Using Gamification as a Collaboration Motivator for Software Development Teams: A Preliminary Framework

Flávio Steffens
MunDDos - PUCRS
Porto Alegre, Brazil
flavio.steffens@acad.pucrs.br

Sabrina Marczak
MunDDos - PUCRS
Porto Alegre, Brazil
sabrina.marczak@pucrs.br

Fernando Figueira Filho
DIMAP - UFRN
Natal, Brazil
fernando@dimap.ufrn.br

Christoph Treude
DIMAP - UFRN
Natal, Brazil
ctreude@dimap.ufrn.br

Leif Singer
University of Victoria
Victoria, Canada
lsinger@uvic.ca

David Redmiles
Ban Al-Ani
University of California
Irvine, USA
{balani,redmiles}@ics.uci.edu

ABSTRACT

Gamification is the use of game elements in non-game context to engage and to motivate people to achieve goals. Its use is becoming very popular in software development organizations due to work being based upon human-centric and brain-intensive activity. This paper presents the topics of collaboration and gamification in the context of software engineering, and proposes a framework that identifies the most common collaboration issues that affect software development teams, and how to apply game elements to motivate a change on their behaviors.

Categories and Subject Descriptors

CCS [**Human Centered Computing**]: Collaborative and Social Computing; D.2.8 [**Software Engineering**]: Metrics—*complexity measures, performance measures*

General Terms

Framework, Gamification, Collaboration

Keywords

Gamification, Game Elements, Software Development, Software Engineering, Teams, Motivation, Collaboration, Issues

1. INTRODUCTION

A software development process requires creative discourse among team members to design and to implement a novel and competitive product that meets usability, performance, and functional requirements set by the customer [19]. In other words, software development demands a large amount of cognitive effort of those who are involved in it.

There is software that can be created only by one person, but in general, software development is a collaborative activity with the participation of professionals that work together to produce quality code [5]. Team members must coordinate the activities, create plans, execute tasks, and also communicate to create a software.

But since software engineering has a high dependence on human factors (e.g., communication, trust building, negotiation, etc), a large number of issues faced during software development is associated with people. Collaboration, in particular, plays an important role in determining the success of a software project [15].

Gamification is the use of game elements in non-game contexts [6], and its use became very popular in several areas but mainly in Marketing with several cases of behaviour changes and effectiveness reported over the last years [13]. Companies from many areas have started using it given its promise of helping them achieve their goals and to keep people engaged in their work [30].

Since collaboration plays an important role in software team activities and its nature of human factors can generate issues that can cause problems in the development process, it is important to find ways to foster this aspect and motivate software teams to collaborate more efficiently.

This paper proposes a framework that identifies the most common collaboration issues that affect software teams, and how to apply game elements to minimize the impact of each issue. To do so, we first identified collaboration issues in software development in light of the 3C Collaboration Model [10] and later proposed which game elements can be used as a motivator catalyst to jump start behaviours in software teams and minimize such issues. Last but not least, we conducted a preliminary evaluation of the proposed framework with experts in software development and in gamification.

The remainder of this paper is organized as follows: Section 2 describes the background on software development, collaboration and gamification, introducing the research questions. Section 3 presents the research methodology we followed in our study. Section 1 presents the preliminary version of the proposed framework defined based on literature. Section 5 describes the preliminary evaluation with experts on the topic. Section 6 concludes the paper with our final considerations and points out our next steps towards stabilizing the framework and using it in practice.

2. BACKGROUND

This section presents background information about the main topics related to this work. First, we present a background information about software development and collaboration, and later we present the topic of gamification.

2.1 Software Development and Collaboration

Having people working in software development projects as teams is one of the best ways to produce good quality products and services. Teams can be defined as collectives who exist to perform tasks, share one or more common goals, interact socially, and maintain and manage boundaries [14]. Teams are embedded in an organizational context that sets boundaries, constrains the team actions, and influences exchanges with other units in the broader entity.

But given that software development is a knowledge-based activity that requires human interaction, researchers have been studying how human factors (e.g., trust and motivation) impact the progress of software development processes.

Motivation is reported to have the single largest impact on practitioner productivity and software quality management [3], so many companies are rethinking their strategies to motivate their employees.

