reflected on the narrative, in a manual way, by the gamification masters (instructors, nutritionists, nurse, etc.) or automatically through the connection, via GoRaceAPI, of specific apps that send real-time daily data about the steps, distance, calories, . . .

Another example can be the use of GoRace for cultural immersion within a tourism or educational domain. We can combine GoRace features with other technologies such as QR scan, social networks, or photo-based tasks in an LMS or other kinds of platforms to design a gamification strategy that involves the visit of specific monuments, the experience of local activities, and the learning of traditions, among other. Or, we can mix all these examples by taking advantage of GoRace architecture to design a gamification strategy that involves learning, cultural immersion, and daily physical activity to promote specific behaviors or social awareness in, for instance, a society domain, where we can connect, via GoRaceAPI, several apps, and platforms that provide data

TABLE 4. Overview of GoRace's game elements.

Dynamics

Sense of Competence (A)	Recognition (A)	Reputation (A)	Relationships (S/A)
Success (A)	Satisfaction (A/S/E/K)	Mastery (A/E)	Commitment (E/S)
Responsibility (E)	Curiosity (E)	Relevance (E)	Joy (E/A)
Feeling Valuable (A)	Context (E/A)	Progress (A/E/K)	Interaction (S/A/E/K)
Rule (E)	Conscience (E/K/A/S)	Fixed Structures (E)	Integration (S)
Respect (S)	Social Rank (A/S/E)	Gaining Visibility (A)	Prestige (A/S)
Charity (S)	Community (S)	Common good (S)	Conflict (K)
Connection (S/E)	Frustration (E)	Sympathy (S)	Love (E/S)
Pride (A/S/E/K)	Solidarity (S)	Altruism (S)	Step By Step (A/E)
Captivating (S/K)	Pleasure (A/S/E/K)	Zeal (E/A)	Loyalty (A)
Faithfulness (E/A)	Companionship (S)	Social Environment (S)	Camaraderie (S)
Optimism (E/A)	Stress (E/A)	Sensation (E/A)	Loss Aversion (A)
Imagination (E)	Fascination (E)	Conviction (A/E)	Excitation (E)
Emotion (E/S)	Confidence (A/E)	Narrative (E/S)	Plot (E/S)
Story (E/S)	Novelty (E)	Fantasy (E)	Influence (S/K)
Metaphor (E/K/A/S)	Concentration (E/K/A/S)	Abstraction (E/K/A/S)	Socialization (E/K/A/S)
Rivalry (K/A)	Expression (E/K/A/S)	Predictable Consequences (A/E)	Linearity (A)
Anxiety (E/A)	Pretense (K/E)	Envy (K)	Aggression (K)
Distress (E)	Subversion (K/E)	Flirting (K)	

Mechanics

Challenges (E/K)	Discovery (E/A)	Meaning (E)	Autonomy (E/K/A)
Objectives (A)	Achievements (A)	Control (A/K)	Fun (E/K/A/S)
Different Experimentations (E/A)	Experience (E)	Adaptation (E)	Effort (A)
Overcoming (A/E)	Self-efficacy (A)	Preference (E/K/A/S)	Participation (S)
Feedback System (A/K/E)	Rewards System (A/E)	Prize (A)	Routes (E/A)
Strategies (E/K/A)	Increasing Difficulty (A/E)	Low Risk (A)	Tournament (S/K/A)
Complexity (E)	Power (A/E/K)	Rivalry (K/A)	Creativity (E/A)
Attention (E/K/A/S)	Praise (E/A/S)	Beauty (E)	Serendipity (E)
Realization (A)	Ability (E)	Immersion (E/K/A/S)	Opportunity (A/E)
Obstacle (A/E)	Acceptable Failure (E)	Precision (A)	Productivity (A)
Assistance (S)	Stimulus (E)	Creation (E)	Triumph (A)
Encourage (E/K/A/S)	Independence (E/A)	Surprise (E)	Persistence (A)

TABLE 4. *(Continued.)* Overview of GoRace's game elements.

Transparency (A/E)	Competition (K/A)	Contest (K/A)	Cooperation (S/K/A)
Collaboration (S)	Sharing (S)	Failure (E/A)	Missions (E)
Transition System (A)	New Features (E/A)	Freedom (E)	Logical Conclusion (A) ++
Behavior (A)	Time Counting (E)	Paths (E)	Periodic Verification (A)
Differentiated Solution (A/E)	Compensating (A)	Correcting Misconceptions (E)	Simulation (E)
Incentive (S)	Action (E/K/A/S)	Betting (K/A)	Exchanges (S/A)
Comedy (E/S)	Focus (E/A)	Scenarios (E)	Danger (E)
Judgment (A)			

