Exploring Gamification in Process Mining Education: Towards a Playful and Engaging Approach

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Abstract. This article explores how gamification, i.e. the integration of game elements, of the teaching of Process Mining enhances its effectiveness. By combining traditional academic teaching with game elements, gamification stimulates student engagement, facilitates understanding of complex concepts and encourages active learning. This article defines what gamification is (what), what it can bring to the teaching of Process Mining (why), how it can be implemented (how) as well as its limitations and how its development can be envisaged based on strong theoretical concepts and data gathered from the audience concerned.

Keywords: Teaching · Gamification · Process Mining

1 Introduction

In the maze of technical subjects such as Process Mining, teaching can sometimes seem like a complex quest to capture students' attention and stimulate their desire to learn. But what if learning became as captivating as a gaming adventure? It is in this exploration of educational possibilities that gamification comes into its own, transforming concepts into challenges, courses into quests and students into enthusiastic gamers.

Teaching technical subjects related to Process Mining presents specific challenges for teachers including:

- Complexity of technical concepts: Process Mining concepts, such as algorithms, data preprocessing techniques, and visualization methods, can be complex and abstract. Teachers need to find ways to make these concepts accessible and understandable for students new to the field.
- Rapid evolution of the field: The field of Process Mining is constantly evolving, with new techniques, methods and tools emerging regularly. Teachers need to keep up to date of the latest advances and adapt to new trends to ensure the relevance and quality of their teaching.
- Accommodating different levels of competence: Students may have varying levels of competence in Process Mining techniques and tools. Teachers must adapt their teaching to take into account these differences and provide adequate support to each student, offering differentiated learning activities.

- Availability of appropriate tools and data: Process mining often involves the use of specific tools and software for data analysis. Teachers must ensure that students have access to these tools and provide them with relevant data sets for their practical learning activities.
- Integrating theory and practice: Process mining is based on a solid theoretical foundation, but it is also essential to link these theoretical concepts with practical applications to help students understand how Process Mining techniques are used in real-life contexts. Teachers need to find a balance between theory and practice in their teaching.

Traditional teaching approaches, such as lectures and case studies, may not be sufficiently involving to enable a thorough understanding of Process Mining concepts. It is therefore crucial to explore new pedagogical approaches which offer a fun, interactive and practical learning experience to help students to assimilate Process Mining concepts in an effective and sustainable way.

This innovative teaching approach should involve students by making them active in their learning using interactive methods, stimulating challenges and hands-on activities that encourage students [13]. It needs to provide opportunities for active learning, where students can manipulate, solve problems, make decisions and directly experience Process Mining concepts. This is supported by the fact that they learn best when they are involved in concrete and hands-on activities [27]. Innovative teaching approaches should help students to develop the analytical skills needed to apply Process Mining techniques and should encourage collaboration between students, promoting the exchange of ideas, team problem-solving and effective communication. By adopting innovative pedagogical approaches that address these needs, teachers will facilitate students learning of Process Mining and effectively prepare them to apply these concepts in real-life situations [9].

Gamification, defined as the strategic integration of game mechanisms into non-game environments, aims to increase user engagement, motivation and participation [4]. This interactive and engaging pedagogical tool, can make a significant contribution to this innovative approach. It can be designed to be used in groups, encouraging cooperation, discussion and the sharing of knowledge. This enables students to work together, explore different perspectives and strengthen their collective understanding of Process Mining concepts. Gamified content can offer challenges that encourage students to use their analytical thinking to analyze, identify patterns, detect anomalies and draw relevant conclusions and they can be designed to represent the different stages of Process Mining, enabling students to discover and apply key concepts in a practical, tangible way.

The aim of this article is to answer the what, why and how of gamifying the teaching of Process Mining. In addition to bibliographical references, the hypotheses put forward are based on the responses of 52 bachelor's and master's students in civil engineering in computer science and management at the University of Mons who took part in gamified learning activities as well as a group of 17 students from Poznan University of Technology following a course focusing on cyber-security and Process Mining

After this introduction, which deals with the what, this paper will be structured as follows: Section 2 will give a detailed presentation of the mechanics that can be used to gamify a Process Mining learning activity, with a concrete example. This section refers to the how. Section 3 looks at the theoretical benefits of using gamification to teach Process Mining. This section will answer why. In Section 4, we will look at the points to consider when designing a gamified activity, and discuss the main issues involved. The final section concludes the article with a look ahead.

2 Gamification strategies for Process Mining

The aim of this section is twofold. Firstly, we will take stock of the best-known and most effective gamification methods and techniques. Secondly, these approaches will be applied concretely to the case of Process Mining. These strategies are carefully designed to optimize user engagement, motivation and learning, while facilitating a better understanding of the processes being analyzed [13].