Intrinsic motivation - the act of doing something because it is inherently interesting or enjoyable - is being discussed in recent years as a means to engage and motivate employees. Ryan and Deci [22] explain that intrinsic motivation results in high-quality learning and creativity. Pink [21] discusses the advantages of intrinsic motivation compared to the traditional external motivation of fear, money, and rewards.

Besides motivation, another human factor that is important to achieve success in a software development process is collaboration. Most modern businesses require their workers to establish collaborative relationships to achieve organizational goals [24]. Kusumasari et al [15] explain that collaboration and coordination in a software development project play an important role in defining the success of a software project. Treude, Storey and Weber [28] stated that research on issues related to communication, collaboration and coordination has increased significantly over the last decade because both industry and academia acknowledge the importance of team work in software development.

Collaboration can be seen as the combination of communication, coordination and cooperation [10]. Communication is related to the exchange of messages and information among people; coordination is related to the management of people, their activities and resources; and cooperation is the production taking place in a shared space. All of these concepts are connected to and interrelated with awareness, that is an understanding of the activities of others, which provides a context for one's own activities [27].

A model called the '3C Collaboration Model', originally proposed by Ellis et al [8] and later extended by Fuks et al [10] (see Fig. 1), is used to organize Computer Supported Cooperative Work (CSCW) tools and components [11] [9] according to their collaboration, communication, and coordination dimensions. This model was then used by Steinmacher, Chaves and Gerosa [27] to help categorizing papers that studied awareness. After studying the topic for a while they realized that it is easier to analyze issues and problems decomposed into each of the 3C dimensions separately than altogether; thus their study.

The three dimensions used in the 3C Model were described

as ontologies to guide team collaboration by Vivacqua and Garcia [29]. These ontologies describe a set of activities of a specific domain and its concepts. Also, Vivacqua and Garcia included another important dimension to their ontologies: group formation, which is necessary to take place before collaboration can happen, to understand why and how groups and teams are formed.

Given the above, we note as motivation and collaboration are important aspects for software development teams, influencing directly the quality, productivity and success of projects. Motivation drives the real desire of team members to accomplish their tasks with quality and productivity. The 3C Collaboration Model (communication, coordination, cooperation), plus awareness and group formation, are useful dimensions to identify and to evaluate collaboration issues.

2.2 Gamification

The widely spread definition of gamification is "the use of game elements in non-gaming contexts" [6]. Aspects of play and fun may have been incorporated in non-game activities before, but gamification represents a more ordered and aware approach.

The most elementary gamification element consists of a reward mechanism that awards people in response to the accomplishment of certain activities (also known as challenges) that need to be encouraged [7]. Other elements can be more complex and lead to intrinsically motivating the practitioners: "quests" or "epic meaning", i.e, the idea of storytelling to create a purpose for the tasks [2].

Gamification is based upon the use of game elements and mechanics, but in literature there is no consolidated list or classification of these game elements. The company Badgeville [2] created a collaborative wiki in 2011 to list and describe the game elements that are most commonly used in gamification resources. The list is composed by 31 game elements, which can be found online[1]. Their description, as exemplified below, can help us to understand how to apply them.

1. **Achievements**: A virtual or physical representation of accomplishment. Badges can be earned from completing tasks/missions in gamification platforms;

2. **Levels**: A system, or "ramp", by which players are rewarded an increasing value for an accumulation of points. Leveling is one of the highest components of motivation for gamers;

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[1]BadgeVille Wiki have two resources for game elements available at http://bit.ly/BVGameMechanics and http://bit.ly/BVGameFeatures
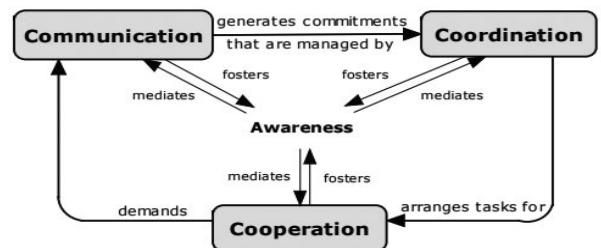

Figure 1: The 3C collaboration model [10]

Business companies are seeking gamification as a tool to motivate and engage employees in activities and tasks [1], to achieve goals [18], to change behaviors [25], and to keep people engaged in their work [30].