Components

Results (A)	Performance (A)	Evolution (A/E)	Free Lunch (A/E)
Investment (A)	Attempt (A/E)	Tasks (E)	Cycles (E)
Social Group (S)	Reinforcement (E/A)	Tips (E)	Classification (A)
Trigger Event (E/S/A)	Communications (S)	Trophies (A)	Points (A/K)
Medals (A/K/E)	Leaderboards (A/K/E)	Virtual Identity (S/E)	Avatar (S)
Profile (S/A)	Character (S/K)	Energy Pills (A)	Stamps (A)
Symbol (A)	Levels (A)	Score (A/E)	Star (A)
Users Table (A/S)	Virtual Goods (A)	Certification (A)	Rounds (E)
Episodes (E)	Assignments (E)	Volunteering (S)	Error (A/E)
States (E)	Phase (E)	Tutorial (E)	Rankings (A)
Unlockable Content (A/E)	Notification (A)	Comparison (K/A)	Ghosts Images (E)
Bonus (A)	Time Pressure (E)	Flow (E)	Lives (A/E)
Activity (E/K/A/S)	Specialization (E/K/A/S)	Populational Graphic (A/E)	Consulting Statistics (A/E)
Record (A)	Evaluation (A)	Comments (S)	Views (A/E)
New Roles (E)	Tracking (A/E)	Report (A/S)	Category (A/E)
Return (A/E)	Repetition (A/E)	Global Knowledge Map (A)	Customization (S/E)
Troubleshooting (A/E)	Exploration (E/K/A/S)	Collectible Cards (A)	Marathon (K)
Penalty (E)	Money (A)	Gifts (A)	Badge (A)
Label (S)	Nickname (S)	News (E/S)	Combos (A/K)
Interest Curve (A/E)			

from different activities whose results will allow participants to advance within the GoRace narrative (see Fig. 15).

V. EXPERIENCE WITH GORACE

In order to validate the features of GoRace and its effectiveness, since 2018 we have conducted a total of eight gamification experiences. The majority of these gamification experiences have been carried out in an educational domain to improve participants' engagement, motivation, and learning outcomes, which the exception of two of them where GoRace was applied to gamify a session in an international conference for improving participants' engagement and within a Spanish course to foster not only engagement and motivation in Spanish learning but also cultural immersion. Table 5 summaries the general information of these gamification experiences.

TABLE 5. Current gamification experiences conducted with GoRace.

Experience	Domain	Course	Institution	Year	Length	Population
E1	Education	Computer Fundamentals	University of Cádiz	2018-2019	1.5 months	48 students
E2	Education	Computer Fundamentals	University of Cádiz	2018-2019	1.5 months	50 students
E3	Education	Software Engineering	University of Cádiz	2019	2 months	111 students
E4	Education	Information and Communication Technology	Secondary School "Liceo Sagrado Corazón"	2019	1.5 months	69 students
E5	Research	-	EuroSPI Conference	2019	1.5 hours	15 professionals / researchers
E6	Education	Spanish Language Training	EduEurope Language Center	2019	2 months	12 students
E7	Education	Information and Communication Technology	Secondary School "Liceo Sagrado Corazón"	2019-2020	8 months	60 students
E8	Education	Software Quality, Validation and Verification	University of Oviedo	2020	3 months	150 students

FIGURE 15. Example of the architecture of a multi-context gamification experience with GoRace.

TABLE 6. In-game questionnaire.

Quality factor: User experience		
Dimension	**Sub-dimension**	**Items**
Usability	**Aesthetics**	GoRace design is attractive (interface, graphics, etc.)
	Learnability	Learning to use GoRace was easy for me.
	Operability	I think that GoRace is easy to use.
Social Interaction		GoRace promotes cooperation and/or competition among the players.
Fun		I consider that GoRace allows me to carry out my activities in a funnier way.

TABLE 7. Categorization of comments about GoRace's strengths.

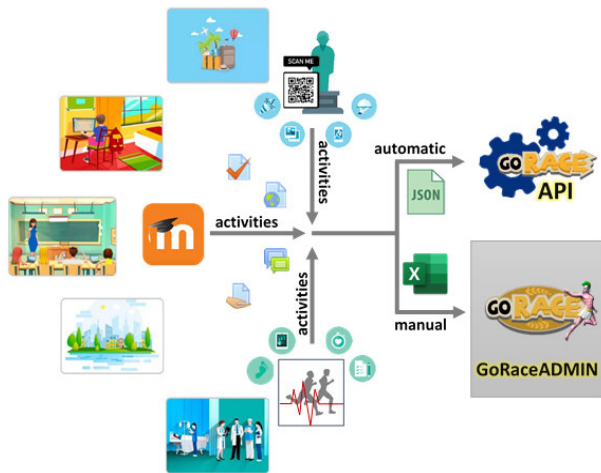| Strengths	Frequency
Usability (easy to use, learnability, operability,…)	14
Fun	12
Technical quality (performance, servers, speed,…)	3
Social interaction (Collaboration, competition,…)	13
GoRace's design	12
Help, support or increase learning	8
Game elements (shop, relics, points,…)	12
Increase engagement, interest or motivation in the course	9
Focused attention (effort, dedication, continuous work,…)	3

As Table 5 shows, a total of 515 participants have been immersed in the gamification experiences. To collect preliminary feedback on the participants' experience during the use of GoRace, they were asked to answer an in-game questionnaire. This questionnaire aimed at evaluating the user experience with GoRace and it was designed following the Technology Acceptance Model (TAM) that determines the user acceptance of any technology perceived usefulness and perceived ease of use factors [54], and the MEEGA+ evaluation model designed for assessing the user experience and the perceived learning factors of educational games [55].