2.1 Competitions and Rankings

The incorporation of a competitive dimension, through rankings and leaderboards, to Process Mining, arousing a desire for performance among students. Indeed, 85% of the students questioned found that competition is a source of motivation. The principles of flow theory [17] offer guidelines to balance challenges and skills, ensuring a rewarding and motivating experience. Furthermore, coopetition, by encouraging cooperation between students while maintaining friendly competition, can foster a positive and collaborative learning environment [2]. For example, each student, divided into teams, carries out process analyses. Each performed analysis is assessed in terms of the accuracy of the results, the time taken to complete them and the complexity of the problems solved. These measurable criteria help to quantify user performance. A league table can then be drawn, enabling everyone to see where they stand. An important and necessary comment on this strategy is that it is vital to ensure that the competition is not overwhelming, as it could generate anxiety or discourage some less competitive users.

2.2 Objectives and Rewards

The introduction of specific objectives and the distribution of rewards are proving to be essential elements in boosting student motivation in process analysis. By breaking down the process into achievable mini-goals, gamification creates a structure that transforms complex tasks into achievable steps. This approach [19] to self-determination theory suggests that satisfying basic psychological needs such as competence and autonomy is essential for nurturing intrinsic motivation [27]. The distribution of rewards, whether virtual (badges, points, etc.) or

linked to concrete advantages (access to advanced functions, for example), further amplifies this motivating dynamic. Rewards act as positive reinforcements, strengthening the desired behaviours. For example, an objective might be to complete the analysis of notebook production processes in less than 45 minutes. This kind of specific objective provides students with a clear short-term direction, avoiding potential confusion and frustration.

2.3   Quests and Missions

The creation of quests and missions transforms process analysis into an interactive adventure, stimulating the exploration of various aspects of the processes. This approach can be enhanced by narrative scenarios that emotionally connect users to tasks and improve perceived relevance. Concepts [18] from experiential learning theory explain how these missions can encourage active reflection and learning, by providing a practical and engaging experience. For example, students could be asked to solve the mystery of delays in the notebook production process by collecting data, modeling the process and carrying out the analysis that identifies the critical points. These missions are based on narrative scenarios, which will be described later in this section, which add an element of intrigue and emotion to the activity, allowing users to project themselves into concrete and motivating situations.

2.4   Playful Micro-Interactions

Micro-interactions are small animations, visual reactions and feedback that occur in response to the user's actions, adding a fun and interactive dimension to the whole experience. The integration of playful micro-interactions can add a touch of fun and dynamism to the user experience. These elements can increase engagement and make the overall experience more enjoyable [26]. By combining serious learning with fun elements, users are more likely to stay engaged and extend their participation over time. For example, when the user successfully completes a process analysis, a celebratory animation can be displayed, accompanied by a festive sound to reinforce a feeling of satisfaction.

2.5   Narrative Progression

By incorporating a narrative structure [28], characters and stakes, gamification can create a deeper and more meaningful context for exploring processes. Building a narrative progression involves creating a story around the process analysis. This story will therefore introduce fictional characters who interact with the processes, challenges to overcome and issues to address. The introduction of a narrative has several advantages. Firstly, it gives an emotional dimension to the activity, the emotional connection between the students and the characters/situations. This can make the teaching more immersive and stimulating, while creating a feeling of attachment to it that encourages memorisation. For

example, students may be given the role of detectives tasked with solving complex process-related problems with the help of fictional characters representing one algorithm or another, or explorers navigating through uncharted territory equipped with X-OR and X-SPLIT enabling them to model the given situation. The implausibility of narrative contexts is not a hindrance, since only 16% of students pay attention to its realism.

2.6   Personalising the Experience

Integrating the personalising of the experience is a strategy that strengthens student engagement and investment in the learning activity. It does this by enabling students to shape and adapt their virtual environment according to their preferences and skills.Customization can take a number of forms. Students may be able to choose the types of quests or challenges that best match their interests. For example, an optimization-oriented user might focus on challenges related to process improvement, while another student might choose an activity related to process modeling. This approach greatly stimulates student motivation but is double-edged since, as in the example mentioned above, if it is fully applied, it does not guarantee that all students will acquire all the knowledge required. As well as a skills-based aspect, customisation can involve the visual and interactive elements of the interface. Students could be allowed to choose themes, colors and avatars that reflect their personal style. This visual customization creates a sense of ownership and identity, which can strengthen the emotional bond with the application.

3   Contribution of Gamification to Process Mining

The integration of gamification strategies in the context of Process Mining has a major impact on the teaching of the latter. This impact [4] can take the form of a significant increase in user engagement, improved learning and a deeper understanding of the subject matter. By using elements of game design, gamification can transform a potentially complex and even austere activity into a motivating and interactive experience. This section examines the positive effects of gamification and highlights the benefits observed after justifying the appropriateness of this approach to the specific characteristics of teaching of the Process Mining.