Researchers also found evidence for the impact of the use of gamification in software development environments. Singer and Schneider [25] proposed the gamification of a version control system, to encourage computer science students to make more frequent commits. The results of the experiment revealed good practices and pointed to improvements that may help to achieve even better results. Lotufo, Passos and Czarnecki [16] proposed a work to improve bug tracking systems using game mechanisms, to encourage teams to increase the frequency and the quality of their contributions. As a result, they concluded that by applying a reputation and reward system, the improvements are readily accessible.

Moccozet et al. [17] did not focus on software development, but their work was one of the first studies that tried to understand how gamification and collaboration could work together. They created a gamified online community for students to improve the group work among them. They described how they gamified the platform and, as a result, stated how it encouraged students to contribute and collaborate more. Snipes, Nair and Murphy-Hill [26] conducted their study based on the idea that software development practices and tools are constantly evolving. They proposed an idea by adding game-like feedback to the development environment to help improve adoption of tools and practices for code navigation. They identified that most of the developers are interested in gamification.

Game elements can be used as a motivator to consolidate practices and change behaviors of people at work. Gartner predicts that by 2016, gamification will be an essential element for marketing, user loyalty and employee engagement [4], an important evidence that this is a promising theory that can be also used in software development industry.

3. RESEARCH METHODOLOGY

Despite the fact that gamification became a trend in software development research in the last years, we do not find any study that addresses how game elements could foster collaboration in software teams. Besides the fact that software is a huge area with different activities, we can state that some collaboration issues are common for all of them. For that, it is important to understand which are the most common collaboration issues in software development and how game elements could help to minimize these issues. So, our research can be characterized as an *exploratory study*.

Our research design is based on four main phases as follows: literature review, exploratory, framework development and framework evaluation, as shown in Figure 2. The phases and their main activities are described next.

3.1 Phase 1: Literature Review

We first conducted an informal literature review on the topic of gamification, aiming to identify how mature the subject is, which papers, authors and keywords are relevant and also which areas are researching the subject the most.

Based upon the results, we planned and conducted a literature review to investigate and to understand how gamification is applied in work and in software environments, and which are the game elements used in both scenarios. Gamification had already two systematic literature reviews

[12] [20] which help us to understand the topic. Most of our findings are mentioned on these works. Next, we made a literature review in collaboration to identify the common issues that impacts collaboration in software teams. Finally, we studied the topic of motivation in software engineering to understand what drives people to accomplish their work.

As a result of this phase, in collaboration, we were able to generate an initial list of 343 issues collected in literature that could be considered as our raw data. These issues were then analyzed, classified using the 3C Collaboration Model [10][27], and grouped by the first author avoiding duplicates and merging similarities. This processed resulted in a list with 34 most common collaboration issues. This consolidated list was then reviewed and discussed with the second author, a senior researcher, and later validated with experts as presented next.

For gamification, we found that authors like Zichermann [31], Hamari [12], and Pedreira [20] provides lists of game elements which are not available for quick references or do not have enough information for us. We discover a list of 31 game elements that was created by a gamification company called BadgeVille [2]. This list was chosen for this work, because it provides additional information, examples and other useful data that could be useful for the research.

3.2 Phase 2: Exploratory

In this phase we interviewed 3 experts on software development, selected based on our contacts and their level of expertise on the topic (e.g., at least 5 years of experience) and invite them to evaluate the preliminary list of issues encountered in literature, classify those issues using the five dimensions based on the 3C Model (communication, coordination, cooperation, awareness and group formation) and to discover new issues (if possible). To generate more relevant results for further analysis, the first and second author also contributed for the activity.

The experts received 34 small printed cards containing the identified issues, a number ID, and a short description about it. They were introduced to the dynamics and were asked to classify each issue in one of the previously mentioned five dimensions. They were also instructed to feel free to point out if they did not feel that a particular issue was relevant for the list. At the end of the dynamics, each expert was interviewed to see if she would like to add any other collaboration-related issue that she might have experienced in her work environment.