The questionnaire is included within GoRaceGame app and participants can access to complete it at any time during the gamification experience. In addition, the app displays it when a participant has reached the 50% of the race. This questionnaire is voluntary and consists of 5 items designed to evaluate the user experience with GoRace. This questionnaire is based on 5-point Likert scale implemented in GoRace as a 5-stars scale, where 5-stars means strong agreement, 4-stars means agreement, 3-stars means indifferent, 2-stars means disagreement, and 1-star strong disagreement. Table 6 shows the 5 items defined to assess the user experience quality factor by three dimensions.

149 participants completed the in-game questionnaire during the gamification experiences. As Fig. 16 shows, more than 85% of the participants rated the five items with the highest value of 5 stars providing their strong agreement with the player experience of GoRace in terms of usability, social interaction, and fun. These results indicate that the users' attitude during the gamification experiences was positive, and give us a high positive preliminary evidence about the acceptance of GoRace as a user-friendly and fun tool that promotes social interactions among the participants.

Moreover, through the in-game questionnaire, participants were able to provide additional feedback about their perceptions and attitude towards their experience with GoRace. For that, we defined three open questions in which participants were asked to provide three strengths, three improvement suggestions, and any other comment they would like to transmit us about GoRace and their experience. A total of 42 answers about the strengths, 38 answer related to the improvement suggestions, and 14 general comments were obtained from the gamification experiences.

User Experience (In-game Evaluation)

	I consider that GoRace allows me to carry out my activities in a funnier way.	GoRace promotes cooperation and/or competition among the players.	I think that GoRace is easy to use.	Learning to use GoRace was easy for me.	GoRace design is attractive (interface, graphics, etc.)
■ Strongly Disagree	3%	3%	2%	1%	2%
■ Disagree	3%	2%	1%	0%	1%
■ Indifferent	2%	1%	1%	3%	4%
■ Agree	3%	3%	3%	3%	7%
■ Strongly Agree	89%	91%	93%	93%	86%

■ Strongly Disagree ■ Disagree ■ Indifferent ■ Agree ■ Strongly Agree
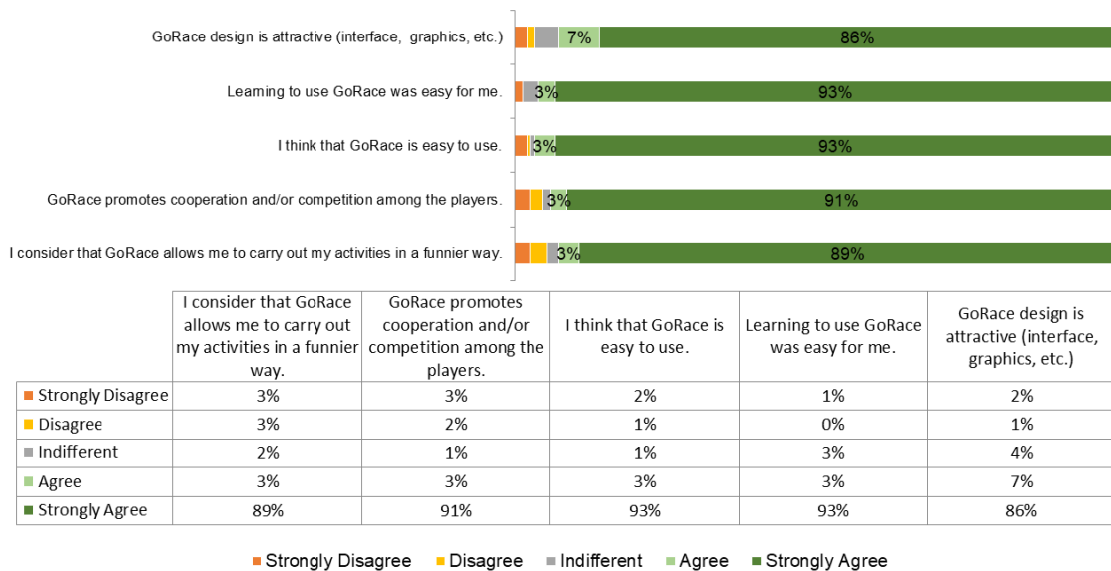
FIGURE 16. Outcomes of the user experience evaluation.

Participants' comments about the strengths were oriented to highlight some features of GoRace and their experience with it which can be categorized in nine issues, as Table 7. The majority of the comments highlighted the usability, fun and social interaction that GoRace provided to the domain, as well as, the GoRace's design and its game elements. Some examples of these comments are: *"Its' funny, it motivates me more to make an effort, and I think it has good aesthetics"*, *"I like that we can see our progress, I like that there is a ranking and I like that we are rewarded in the game for our activities in class, as it motivates us to improve"*, *"Very interesting game! It is easy to use. It increases the level of attention in class"*, or *"It is fun, it rewards our real-life activities, and it makes participation enjoyable"*.

