An experience report of utilizing the BPM Wheel serious game to evaluate BPM learning in higher education

Matheus R. B. Nobre[1], **Jéssyka Vilela**

[1]Centro de Informática, Universidade Federal de Pernambuco (UFPE)
Av. Jornalista Aníbal Fernandes, Cidade Universitária – Recife – PE – Brazil

{mrbn,jffv}@cin.ufpe.br

Abstract. *Business Process Management (BPM) is key for organizational improvement, focusing on efficiency, flexibility, and strategic alignment. Educating professionals in BPM provides them with the necessary skills for process optimization. However, there are few serious games and collaborative activities to improve BPM education, highlighting a gap in interactive learning resources. This work provides an experience report concerning applying the BPM Wheel serious game to assess the concepts of process analysis and performance indicators in a BPM discipline of the Bachelor of Information Systems at a public university. We applied the game in a 100-minute class assignment with thirty-six students divided into six teams, involving a professor and one tutor. We evaluated the students' perceptions regarding the game through a feedback questionnaire. The results indicated a positive reception regarding the effectiveness of the BPM Wheel game in learning, with students expressing strong agreement. Additionally, they highlighted the high level of engagement provided by the serious game and a generally positive reception regarding usability.*

1. Introduction

Business processes outline how organizations perform tasks to deliver value to their customers, and applying BPM focuses on cross-functional processes that add value for these customers. Intentional management of these processes results in stronger business practices leading to more effective, efficient, and agile processes, ultimately providing greater returns to stakeholders [CBOK 2009].

In a systematic mapping study [Nobre and Vilela 2024], we found that using Serious Games emerges as an innovative approach in BPM teaching. These games allow students to apply BPM concepts in a simulated environment increasing student engagement and providing real-time feedback, allowing instant comprehension of proposed solutions' errors. These findings highlight how these technologies are transforming BPM education, offering students a more engaging and effective approach.

Business process modeling is a crucial skill for computer engineers, yet many students struggle to understand and apply the concepts correctly. Using gamification when teaching BPM, rewards for successful modeling solutions, and penalties for errors increase student interest and motivation significantly [Garaccione et al. 2023].

In this experience report, we adapted the BPMN Wheel serious game [Kutun and Schmidt 2019] to address not only process modeling but also performance analysis and performance indicators. For this reason, we named this version of the serious game the BPM Wheel. The study involved 36 Brazilian students from a BPM class

in an Information Systems undergraduate course. We also analyzed the game's learning effectiveness, the degree of student engagement, and usability by collecting student feedback through a questionnaire. Our main contributions are as follows: (1) we provide one of the few experience reports in BPM teaching; (2) we show how BPMN Wheel serious game can be successfully adapted to other BPM concepts; (3) we provide students' perceptions regarding the game.

This paper is organized as follows: in Section 2, we discuss background and related work; in Section 3, we explain the BPMN Wheel serious game; in Section 4, we describe the research design; in Section 5, we provide the results of our research questions, and in Section 6, we present some conclusions and future work.

2. Background and Related Work

2.1. Business Process Management (BPM)

BPM is a managerial discipline and a set of technologies that support management through processes [CBOK 2009]. It can be defined as the support of business processes through methods, techniques, and software to design, execute, control, and analyze operational processes involving humans, organizations, and information. BPM is essential for adapting to market demands, optimizing operations, and driving innovation ([Ko 2009]).

The conduction of BPM projects requires that a BPM lifecycle, which defines the steps and activities to be conducted in BPM projects, be followed [Ko et al. 2009]. Several BPM lifecycles have been proposed. In this paper, we consider the lifecycle of [Oliveira 2014], which defines six steps: planning, AS-IS modeling, process analysis, TO-BE process design, process implantation, and process monitoring.

2.2. Serious Game

Serious Games (SG) are innovative educational tools that employ gaming elements to provide immersive and engaging learning experiences. [Garcia et al. 2020] explain that these games offer simulated environments that challenge players to solve specific problems related to professional practice, promoting the development of relevant skills for the field of study in which they are utilized.