3.3 Phase 3: Framework Development

Next, based on literature reviews and on our own knowledge of the subject, we identified which game elements can be applied for each issue. The mapping was a subjective process where we defined which are the desirable behaviors
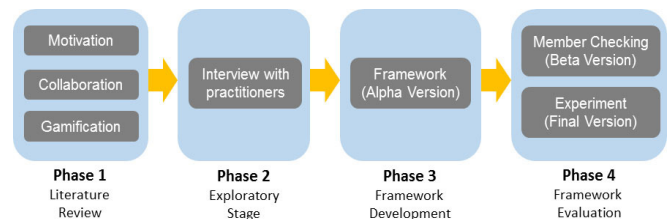

Figure 2: Proposed research design

expected for the collaboration issues identified, and how the game elements could help to foster that. For example, the issue "No Meetings" is defined by "there is no meeting for the team", and as a desired behavior we want to "create a routine of meetings for the team". So, based on examples from literature and on our own understanding of each game element, we choose those who could help to jump start that desired behavior. For example, "quests" could help by creating tasks for team members where they obligatorily need to meet in order to complete the challenge.

The proposed preliminary framework is organized into the five collaboration dimensions, each one composed by one or more identified collaboration issues. Issues are identified by a singular name and description, and brings together the associated desired behaviour (what is expected), game elements and discussion (how the game elements proposed can be applied). The framework is presented in table 1.

This first version was initially proposed by the first author and extensively discussed with the second author for refinement. Later it was discussed among all authors until an alpha version was considered ready for evaluation activities.

3.4 Phase 4: Framework Evaluation

We planned the framework evaluation into two major stages: the preliminary evaluation using member checking technique [23], to collect feedback from experts about the alpha version (presented in this paper) and a second evaluation using a controlled experiment aiming to identify how a sample of the framework is observed in practice (still to take place).

For the preliminary evaluation, we used the member checking technique, which collects feedback on the findings from the subjects who provided the data in the first place [23]. Thus, we contacted two of the experts that participated in the exploratory study (Phase 2) and invited them to provided us feedback about the alpha version of the framework. Given that we could have no concluding feedback, we decided to invite three additional experts, who have at least the same background of the others. Two of them had previous experience with gamification which provides us a different perspective from previous experts.

The controlled experiment is currently being designed. We will select a sample of collaboration issues of our interest and will conduct a two months-long activity with graduate students of a CSCW course in which they will demonstrate how they handle behaviour change promoted based on the introduction of the game elements into the software development processes they will be adopting to complete the task-at-hand. We are considering CSCW students because computer science students often start working in industry early. Most of them are able to address some of the situations presented on the framework.

4. PROPOSED FRAMEWORK

The preliminary framework was developed based upon the findings on Phases 1 and 2 as previously described. The main goal is to consolidate knowledge in a single artifact to facilitate practitioners and researchers work either by being a guideline to be used in practice with software teams or having it as a baseline to further research on the topic. The framework proposes how to use the game elements proposed by BadgeVille [2] to minimize each of the 34 collaboration issues that software teams face in their activities. Table 1 presents the alpha version of it.

5. PRELIMINARY EVALUATION

We present in this section the findings of the preliminary evaluation as introduced in Section 3.4. We initially selected the same five experts that have participated in Phase 2. The main objective of this evaluation was to collect the participants feedback about the alpha version of the framework, and identify whether they would suggest changes or improvements to it. An individual interview of about one hour long was conducted with each of them, having the list of game elements explained and version of the framework, as shown in Table 1. The interview was structured by questions about their opinion about collaboration, gamification and how the issues encountered can be addressed by each set of game elements proposed in the framework.

The feedback was collected, analyzed and grouped in similar suggestions and an action plan was created to address them. The main contributions of this preliminary evaluation are summarized below:

1. **The need for examples in the literature**: All of the experts suggested the use of literature examples to help understand and evaluate each issue and game element suggested. Examples for them will be added to the beta version;

2. **The need for profiles**: Four experts asked if those game elements could be applied to any kind of person. Since it is known that some game elements are most suitable to different profiles, the idea to consider the profiles will also be considered for the beta version;

3. **Limitations of the work**: Each practitioner suggested some different approaches to the framework. For example, one asked if the framework will be suitable for outsourcing teams; another asked if the framework will propose who should apply the guidelines to the team. So it became important to clearly limit the boundaries of the framework scope;

4. **How to measure**: Three experts asked how each behaviour change will be measured. It may be interesting to consider some metrics to measure the effectiveness of the framework, in action;

5. **Publication on web**: One practitioner suggested the publication of the framework on the web, to be easily consulted by other researchers and people interested in gamification studies.

6. CONCLUSION AND FUTURE WORK

Collaboration plays an important role in software team activities, so it is important to find ways to minimize the impact of its issues, and also foster the collaboration in teams. Gamification is the use of game elements in non-game contexts, and its use is becoming more popular in industry.