   As mentioned in the introduction, the three main challenges in teaching Process Mining, which were highlighted by the students interviewed, relate to the applicative nature of the discipline (in particular the use of tools), the rapid evolution of the discipline and the technical complexity of implementing its methods. Gamification offers clear possibilities to make it easier to get to grips with the tools in a personalized way (particularly the badge system). Because they need to be renewed frequently (to maintain a level of interest), gamified activities can keep pace with developments in the discipline. When it comes to complex technical content, the use of narrative or immersive processes can offer a simplified understanding through the prism of a new point of view.

3.1   Improving Active Learning

Gamification encourages active participation of students, which considerably improves learning. Game design elements such as quests, missions and specific objectives stimulate engagement and motivate users to actively solve problems related to Process Mining. The principles of active learning theory [1] are in line with and underline the benefits of gamification for learning. This theory advocates the importance of active engagement, reflection and practical application to facilitate the acquisition of knowledge. As the section above shows, gamification encourages these three elements by encouraging students to actively solve Process Mining challenges, applying their skills and developing new concepts.

3.2   Strengthening User Engagement

One of the major contributions of gamification is to boost user engagement by integrating the elements described in the previous section. The theory of self-determination [3, 5] describes, in particular, the way in which gamification reinforces students' intrinsic motivation. This theory highlights the fact that individuals are motivated primarily by three feelings: being able to act on their own (autonomy), being capable (competence) and interacting (social connection). Gamification, by offering specific challenges and objectives, gives users a degree of control over their actions, and therefore autonomy. Virtual rewards, on the other hand, reinforce the feeling of competence when users achieve their goals. Co-operation or co-operative activities offer a variety of interactions (adversaries/partners).

Another theory [22], that of the behavior of organisms, once again highlights the link between gamification and reinforcement of commitment. According to this theory, behaviors followed by positive rewards are more likely to be repeated. By incorporating reward mechanisms into gamification, users are encouraged to participate more fully in the learning activity in order to obtain these positive reinforcements.

3.3   Increasing Understanding of Processes

Gamification, by introducing the elements outlined above, can significantly enhance the understanding of processes. By offering practical scenarios to students and encouraging them to solve concrete problems, gamification adds a layer of meaning to analysis activities, making it easier to understand complex processes.

Experiential learning theory [16] supports the positive effect of gamification on the understanding of the processes studied, and therefore on the analysis that can be made of them. By offering students practical challenges, scenarios outside the conventional academic framework and specific assignments, gamification encourages learning by doing. Users gain a deeper understanding of processes by solving real-life problems rather than simply absorbing theoretical information. Even if the scenarios may seem peculiar or even totally implausible (cf. the example of the explorers navigating through uncharted territory equipped with X-OR and X-SPLIT), a real-life setting reinforces understanding.

The storytelling elements [24] of gamification can improve student engagement and understanding. The interactive approach helps students to grasp complex interactions and sequences of events within a process.

3.4   Promoting Ongoing Commitment

Gamification, by offering progression mechanisms and ongoing rewards, can keep students actively and continuously engaged [20]. Elements such as those described in the previous section encourage users to return regularly to achieve new goals and maintain their position, creating a more sustained learning experience. Students are motivated to stay in touch with the rest of the learning group or to go as far as possible in the reward system [6]. Gamification of learning activities can keep student interest high by constantly proposing new and varied challenges and diversifying the objectives to be achieved, 96% of students were more interested in the proposed learning activity than in other learning activities in the same course. These challenges, updated on a regular basis, avoid monotony and keep students alert to learning issues. In addition, anticipating new challenges stimulates long-term commitment [7].

Another aspect [15] is real-time feedback and public recognition. These two elements are of significant importance in ongoing engagement. Indeed, students are positively impacted by receiving immediate feedback on their actions and by seeing their achievements celebrated by their peers. This reinforces their sense of achievement and encourages them to continue their involvement.

4   Limitations and Points of Attention

The process of gamifying learning linked to Process Mining as described in this article nevertheless has its limitations and requires precautions to be taken on certain specific points. Therefore, this section will be divided into two parts. The first will focus on the elements of gamification on which the teacher must place particular emphasis, otherwise gamification may fail. The second will deal with the limitations of the gamification process and the situations in which it is not advisable to use it.

4.1   Points of Attention

The gamification of learning activities must be carried out in an informed way and must take into account the possible alterations to teaching associated with transforming it into the form of a game. The main concern is that students may be tempted, consciously or unconsciously, to manipulate the data in their possession, the results or the presentation of their analyses in order to gain an advantage [14]. In the test group of students selected, 78% felt that the competitive aspect of the activity was more important than its educational aspect. To avoid this problem, it is crucial that the teacher establishes clear protocols and intermediate verification stages.