On the opposite, regarding the improvement suggestions, we identified two main groups: suggestions related to GoRace and suggestions related to the gamification experience. About GoRace, the majority of the suggestions were focused on providing ideas for new functionalities such as the possibility to fight against players as a way to achieve more benefits, adding more features for customizing their avatars, or integrating a chat. Focusing on the gamification experience, the suggestions emphasized the possibility to acquire more rewards (codes, divine points, relics, etc.) and to obtain the relics of the shop with less effort. Finally, regarding the question about something else to add, the few collected comments reinforced the satisfaction of the participants with GoRace, obtaining comments such as: *"I have not got any suggestions to improve the game, because it is simply perfect"*, *"The game is very cool, has good graphics and helps to improve student performance"*, *"I recommend it"*, or *"Wonderful, inspiring and fabulous"*.

These comments support the positive results obtained about the user experience, and also provide preliminary posi-

tive evidence of the satisfaction, immersion, engagement, and motivation that the use of GoRace produces.

VI. LIMITATIONS AND THREATS TO VALIDITY

In this work, we have introduced and analyzed GoRace a multi-context and narrative-based gamification suite which features allow to support all the gamification process from the design of the gamification strategy to its implementation and monitoring, providing high flexible tailored gamification solutions that goes beyond the classic game elements. Nevertheless, the present work has some limitations and we recognize that there are specific issues that can threat the validity of our empirical evaluation.

First, one of the main features of our proposal is its flexibility for generating tailored solutions to gamify any desired domain, as well as, for integrating the activities of any domain resource within the gamification strategy. In that sense, we have introduced how GoRace has the ability to gamify different domains, we have described some examples to apply it, and we have briefly introduced the gamification experiences carried out with Gorace, but the current experiences conducted only have involved a single domain. Hence, we have not presented any data about a multi-context gamification experience which is an important issue in which we still working with the goal to validate this functionality. Nevertheless, this validation can be assumed by the definition of the GoRace architecture, which provides a clear image of how GoRace is connected with the domain resources, just using GoRaceAPI, allowing the integration of any desired resource of any domain to be part of GoRace's gamification experiences. Moreover, this type of architecture is supported by other authors such as [56] whose work proposed a valuable gamification architecture based on an API for integrating many tools that support

different domains. So, we can conclude that this type of architectures provides gamification tools with the required flexibility and system-independence that the gamification scope needs [6], [8], [9].

Second, GoRace has not had any commercial nature up to now so it has been only used with a research-based interest without a profit-making purpose. For that reason, GoRace makes use of the free services of the Google Maps API to obtain and provide information about the maps, routes, and places. Google offers $200 monthly credit in free usage of its service allowing around 200.000 requests/month. Although, for conducting our research we did not have any problem with this service, to conduct gamification experiences that involve a high amount of participants and require continuous access to GoRace, or multiple gamification experiences at the same time, using this service is a limitation. To overcome this limitation, we have decided to explore the open-solution provided by OpenStreetMap and implement the Maps service in our own servers, avoiding in that way, the possible limitation that the use of Google Maps service can suppose to the scalability of GoRace suite.

Third, regarding the evaluation of the GoRace against the requirement for gamification element analytics proposed by [18], we can observe how some improvements can be made. Although the results of the evaluation indicated that GoRace satisfies all the requirements for gamification element analytics, this evaluation allowed us to identify the requirements that GoRace partially fulfills which are the User Characteristics and the Alerting requirement. These requirements are not entire fulfilled because GoRace does not collect any information about the participants' features and does not allow gamification masters to create their own alerts to be informed about the progression and interaction of participants with the game elements. These limitations do not affect the outcomes of this work but limit the type of analytics that GoRace provides to gamification masters for controlling and monitoring the gamification experiences. The integration of the Bartle's Test in the process to access GoRace or the creation of adapted alerts by gamification masters according to the measures of the game elements could be options that may help to cover these limitations and that we will take into account for the future version of GoRace.

Fourth, the use of the catalog of game elements defined by [21] can be a limitation for the evaluation of the game elements implemented in GoRace since the catalog provides gamification requirements to standardize specific requirements for gamified educational software. GoRace is a software that can be used in any domain, not only within the educational domain, therefore, the use of this catalog can be an object of discussion. Our decision of using this catalog was based on the extensive, completed, and clear categorization of the game elements that it provides, as well as, on the support of other studies and authors that concluded that bearing in mind the extensive number of research and empirical studies related to gamification on education, the educational domain

can be used to give an overview of the entire gamification scope [3], [57].