This study proposed a preliminary version of a framework to use gamification as a motivator for software development teams to minimize their collaboration issues, which often affect group formation, communication, coordination, cooperation, and awareness.

This version of the framework was created based upon the findings of literature reviews and interviews with experts. Later, we mapped each issue to game elements that might help foster collaboration in teams. These results were

Table 1: The Alpha Version of the Framework Proposed

Communication				
#	Issue	Description	Desired Behavior	Game Elements	Discussion
1	No common sense between team members	Team members don't have common sense, aligment, compromise, motivation, etc.	Teams must have a common sense about the expectations of the project.	Cascading Information Theory, Achievements, Quests, Notifier, User Profile, Status	Cascading information theory can help the team to achieve the common sense of the work to be done. Quests and achievements can create a step-by-step path where team members can learn all important thing about the project. Notifiers, user profile and status also may help in the situation.
2	Excessive Communication	Overload of information and communication	Team members must know exactly who should be aware of their information	Achievements, Appointments, Quests, Notifier, User Profile, Status	Achievements, appointments and quests can create and describe the team members who must be aware of the results of the accomplishment. Notifier, user profile and status can support the idea for knowing who must be informed about something.
3	Ineffective Communication	There's no common ground between team members and this affects the quality of communication	Team members must have a similar language for working together.	Cascading Information Theory, Achievements, Quests, Notifier, User Profile, Status	Cascading information theory can help the team to achieve the common sense of the work to be done. Quests and achievements can create a step-by-step path where team members can learn all important thing about the project. Notifiers, user profile and status also may help in the situation
4	Lack of Focus in Meetings	Too much distraction in meetings causes loss of information and impacts decisions	Improve the focus in meetings by creating mechanisms to help it	Achievements, Reward Schedules, Countdown, Loss Aversion, Virality, Blissful Productivity	Achievements, reward schedules and loss aversion can create some behaviors that will reward the team members who paid attention in the meeting. Countdown can create the awareness that the team must use that specific amout of time do conclude the meeting. Virality can create the idea that team members must conclude the meeting together. Blissful productivity can be used to create an interest in the meetings.
5	No Meetings	There are no meetings for the team	Create a routine of meetings for the team	Achievements, Quests, Appointments, Notifier, Bonuses, Levels, Points, Leaderboard, Progression	Achievements, quests and appointments are crucial to help create the routine of meetings. Also, notifier can notify the team members about the meetings. The rewards will come in form of bonuses, points, etc.
6	No Technical Discussions	Team members don't discuss technical information	Create a routine for fostering technical discussions	Achievements, Quests, Appointments, Notifier, Bonuses, Levels, Points, Leaderboard, Progression	Achievements, quests and appointments are crucial to help create the routine of meetings. Also, notifier can notify the team members about the meetings. The rewards will come in form of bonuses, points, etc.
7	Lack of Informal Communication	There's no Informal communication (not involving work) or ad-hoc communication	Foster the informal communication in the team, by allowing them to gather outside the workspace	Achievements, Quests Appointments, Bonuses Levels, Points, Leaderboard, Virality, Community Collaboration	Achievements, quests and appointments are crucial to help create the routine of informal communication. The rewards will come in form of bonuses, points, levels, etc. Community Collaboration and Virality also can help people to cooperate.
8	Lack of face-to-face communication	Team members don't have rich face-to-face communication	Sit the team together to help the face-to-face communication	Achievements, Quests, Appointments, Bonuses Levels, Points, Leaderboard, Virality, Community Collaboration	Achievements, quests and appointments are crucial to help create the routine of face to face communication. The rewards will come in form of bonuses, points, levels, etc. Community Collaboration and Virality also can help people to cooperate.
9	Lack of Feedback	Team members don't give feedback to each other	Foster the feedback process in the team	Achievements, Quests, Appointments, Bonuses, Levels, Points, Leaderboard, Progression, Virality , Community Collaboration, Loss Aversion, Lottery	Achievements, quests and appointments are crucial to help create the routine of feedback. The rewards will come in form of bonuses, points, levels, etc. Community Collaboration and Virality also can help people to cooperate. Loss Aversion can make team members focus on giving feedback in a specific timebox. And lottery may create an environment where team members must give random feedback to team members based on chance.
Coordination				
#	Issue	Description	Desired Behavior	Game Elements	Discussion
10	No clear goals	No clear goals and objectives about the work to be done	Goals are clear and available for every team member	Achievements, Cascading Information Theory, Epic Meaning, Quests	Achievements and quests can create milestones that the team might follow to achieve the goal, giving them the step-by-step to success. Cascading Information Theory may give to the team only the right information for the time they need, making them focused on mastering the first steps. Epic Meaning may give the goal a special narrative, giving the feeling that the team will be really impacted by achieving the goals.
11	No clear tasks	No clear tasks for the work to be done	Tasks are properly defined and team members know what to do	Achievements, Quests, Combos, Progression	Achievements and quests may create the ideal meaning for each task, giving purpose for them. Combos can create the step-by-step desired results to be achieved. Progression will allow the team members to see the stage of the work done and to be made.
12	Unrealistic plan	Unrealistic schedules, milestones, goals, estimates, etc.	Plans should be created with the participation of every team member, to gather every opinion and then guarantee better estimates.	Community Collaboration, Virality, Discovery, Loss aversion, Urgent Optimism	Virality (when considering only the team) and community collaboration (stakeholders) can help team members to cooperate in creating the plan. Discovery allow members to seek for better ways to understand and achieve the goals. Loss aversion can be used to make members update the plan constantly, so they will not lose privileges (for example, if they do not update the plan, they will be responsible for the estimates). Urgent optimism may be useful to help members to have the feeling that the plan is able to have success.
13	No clear roles	Team members don't know or are not satisfied about their roles in the project	Team members must know their responsabilities, and also the ones of their colleagues	Achievements, Appointments, Quests, User Profile	Appointments, achievements and quests can help define the roles and expected tasks of team members. User profile is useful to allow the others to see their information.