The application of serious games suggests significant improvements in student motivation, as well as perceived competence. [Arachchilage and Hameed 2020] observed that players are encouraged to enhance their coding behavior, thus stimulating the development of skills relevant to professional practice in software development. Similarly, [Grace and Cohen 2016]) found, particularly in the context of BPM education, that SG has the potential to significantly enhance knowledge acquisition, offering an effective alternative to traditional teaching methods in the context of software engineering education.

2.3. Related Work

BPM Teaching is an ongoing area of research, with some relevant contributions using PBL, serious games, and gamification. A systematic mapping study on the topic [Nobre and Vilela 2024] identified only 21 research papers. We observed that the majority address business process modeling. Business process analysis, which is the focus of

our study, is not addressed by the selected studies, and only 3 studies cover business process performance. This suggests that the field's maturity is low and highlights the need for contributions emphasizing empirical approaches.

Problem-Based Learning (PBL). Some studies use the PBL methodology in several areas. The students' perceptions of online courses during the COVID-19 pandemic are investigated by [Gomes et al. 2021]. An experience of teaching software engineering using PBL is described by [Souza et al. 2021]. The use of PBL in database design is explained by [Josko 2020]. However, we found only a study regarding the use of PBL in BPM teaching. The study of [dos Santos et al. 2023] presents their experience with the PBL involving three disciplines of an undergraduate curriculum in Information Systems offered in the same timeline: Enterprise Management Systems, Project Management, and Business Process Management. These disciplines are connected through a real client's project. Throughout the semester, students use their course knowledge to propose solutions to the project's problem.

Experience Report in BPM teaching. Articles that report experiences of teaching BPM through serious games are also found in the literature [Chow 2021] [Sarvepalli and Godin 2017] [Tantan et al. 2016] [Grace and Cohen 2016] [Ribeiro et al. 2012]. For instance, [Chow 2021] highlights the alignment between SG and PBL in promoting active and practical learning, with both methods encouraging problem-solving and critical thinking. [Sarvepalli and Godin 2017] propose Serious Games (SG) as a pedagogical tool for BPM education, citing positive outcomes from adapting the Paper Game, emphasizing innovation in teaching methods to meet market demands.

Considering the growing importance of serious games as innovative educational tools in various fields, our work adapted the BPMN Wheel serious game [Kutun and Schmidt 2019] to investigate its applicability as an assessment tool of the concepts of process analysis and performance indicators. Concerning other works in BPM teaching, we contribute with an experience report of a serious game reinforcing the empirical grounding of BPM teaching and suggesting improvements by discussing lessons learned.

3. The BPM Wheel serious game

In this section, we provide a brief description of BPMN Wheel [Kutun and Schmidt 2019] and the differences between BPMN and BPM Wheels.

3.1. The BPMN Wheel

The BPMN Wheel comprises fourteen fields divided into options for learning cards (containing content on the topic of interest), control question cards (with questions on the topic), teamwork, and a notation element wheel. When the wheel is on the notation elements option, the team must spin the Notation Element Wheel (a second wheel containing options for each available notation element) to decide which element they can receive.

The game anticipates that if the teamwork option is selected, students will have a determined time to try to model a part of the process. BPMN Wheel also incorporates the use of coins as a reward for correct answers to control questions, which could also be exchanged for notation elements. Notably, [Kutun and Schmidt 2019] do not specify the

number of elements that could be received per team per turn in their study. Additionally, the study does not specify the textual description of the process used in the execution of the game, nor details such as how many elements could be exchanged for each coin.

3.2. Differences between BPMN and BPM Wheels

The serious game BPM Wheel was created by adapting the mechanics, objectives, and dynamics of the BPMN Wheel. This was needed due to the lack of games for process analysis and indicator measurement, as well as to meet time constraints and educational goals. The differences between the original wheel and this version are shown in the Table 1.

Table 1. Comparison between the original study and this application.