Finally, regarding the preliminary evaluation of the user experience with GoRace, the validity of the results may be influenced by the measures and instruments used to obtain the data, and the specific gamification experience in which participants were involved. The measures and instruments used to obtain the data were based on well-known models such as the technology acceptance model [54], and the model for the evaluation of educational games [55] that have been designed based on standard questionnaires and scales. On the other hand, although we have analyzed the results obtained in the eight different gamification experiences conducted together, in the majority of the experiences, GoRace has been applied to gamify an educational domain with similar goals, and the in-game questionnaire focuses on obtaining general feedback about the use of GoRace regardless of the gamification experience where it is used.

VII. CONCLUSION AND FUTURE WORKS

Gamification is a potential approach to foster motivation, engagement, behavioral changes, friendly competition and collaboration in different contexts such as employee performance, social loyalty, customer engagement or students learning achievement, which popularity in the recent years has encouraged its application in a diversity of domains, including health, education, business, society or tourism. However, although all their promising benefits and rapidly developing, gamification community should face a variety of theoretical, empirical, and technological challenges [6], [8], [9]. This work focuses on the technological challenges existing in the gamification scope to introduce a gamification software proposal for designing, implementing, executing, controlling, and monitoring gamification strategies. Our proposal, called GoRace, is a multi-context and narrative-based gamification suite that makes use of the latest technologies and advances on gamification domain to provide a user-friendly environment that allows the creation of tailored flexible system-independent gamification solutions and their deployment for immersing participants in a fantasy virtual world where they will participate in a legendary Olympic race to achieve immortality.

Concretely, GoRace suite provides the following contributions to the gamification domain: (a) it provides gamification designers with a user-friendly environment to support the design and automate the implementation and deployment of non-intrusive adapted gamification solutions, (b) it offers system-independence and a high flexibility regarding the scalability of resources and domains that can be involved in a gamification experience, thanks to their architecture based on a REST API that deals with the external connections and integration of any domain resources, (c) it provides gamification masters with an easy to use and centralized application, GoRaceAdmin, to manage all the gamification experiences in which they are involved, providing a variety of functionalities and mechanisms to control and monitor them,

as well as, to improve and add dynamism to the story in real-time, involving them in the narrative of the experience and allowing their imagination to create a unique experience for their participants, and (d) it provides participants with a centralized application, GoRaceGame, that goes beyond the implementation of the classic game elements and immerses participants in a legendary Olympic race in which their progression is determined by their performance in the domain's real-life activities, being the narrative the main game element of the gamification experiences.

The above-mentioned contributions have been reached by undertaking the following research activities:

1) We have conducted an analysis of the advances in gamification domain to collect the main technological challenges identified by the latest studies and systematic literature reviews in order to get an overview of the gamification domain and provide a proposal that helps to overcome the identified challenges and support their maturity process.

2) We have identified the most popular gamification software tools for analyzing their strengths and weaknesses in order to provide our proposal with enough background and functionalities for avoiding the main lacks found in the rest of tools such as the poor flexibility, the non-independence with the system that they gamify or the implementation of the classic game elements.

3) Bearing in mind the main lacks of the gamification software tools, we have created GoRace, a multi-context and narrative-based gamification suite that support the entire gamification process providing gamification designers and gamification masters with the necessary mechanisms to design, implement, execute, control, and monitor tailored system-independent gamification solutions and immerse both gamification masters and participants in a narrative-based gamification experience.

4) We have analyzed the ability of GoRace to support gamification masters in monitoring gamification experiences by evaluating the coverage of the requirements for gamification elements analytics provided by [18]. As a result, GoRace satisfies, at least partially, all the requirements, which ranks it over the tools analyzed in [8].

5) We have analyzed the ability of GoRace to cover the catalog of 229 game elements provided by [21] as a way to get evidence of the GoRace's disruption with the traditional use of the classic game elements that tend to the pointsification of the gamification experience. As a result, GoRace is able to cover in a rough way a total of 131 game elements of the catalog being divided into 38 game dynamics, 45 game mechanics, and 48 game components.

6) We have conducted eight different gamification experiences to validate the features of GoRace. From these gamification experiences, 149 participants provided feedback about their user experience. As a result,

we obtained high positive preliminary evidence about the acceptance of GoRace as a user-friendly and fun tool that promotes social interactions and generates satisfaction, immersion, engagement, and motivation among their participants.

On the other hand, this work provides a detailed description of the implementation process of gamification by using GoRace, as well as, its features and architecture, in order to clarify how gamification is implemented and provide an idea about its complexity and costs. This is an issue that has not been sufficiently explored and can help organizations to make a better informed decision-making towards its potential adoption [10].

Focusing on our next research steps, since 2018, we have conducted eight different gamification experiences whose preliminary users experience evaluations through an in-game questionnaire have been shown in this work. Nevertheless, we are analyzing each of them within their specific domain to obtain empirical results that allow us not only to assess the acceptance of GoRace, but also its effectiveness to provide gamification experiences that reach the business goals of the gamified domain. For that, these gamification experiences have been conducted under empirical evaluations through experiments based on study cases and control and experimental groups. The analysis of these results will give us more information for providing insight, not only about the strengths and weaknesses of GoRace, but also about the implications of using gamification to foster different goals such as engagement, motivation, or improvement of the cognitive achievement. Hence, GoRace offers the flexibility to put into practice and test gamification benefits in different domains, being a potential gamification suite to support gamification scope in order to contribute to reducing the disconnection between the theoretical and applied gamification [58], and support the development, test, and empirical validation of current and new theories for the consolidation and evolution of the discipline.