#	Problem	Description	Requirement	Game Elements	Explanation
14	Lack of support for new members	Newcomers don't have specific support from team members	Newcomers must know what to do, and the team must know how to support them.	Achievements, Appointments, Quests, Bonuses, Cascading Information Theory, Discovery, Levels, Points, Progression, Reward Schedules, Status, Leaderboard, User Profile	Newcomers might have achievements, appointments, quests and bonuses to begin knowing what to do and the expected results. A cascading information theory can help them to have a tutorial for understanding the new processes. Let them discover the new work. The use of levels, bonuses, points, progression, status and leaderboard is also interesting for the team to be rewarded by supporting the new member.
15	Lack of involvement from managers	Managers don't support the team	Managers must support the team, when needed.	Appointments, Community Collaboration, Epic Meaning, Ownership, Quests, Virality	Appointments and quests can be set up to help the team to synchronize actions with the managers. Community Collaboration enable the managers to take part in the problem solving, helping directly the results of the procces. Epic Meaning and Ownership may boost the interest by the manager in participating in the process, because they can see the value of that. Virality creates the background to allow people to cooperate
16	Excessive Workload	Team members work many extra hours on tasks	Team members must not burn out too much.	Countdown, Loss Aversion, Notifier, Achievements, Bonuses, Points, Levels, Progression, Leaderboard	Countdown might incentivize the team members to not overcome the specific time. Notifiers can give some alerts to the team members who are working too much. Bonuses, points, levels, progression and leaderboard may encourage the change of behavior, rewarding those who do not work too much. Also, loss aversion may help team members to not lose achievements by maintaining the routine to not burnout.
17	Excessive Changes in Plan or Process	Planning and processes (like methodology) change frequently	Plans must maintain a minimum of previsibility to give the team some security in work	Quests, Progression, Activity Feed, Notifiers	Quests can be used to create a set of steps that every task in the plan may have. Changes will impact the progression, so team can see this happening. Activity feed and notifiers can be used to maintain a log of the activities, helping the team to see how things are going or when they changed.
18	Lack of Challenges or Purpose	The project doesn't represent a meaningful motivation for team members	The project must represent a challenge for the people who will work on it	Achievements, Appointments, Blissful Productivity, Bonuses, Combos, Discovery, Epic Meaning, Levels, Loss Aversion, Ownership, Points, Progression, Quests, Rewarded Schedules, Status, Instances, Easter Eggs, Leaderboard	Achievements, appointments, quests, loss aversion, rewarded schedules can create an environment where the team can have small objectives to accomplish. Doing that, they will be able to get bonuses, combos and points, that will affect their levels, status and the sense of progression and leaderboard. The Epic Meaning and ownership may create also a good environment for the work to do. Easter eggs and instances can create some "chaotic" things making the team leave the routine.
19	Lack of incentives	There's no extrinsic motivation for team members	There should be incentives from the company to generate motivation in the teams	Achievements, Bonuses, Combos, Levels, Points, Progressions, Quests, Rewarded Schedules, Leaderboard, Status	Team members can achieve some rewards, that could be "in game" or even real extrinsic rewards, for accomplishing some quests or seeking some achievements. That will affect their levels, status, progression and leaderboard.
20	Lack of Autonomy	Team members don't have autonomy to work	Team members must have autonomy to decide the best way to work on the problems	Discovery, Community Collaboration, Virality, Ownership	Discovery may give the team the idea of discover how to achieve better ways to work. Community Collaboration and Virality make the team members work together, and have their own opinions, to change the progression of work. Ownership can give the team members a reason for feeling like owning something special about the work.