Setting	**BPMN Wheel**	**This application**
Study goal	Practice process modeling	Assess students knowledge on process analysis and performance indicators
Content	BPMN Modeling	Process analysis and performance indicators
Country	Germany	Brazil
Participants	28	36
Teams	Eight teams of three to four members	Six teams of six members
Students' profile	Undergraduate students of a bachelor of Digital Business in a BPM discipline	Undergraduate students of a bachelor of Information Systems enrolled in a BPM discipline
Time available to perform the activities	70 minutes	100 minutes
Artifacts produced by the students	BPMN Model	BPMN Model, Problem Categorization Map, 1 Ishikawa Diagram, List of suggested performance indicators classified, 1 Performance Indicator Specified
Number of Wheels	2	1
Reward mechanisms	Use of coins which could be exchanged for notation elements	Use of candies as immediate rewards to enhance motivation. Box of chocolates to the winner team. Grading of the artifacts produced.
Learning cards	40 learning cards	18 learning cards
Control question cards	20 control question cards	42 control question cards

Our game consists of spinning the BPM Wheel, illustrated in Figure 1, which two colors distributed equally in the wheel. The game is played clockwise. A member of each team, one at a time, spins the wheel. Depending on the field where the wheel stops, the team performs specific actions:

- Learning Cards (blue color): The player reads the first learning card from the pile and puts it back. These cards complement the necessary theoretical knowledge.
- Control Question Cards (yellow color): they allow the team to answer theoretical questions. Each team could choose up to five notation elements as a reward for correctly answering control questions, allowing them to start their modeling. For each correct answer, the student who spun the wheel also received a candy (Figure 2) as a reward.

BPM Wheel was applied as part of the final assessment of the academic semester. The students spun the BPM wheel until they had the number of modeling elements (activities, subprocess, events, pools) enough to model the process on the team poster board. To attract students' attention and increase their motivation, the set of 11 game mechanics described in Table 2 was implemented.

Figure 1. BPM Wheel Elements.

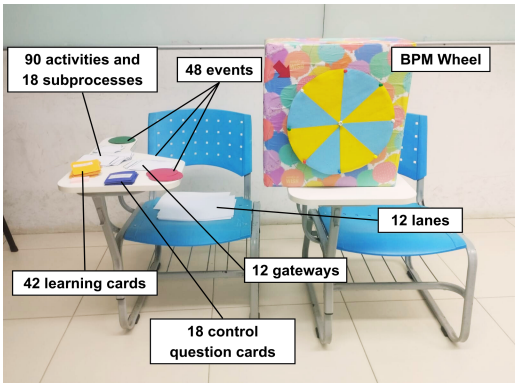


Figure 2. BPM Wheel Rewards.

Table 2. Gamification elements of the BPM Wheel

Distinctives	The winner team is crowned as BPMN Modeling Experts
Seeking Help	Control questions can be answered by the team
Clear Objectives	Correct modeling of the business process
Collaboration	Modeling and analysis of the process as a team
Competition	Process model with the best model quality
Customization	Players can select and organize notation elements as desired
Epic Meaning	Each player contributes to the team's success
Opinion	Answers to questions are printed on the back of control question cards
Progression	Measurable based on textual process description
Quests	Control of questions of different types
Time Pressure	For process modeling, as well as teamwork
Teamwork	The team will model the process as others answer questions from the BPMN Wheel

4. Research Design

In this section, we describe the methodological approach employed in this study.

4.1. Research Questions

The primary objective was for teams to collaboratively model in BPMN, analyze a predefined business process model, and propose performance indicators. The following research questions motivated the conduction of this work:

RQ1: What is the game learning effectiveness?

RQ2: What is the degree of engagement of the students using the game?

RQ3: What is the degree of usability of the game?

4.2. BPM Course and Students' Profile

This paper is placed on an in-person BPM discipline taught in Portuguese, involving 36 undergraduate students enrolled in an Information Systems course with no or low BPM experience. The course has a duration of 60 hours. We employed a methodological strategy that included theoretical lectures, several modeling exercises, exams, and the conduction of an interdisciplinary PBL project [dos Santos et al. 2023]. In this report, we had six groups of six students. These groups were formed using a team formation method (TFM) [dos Santos 2023], which combines several strategies of students' profiles. The

effect of using this method versus self-selected teams on team performance has also been investigated by previous work [Vilela et al. 2024].

Before the application of the game, there were theoretical and practical classes on BPMN modeling, process analysis, and performance indicators. Besides the exercises, the students had the opportunity to apply the concepts in the interdisciplinary PBL project they were conducting with real clients.