Moreover, we are also working on providing solutions to overcome the limitations identified in this work. In that sense, we are working in the design of multi-context gamification experiences that integrate educational and social awareness contexts, among others, in the same gamification experience. The execution of these gamification experiences will allow us to conduct empirical evaluations that will support the validation of the multi-context and flexibility features of GoRace. In addition, these gamification experiences will involve participants into a multi-context experience giving gamification masters and designers more options to create multi-disciplinary gamification strategies that explore the behaviors of participants in different scenarios for reaching more-complex business goals. For instance, we can explore and mix activities related to energy and water consumption, physical activity, and school performance to guide healthy behaviors and raise awareness about specific society challenges in children or teenagers.

Finally, we have previously commented that gamification needs to deal with a set of theoretical, empirical, and technological challenges to achieve their maturity and be exploit at their full potential. We believe that using in a proper way and supporting by adequately software tools, gamification can provide wonderful benefits within a diversity of domains. In this work, we have introduced a gamification suite, that far to be perfect, integrates novel functionalities and mechanisms to overcome some of the main problems of the existing gamification software tools. We consider that GoRace is a starting point in our research path to contribute to the gamification scope for helping to overcome its main challenges. For that reason, we will continue experimenting with GoRace, as well as, getting feedback on their evaluations to improve the suite and the gamification experiences that it offers.

REFERENCES

[1] K. Werbach and D. Hunter, *For the Win: How Game Thinking Can Revolutionize Your Business*. Philadelphia, PA, USA: Wharton Digital Press, University of Pennsylvania, 2012.

[2] L. Sardi, A. Idri, and J. L. Fernández-Alemán, "A systematic review of gamification in E-health," *J. Biomed. Informat.*, vol. 71, pp. 31–48, Jul. 2017.

[3] C. Dichev and D. Dicheva, "Gamifying education: What is known, what is believed and what remains uncertain: A critical review," *Int. J. Educ. Technol. Higher Educ.*, vol. 14, no. 1, pp. 1–36, Dec. 2017.

[4] *Gamification Market by Component (Solution and Services), Deployment (Cloud and On-Premises), Organization Size (SMEs and Large Enterprises), Application, End-User (Enterprise-Driven and Consumer-Driven), Vertical, and Region—Global Forecast to 2025*, MarketsAndMarkets, Pune, Italy, 2020.

[5] *Gamification Market—Growth, Trends, and Forecast (2020-2025)*, Mordor Intelligence, Hyderabad, Telangana, 2020.

[6] J. Koivisto and J. Hamari, "The rise of motivational information systems: A review of gamification research," *Int. J. Inf. Manage.*, vol. 45, pp. 191–210, Apr. 2019.

[7] J. Hamari and P. Parvinen, "Introduction to gamification: Motivations, effects and analytics minitrack," in *Proc. 49th Hawaii Int. Conf. Syst. Sci. (HICSS)*, Jan. 2016, pp. 1307–1308.

[8] A. Calderón, J. Boubeta-Puig, and M. Ruiz, "MEdit4CEP-gam: A model-driven approach for user-friendly gamification design, monitoring and code generation in CEP-based systems," *Inf. Softw. Technol.*, vol. 95, pp. 238–264, Mar. 2018.

[9] A. Rapp, F. Hopfgartner, J. Hamari, C. Linehan, and F. Cena, "Strengthening gamification studies: Current trends and future opportunities of gamification research," *Int. J. Hum.-Comput. Stud.*, vol. 127, pp. 1–6, Jul. 2019.

[10] M. Trinidad, M. Ruiz, and A. Calderon, "A bibliometric analysis of gamification research," *IEEE Access*, vol. 9, pp. 46505–46544, 2021, doi: 10.1109/ACCESS.2021.3063986.

[11] D. Dicheva, C. Dichev, G. Agre, and G. Angelova, "Gamification in education: A systematic mapping study," *Educ. Technol. Soc.*, vol. 18, no. 3, pp. 75–88, Jul. 2015.

[12] A. Rapp, "A qualitative investigation of gamification: Motivational factors in online gamified services and applications," *Int. J. Technol. Human Interact.*, vol. 11, pp. 67–82, Dec. 2015.

[13] B. Heilbrunn, P. Herzig, and A. Schill, "Tools for gamification analytics: A survey," in *Proc. IEEE/ACM 7th Int. Conf. Utility Cloud Comput.*, Dec. 2014, pp. 603–608.

[14] A. Mora, D. Riera, C. Gonzalez, and J. Arnedo-Moreno, "A literature review of gamification design frameworks," in *Proc. 7th Int. Conf. Games Virtual Worlds for Serious Appl. (VS-Games)*, Sep. 2015, pp. 1–8.