21	Lack of Social Events	Team members don't have social events or spaces to build relationship	Foster the social events for helping the team to create an identity	Achievements, Quests, Appointments, Virality, Community Collaboration, Reward Schedules, Virality, Levels, Points, Leaderboard, Progression, Bonuses, Status	Having social events is important, so having achievements, quests, appointments and reward schedules that incentivize this stuff will be great. They will get bonuses and points for it, so it will affect their levels and leaderboard. Also, Community Collaboration and Virality are important to create a cooperation mechanism for them.
22	Lack of Monitoring	There's no monitoring from managers or team members in the work	Make managers be more present and give them this responsability	Community Collaboration, Virality, Achievements, Appointments, Quests, Bonuses, Points, Levels, Leaderboard	Community Collaboration and Virality can create the routine of participation by the managers. Also, achievements, appointments and quests are important to set some objectives where the monitoring is important. Doing that, the team members will be rewarded by bonuses, points, levels and leaderboard.
23	Lack of Training	Team members don't have training for the work to be done	Create a process to have training sessions for the team	Cascading Information Theory, Achievements, Quests, Appointements, Schedule Rewards, Points, Bonuses, Combos, Levels, Progression, Leaderboard, Status, User profile, Urgent Optimism	Cascading information theory can create a tutorial for the training. This also can be accomplished with achievements, quests, appointments and schedule rewards that will create step by step tasks to help team members train. They also will be rewarded by points, levels, combos, leaderboard that will update their status and user profile. Also, notifier can remind them to keep training. Urgent optimism is important to keep the team member with the feeling that they will accomplish the objectives
Cooperation					
24	No relationship between team members	Team members working alone, not talking to each other, not collaborating	Team members must talk to each other, sharing information and work	Achievements, Appointments, Bonuses, Points, Levels, Quests, Leaderboard, User Profile, Virality, Reward Schedule	Achievements, appointments and quests can be used to foster the relationship between members, by creating some specific tasks that will allow them to communicate. Also, reward schedule, bonuses, points, levels and leaderboard can create some rewards for these actions. User profile can be used to show more information about team members, to help them knowing each other. Virality creates the background to allow people to cooperate..
25	No relationship with stakeholders	Team members don't have access to users, clients and stakeholders	Stakeholders must be available to team members	Appointments, Community Collaboration, Epic Meaning, Ownership, Quests, Virality	Appointments and quests can be set up to help the team to synchronize actions with the stakeholders. Community Collaboration enable the stakeholders to take part in the problem solving, helping directly the results of the procces. Epic Meaning and Ownership may boost the interest by the stakeholder in participating in the process, because they can see the value of that. Virality creates the background to allow people to cooperate.
26	Lack of Tools and Resources	Tools to facilitate the collaboration are not available or are not appropriated	Teams must have available the right tools for the work.	Discovery, Notifier	The team is able to explore and discover the best tools to achieve their work. Also, when they are stuck in something, they can generate a notification to ask for help
27	No Shared Work Space	Team members don't have a physical space to share	Team members must sit together and share the same information in most of the time.	Achievements, Appointments, Quests, Activity Feed	Achievement, appointments and quests can create situations where team members must share their work spaces to make information flow. Also, activity feed can help in awareness