4.3. Data Collection and Analysis Procedures

Two instructors facilitated the game execution and guided throughout the process. Before its application, students were briefed on the game's objectives, rules, and expectations. Teams received materials for process modeling and analysis, including a textual description of a pre-defined process and the following templates of the problems categorization map, Ishikawa diagram, indicator classification, and specification.

To collect the data to answer our research questions, we asked the students to fill out an anonymous and voluntary feedback questionnaire listed in Table 3. The questionnaire assessed various aspects of the game, including usability, engagement and learning effectiveness. For each statement, students have five response options: strongly disagree, partially disagree, neutral, partially agree somewhat, and strongly agree. 15 out of the 36 students answered the questionnaire.

Table 3. Feedback Questionnaire

ID	Aspect	Statement	Reference
S1	Usability	The experience of using question cards in BPM Wheel is enjoyable	[Brooke et al. 1996]
S2	Engagement	The learning cards in the BPM Wheel game are engaging	[Troussas et al. 2020]
S3	Usability	I am satisfied with the teamwork interaction proposed in the BPM Wheel game	[Brooke et al. 1996]
S4	Engagement	The question cards in BPM Wheel motivate me to participate in the learning process	[Troussas et al. 2020]
S5	Learning effectiveness	I am satisfied with the learning experience through the game	[Chrysafiadi et al. 2022]
S6	Usability	The advice provided by the learning cards is helpful	[Brooke et al. 1996]
S7	Learning effectiveness	I consider the BPM Wheel game useful for my learning and content review	[Chrysafiadi et al. 2022]
S8	Usability	The overall quality of the BPMN modeling notation elements met my expectations	[Brooke et al. 1996]
S9	Usability	I found BPM Wheel easy to play	[Brooke et al. 1996]
S10	Engagement	I felt confident playing BPM Wheel	[Troussas et al. 2020]
S11	Usability	I found the various functions of BPM Wheel well integrated	[Brooke et al. 1996]

4.4. Threats to Validity

We analyzed the threats to validity considering the classification of [Wohlin et al. 2012]. Regarding *internal validity*, we argue that the students had no prior contact with the proposed game since the BPM Wheel was developed specifically for this study. Therefore, the students had no prior knowledge or experience with the adapted game, ensuring that their reactions and performance during the study reflected their genuine experiences and were not influenced by prior familiarity with the game.

Regarding *external validity*, we believe our results apply in similar educational contexts. However, to confirm this, it is desirable to replicate the study in different educational settings to verify if the results are consistent.

Finally, to mitigate *ethical issues*, it is not possible to relate students' opinions and their names; all information was analyzed anonymously, and the students were not graded based on their answers to the questionnaire.

5. Results

In this section, we describe our experience with applying the BPM Wheel and answer our research questions.

5.1. Application of the BPM Wheel game

The available time for the serious game execution was one hour and forty minutes. The students were briefed on the game's objectives, rules, and expectations before its application. Then, the teams reunited in different parts of the classroom for the game execution (Figure 3). Each team received printed materials: the textual description of the process to be modeled, a classification spreadsheet of indicators, an indicator specification template, and an Ishikawa diagram template. Each team received a poster board for process modeling that acted as a pool.

Figure 3. Teamwork While Playing the Game

Figure 4. Process Modeling Artifacts

It was planned that each team would have the opportunity to spin the wheel seven times so that everyone could obtain the necessary number of elements for process modeling (about 30 elements). However, class space constrained team members' movement to the BPM Wheel each turn. There were five turns, which required an adaptation of the reward mechanism. From the third turn, we allowed each student to receive seven notation elements for each correct control question answered. In the last turn, we increased the reward to ten notation elements to balance the teams' opportunities.

The winning team would be the one that first presented the process modeling without errors or with minimal syntax errors. The process models of the six teams are presented in Figure 3. In addition to BPMN modeling, teams were required to deliver the following artifacts: a problems categorization map, one Ishikawa diagram, a list of indicators classified in the table, and one indicator specified. As a reward, the winning team would receive a box of chocolates (Figure 2).

After the class, we asked the students to voluntarily and anonymously answer a feedback questionnaire. It is important to highlight that we can not determine the number of respondents in each team since the students' feedback was collected anonymously.