[15] Y.-K. Chou. (2013). *Octalysis—The Complete Gamification Framework*. Accessed: Mar. 2021. [Online]. Available: https://yukaichou.com/gamification-examples/octalysis-complete-gamification-framework/

[16] A. Marczewski, *Gamification: A Simple Introduction*. Andrzej Marczewski, 2013.

[17] P. Herzig, "Gamification as a service: Conceptualization of a generic enterprise gamification platform," Ph.D. dissertation, Fac. Comput. Sci., Technische Univ. Dresden, Dresden, Germany, 2014.

[18] B. Heilbrunn, P. Herzig, and A. Schill, "Towards gamification analytics-requirements for monitoring and adapting gamification designs," *Informatik*, vol. 7, pp. 333–344, Dec. 2014.

[19] M. Sillaots, T. Jesmin, and A. Rinde, "Survey for mapping game elements," in *Proc. 10th Eur. Conf. Game Based Learn. (ECGBL)*, 2016, pp. 1–8.

[20] R. Hunicke, M. LeBlanc, and R. Zubek, "MDA: A formal approach to game design and game research," in *Proc. AAAI Workshop Challenges Game AI*, 2004, p. 1722.

[21] M. Peixoto and C. Silva, "A gamification requirements catalog for educational software: Results from a systematic literature review and a survey with experts," in *Proc. Symp. Appl. Comput.*, Apr. 2017, pp. 1108–1113.

[22] S. Deterding, M. Sicart, L. Nacke, K. O'Hara, and D. Dixon, "Gamification. Using game-design elements in non-gaming contexts," in *Proc. Annu. Conf. Extended Abstr. Hum. Factors Comput. Syst.*, 2011, pp. 2425–2428.

[23] G. Zichermann and C. Cunningham, *Gamification by Design: Implementing Game Mechanics in Web and Mobile Apps*. Newton, MA, USA: O'Reilly Media, 2011.

[24] G. F. Tondello, R. R. Wehbe, L. Diamond, M. Busch, A. Marczewski, and L. E. Nacke, "The gamification user types hexad scale," in *Proc. Annu. Symp. Comput.-Hum. Interact. Play*, Oct. 2016, pp. 229–243.

[25] A. Shpakova, V. Dörfler, and J. MacBryde, "The role (s) of gamification in knowledge management," in *Proc. 16th Annu. Conf. Eur. Acad. Manage.*, 2016, pp. 1–40.

[26] A. M. Toda, A. I. Cristea, W. Oliveira, A. C. Klock, P. T. Palomino, M. Pimenta, I. Gasparini, L. Shi, I. Bittencourt, and S. Isotani, "A taxonomy of game elements for gamification in educational contexts: Proposal and evaluation," in *Proc. IEEE 19th Int. Conf. Adv. Learn. Technol. (ICALT)*, Jul. 2019, pp. 84–88.

[27] S. Diefenbach and A. Mässig, "Counterproductive effects of gamification: An analysis on the example of the gamified task manager habitica," *Int. J. Hum.-Comput. Stud.*, vol. 127, pp. 190–210, Jul. 2019.

[28] M. Robertson. (2010). *Can't Play, Won't Play*. Accessed: Mar. 2021. [Online]. Available: https://kotaku.com/cant-play-wont-play-5686393.

[29] O. Pedreira, F. García, N. Brisaboa, and M. Piattini, "Gamification in software engineering—A systematic mapping," *Inf. Softw. Technol.*, vol. 57, pp. 157–168, Jan. 2015.

[30] P. Toledo Palomino, A. M. Toda, W. Oliveira, A. I. Cristea, and S. Isotani, "Narrative for gamification in education: Why should you care?" in *Proc. IEEE 19th Int. Conf. Adv. Learn. Technol. (ICALT)*, Jul. 2019, pp. 97–99.

[31] J. Grobelny, J. Smierzchalska, and K. Czapkowski, "Narrative gamification as a method of increasing sales performance: A field experimental study," *Int. J. Academic Res. Bus. Social Sci.*, vol. 8, no. 3, pp. 430–447, Apr. 2018.

[32] J. T. Pujolà and M. V. G. Argáello, "Stories or scenarios: Implementing narratives in gamified language teaching," in *Proc. 3rd Int. Symp. Gamification Games Learn.*, 2019, p. 13.

[33] F. Durin, R. Lee, A. Bade, C. K. On, and N. Hamzah, "Impact of implementing game elements in gamifying educational environment: A study," *J. Phys., Conf. Series*, vol. 1358, Nov. 2019, Art. no. 012064.

[34] N. Gilbert. (2020). *Comparison of 15 Leading Gamification Software Systems*. Accessed: Mar. 2021. [Online]. Available: https://financesonline.com/top-15-gamification-software-systems/

[35] Pat Research. (2020). *Top 25 Gamification Software*. Accessed: Mar. 2021. [Online]. Available: https://www.predictiveanalyticstoday.com/top-gamification-software

[36] TechnologyAdvice. (2020). *Gamification Software Buyer's Guide*. Accessed: Mar. 2021. [Online]. Available: https://technologyadvice.com/gamification/

[37] L. Ding, "Applying gamifications to asynchronous online discussions: A mixed methods study," *Comput. Hum. Behav.*, vol. 91, pp. 1–11, Feb. 2019.