28	Excessive Conflicts Between Team Members	Conflict between team members happens frequently	Team members must communicate better to avoid having conflicts that will affect the work	Achievements, Appointments, Bonuses, Points, Levels, Quests, Leaderboard, User Profile, Virality, Reward Schedule	Achievements, appointments and quests can be used to foster the relationship between members, by creating some specific tasks that will allow them to communicate. Also, reward schedule, bonuses, points, levels and leaderboard can create some rewards for these actions. User profile can be used to show more information about team members, to help them knowing each other. Virality creates the background to allow people to cooperate.
29	Lack of Knowledge Sharing	Knowledge doesn't flow in the team due to lack of moments and artifacts for knowledge sharing	Foster the knowledge sharing by improving awareness and communication	Achievements, Quests, Appointments, Bonuses, Levels, Points, Progression, Leaderboard, Virality, Community Collaboration, Loss Aversion	Achievements, quests and appointments are crucial to help create the routine of knowledge management. The rewards will come in form of bonuses, points, levels, etc. Community Collaboration and Virality can help people to cooperate. Loss Aversion can make team members focus on maintaining the artifacts or communication in a specific timebox.
Group Formation					
30	Individual over teams	When individual goals are more important than the team goals	Team members must understand the importance of the team, seeking their personal goals by achieving the team goals.	Achievements, Blissful Productivity, Bonuses, Epic Meaning, Free Lunch, Levels, Points, Progression, Quests, Status, Virality, Activity Feed, Leaderboard, Reward Schedule	Achievements and quests can help create specific tasks that must be achieved in cooperation. This will give to the team members points and bonuses, that will improve their levels and improve their status and leaderboard. The blissful productivity combined with virality can make the team work together and hard, which will impacts directly the personal. Free lunch will give the member an opportunity to have rewards based upon the work of the others. Also, the activity feed can help team members to be aware of what the others are doing.
31	Lack of trust	Team members don't trust each other	Team members must know each other to start building a relationship	Achievements, Appointments, Quests, User Profile, Virality	Achievements, appointments and quests can be used to foster the relationship between members, by creating some specific tasks that will allow them to communicate. User profile can be used to show more information about team members, to help them knowing each other. Virality creates the background to allow people to cooperate.
Awareness					
32	Lack of Perception of Work in Progress	Team members don't have the perception of status, who is working on specific tasks, who to report, etc. Team members don't have the perception of status, who is working on specific tasks, who to report, etc.	Create an environment that fosters the perception of work by team members	Achievements, Appointments, Quests, Progression, Activity Feed, Notifier	Achivements, appointments and quests create the milestones where the work can be visualized, and also, the progression helps to see how far the work is made, and how much is pending. Activity feed and notifiers can also help the teams to be instantly aware of work.
33	Lack of Perception of Team Availability	Team members don't have the perception about team members' availability or status	Create an environment that fosters the awareness of team members	Status, User Profile, Activity Feed, Notifiers	Status and user profiles can have the availability of the team members. Notifiers and activity feed can help the team members to be aware of who is doing what, and if they are available or not
34	Lack of Sources to Help Awareness	There are no artifacts, documents or tools to help teams to maintain awareness	Create an environment that fosters the cooperation of documents by team members	Achievements, Appointments, Quests, Progression, Activity Feed, Notifier	Achivements, appointments and quests create the milestones where the work can be visualized, and also, the progression helps to see how far the work is made, and how much is pending. Activity feed and notifiers can also help the teams to be instantly aware of work.

preliminarily evaluated by a group of experts who suggested improvements for the beta version of the framework.

Our preliminary evaluation was limited to 5 experts but given their level of expertise we consider this version stable enough to be used in our next steps. Also, given the limited number of empirical studies reporting how game elements are used in practice, we need to further explore how they can effectively help in practice, thus our experiment. Although this is an ongoing work, we believe that this initial version can be of use to both experts and researchers.

We are currently designing the second stage of our planned evaluation as previously presented: the experiment. We expect that this controlled activity will bring us new insights and a better understanding of how the framework can be used in practice. Also it may be interesting to analyze how each issue is related and how their interactions could be affected by the interventions of the game elements. The framework do not considers any software development areas or roles, and their specific collaboration issues, which might be interesting for future work.

As seen in the feedback collected until now, the framework has the potential to be a very interesting tool to be applied in work environments and help to minimize collaboration issues in software teams.

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