Another point of attention concerns responsibility and the healthy nature of competition [23]. The aim of gamification is to create friendly competition between students but, for the same reasons as mentioned in the previous paragraph, this can become excessive and lead to some participants becoming discouraged or even dropping out. Among the panel surveyed, 12% of students felt uncomfortable with the competition at least once during the proposed learning activity. The teacher's role is to strike a balance between maintaining respect between participants and encouraging them to compete [10].

The final point concerns the conception of the activity itself and the difficulty in balancing long-term and immediate learning. Students will be tempted to work on the surface, quickly but sufficiently to obtain the reward (badge, next test, first place, etc.) to the detriment of a more in-depth and systematic approach. It is important that the teacher succeeds in instilling the idea that gamification is a pretext for learning and not an end in itself [25].

4.2   Limitations

The main objective of this article is to highlight the clear benefits of gamification of learning activities linked to Process Mining, however there are some limitations to this process:

- Objective creep [11]: If the gamification process is not properly aligned with the objectives of the learning activity, students will focus on the rewards and fun elements rather than the actual understanding and analysis of the comps. This could compromise the effectiveness of the analysis.
- Sensitivity to Individual Preferences [12]: Each student has individual preferences when it comes to the game elements that motivate them. What works for one student may not work for another. Therefore, some students may not respond positively to gamified elements, reducing their potential engagement. An alternative to this limitation is to diversify the nature of the activities on offer as much as possible.
- Temporary effects [21]: Gamification elements can lead to temporary engagement effects. Once the students have achieved all the rewards or reached the highest levels, their motivation to participate may wane. The sustainability of engagement must be carefully considered to avoid rapid decline. An important note is that this phenomenon is also present in conventional academic teaching, where motivation is linked to passing the exam and not to acquiring the desired skills.
- Visual overload [8]: Adding gamified elements such as badges, points and leaderboards can potentially create visual overload in the student interface. Too much gamified information can confuse the experience and distract users from the main objective. Even more so for students with attention deficit disorders. This aspect needs to be taken into account right from the design stage of the learning activity, in order to offer a visually coherent package.
- Maintenance and evolution [12]: Gamification requires ongoing maintenance to remain effective and attractive. Gamified elements should be updated

regularly to avoid stagnation and obsolescence. In addition, it's important to plan the evolution of gamification in line with the changing needs of students and the objectives of the learning activity.
– Cognitive overload [8]: Excessive use of gamification elements can potentially lead to cognitive overload for students. Too much information, rewards and notifications can make the experience confusing and distract students from the main objective of analyzing processes. A balanced, minimalist design is essential to avoid this overload.

5   Conclusion and Perspectives

In this article, we have shown that gamification is an effective and relevant solution for revitalizing the teaching of technical subjects, particularly Process Mining, and stimulating active learning. The innovative pedagogical approach described is a combination of playful elements and classic academic concepts of transmissive teaching. It offers a new dimension to education, transforming classrooms into captivating educational playgrounds. Gamification provides a new way of overcoming the traditional challenges of teaching Process Mining, by appealing to students' natural curiosity and encouraging them to explore, experiment and collaborate. By focusing on active learning and active participation, gamification bridges the gap between theory and practice, creating a more immersive and rewarding educational experience.

However, it is essential to bear in mind that gamification is not the ultimate solution and is far from being a turnkey solution. PRecaution, consideration and long-term design are necessary and vital to avoid potential pitfalls such as discouragement, diversion from initial objectives, dependence on achievement marks or student confusion. In addition, a personalised approach that takes account of students' individual preferences can maximise the effectiveness of gamification.

The stated aim of this article was to answer the three questions about gamification: what, why and how. The first question was addressed by referring to the existing literature and clearly defining the concepts involved. The second question was addressed by highlighting five major aspects of teaching for which gamification provides a new and effective solution. This new and effective solution translates into the implementation of how-to methods, which answers the third question. These methods, which have been theorised and tested in numerous learning contexts, are clearly described and illustrated in the field of Process Mining.

The perspectives for gamification in the teaching of Process Mining are twofold. Firstly, there are currently no independent gamification tools (online games, board games, card games, etc.) developed for the exclusive and specific use of Process Mining teaching. Secondly, one of the aspects of gamification is the personalization of learning paths. In this area, Process Mining allows the learner to act as a disciple in his own right, and thus participate in the gamification process.

Finally, gamification does not and will never replace teaching expertise. It should be seen as an effective way of captivating and motivating learners. The thoughtful integration of gamification into mainstream academic teaching will enable teachers to produce generations of Process Mining experts who are motivated, curious and well prepared for the ever-changing realities of technology.

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