[38] I. Bouchrika, N. Harrati, V. Wanick, and G. Wills, "Exploring the impact of gamification on student engagement and involvement with e-learning systems," *Interact. Learn. Environ.*, vol. 4, pp. 1–14, Jun. 2019.

[39] L. Toland. (2019). *Top Marketing Gamification Cases*. Accessed: Mar. 2021. [Online]. Available: http://www.enterprise-gamification.com/top-marketing-gamification-cases/

[40] Z. Zainuddin, S. K. W. Chu, M. Shujahat, and C. J. Perera, "The impact of gamification on learning and instruction: A systematic review of empirical evidence," *Educ. Res. Rev.*, vol. 30, Jun. 2020, Art. no. 100326.

[41] J. Bosboom, E. D. Demaine, A. Hesterberg, J. Lynch, and E. Waingarten, "Mario kart is hard," in *Proc. Jpn. Conf. Discrete Comput. Geometry Graph*, 2015, pp. 1–8.

[42] P. Rauch, "God of war: What is it good for?" in *Designing Games for Ethics: Models, Techniques and Frameworks*. IGI Global, 2011, pp. 98–108.

[43] A. Rapp, "From games to gamification: A classification of rewards in world of warcraft for the design of gamified systems," *Simul. Gaming*, vol. 48, no. 3, pp. 381–401, Jun. 2017.

[44] J. Goodpastor. (2019). *World of Warcraft Culture in Classic and Launch*. Accessed: Mar. 2021. [Online]. Available: https://craft.gamercraft.com/games/world-of-warcraft-culture-in-classic-and-launch/

[45] J. Park, D. Liu, M. Y. Yi, and R. Santhanam, "GAMESIT: A gamified system for information technology training," *Comput. Educ.*, vol. 142, Dec. 2019, Art. no. 103643.

[46] M. Featherstone and J. Habgood, "UniCraft: Exploring the impact of asynchronous multiplayer game elements in gamification," *Int. J. Hum.-Comput. Stud.*, vol. 127, pp. 150–168, Jul. 2019.

[47] E. Sanchez, S. Young, and C. Jouneau-Sion, "Classcraft: From gamification to ludicization of classroom management," *Educ. Inf. Technol.*, vol. 22, no. 2, pp. 497–513, Mar. 2017.

[48] S. Papadakis and M. Kalogiannakis, "Using gamification for supporting an introductory programming course. The case of classcraft in a secondary education classroom," in *Proc. Interactivity, Game Creation, Design, Learn., Innov. Int. Conf.*, 2018, pp. 1–6.

[49] F. C. Eugenio and A. J. T. Ocampo, "Assessing classcraft as an effective gamification app based on behaviorism learning theory," in *Proc. 8th Int. Conf. Softw. Comput. Appl.*, Feb. 2019, pp. 325–329.

[50] A. Russell and F. Berriman. (2015). *Progressive Web Apps: Escaping Tabs Without Losing Our Soul*. Accessed: Mar. 2021. [Online]. Available: https://infrequently.org/2015/06/progressive-apps-escaping-tabs-without-losing-our-soul/.

[51] A. Biørn-Hansen, T. A. Majchrzak, and T.-M. Grønli, "Progressive Web apps for the unified development of mobile applications," in *Proc. Int. Conf. Web Inf. Syst. Technol.*, 2017, pp. 1–8.

[52] A. Antonaci, R. Klemke, and M. Specht, "The effects of gamification in online learning environments: A systematic literature review," *Informatics*, vol. 6, no. 3, p. 32, Aug. 2019.

[53] R. Bartle, "Hearts, clubs, diamonds, spades: Players who suit MUDs," *J. MUD Res.*, vol. 1, no. 1, p. 19, 1996.

[54] A. Abu-Dalbouh, "A questionnaire approach based on the technology acceptance model for mobile tracking on patient progress applications," *J. Comput. Sci.*, vol. 9, no. 6, pp. 763–770, Jun. 2013.

[55] G. Petri, C. Gresse von Wangenheim, and A. F. Borgatto, "MEEGA+, systematic model to evaluate educational games," in *Proc. Encyclopedia Comput. Graph. Games*, 2019, pp. 1–7.

[56] O. Pedreira, F. Garcia, M. Piattini, A. Cortinas, and A. Cerdeira-Pena, "An architecture for software engineering gamification," *Tsinghua Sci. Technol.*, vol. 25, no. 6, pp. 776–797, Dec. 2020.

[57] S. Subhash and E. A. Cudney, "Gamified learning in higher education: A systematic review of the literature," *Comput. Hum. Behav.*, vol. 87, pp. 192–206, 2018.

[58] K. Seaborn and D. I. Fels, "Gamification in theory and action: A survey," *Int. J. Hum.-Comput. Stud.*, vol. 74, pp. 14–31, Feb. 2015.

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