5.2. RQ1: What is the game learning effectiveness?

Considering the aspects of learning effectiveness (S5 and S7 of Table 3) in the BPM Wheel game, the students raised some insights. Satisfaction with the learning experience through the game (S5) was widely shared by 14 out of 15 students (Figure 5). The usefulness of the game for learning and content review (S7) was also recognized by 13 out of 15 students.

Figure 5. Evaluation of learning effectiveness

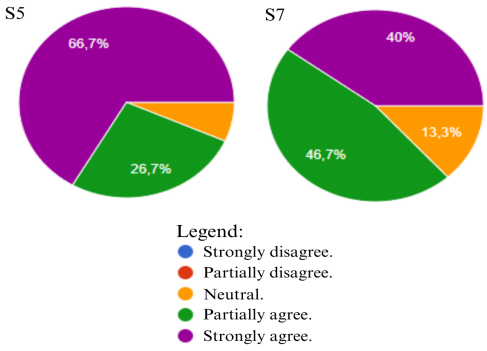
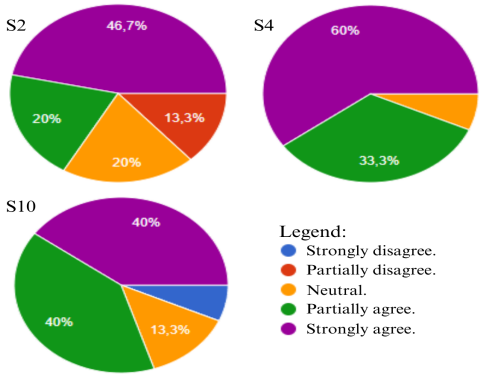


Figure 6. Evaluation of engagement



5.3. RQ2: What is the degree of engagement of the students using the game?

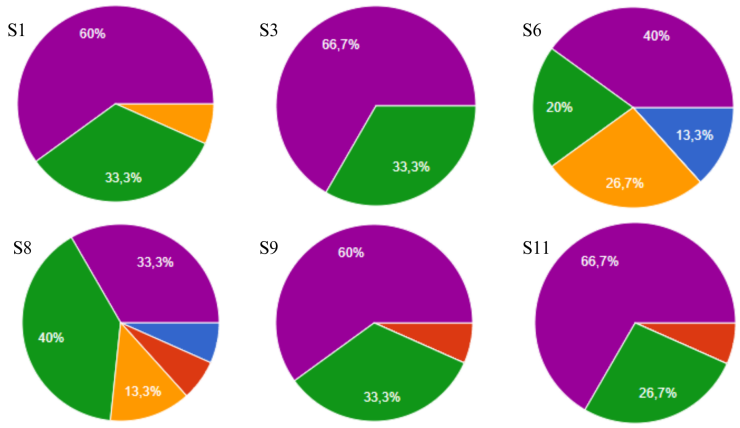
Students' perceptions were predominantly positive regarding the engagement (Figure 6) provided by BPM Wheel (S2, S4, and S10). Ten students reported being engaged with the learning cards (S2). Additionally, the question cards were considered motivating for the learning process, with 14 out of 15 students agreeing with their effectiveness in motivating participation (S4). As for students' confidence when playing BPM Wheel, twelve students expressed confidence (S10).

5.4. RQ3: What is the degree of usability of the game?

Regarding usability (S1, S3, S6, S8, S9, and S11) in Figure 7, fourteen students expressed strong satisfaction with the experience of using the question cards (S1). There was also a positive reception towards the proposed team interaction in the game, with all students expressing satisfaction (S3).

9 of 15 students found the advice provided by the learning cards useful (S6). Regarding the overall quality of BPMN modeling notation elements (S8), 11 out of 15 students agreed, two remained neutral, and two disagreed. This variation in responses indicates that some participants may have had different expectations regarding the quality of notation elements. We believe that this variation occurred because we printed the elements too big for the poster board making it difficult for the teams to place the modeling elements legibly.

Figure 7. Evaluation of usability



The easiness of playing BPM Wheel was also highlighted, with fourteen students agreeing with this statement (S9). Finally, fourteen students also positively evaluated the integration of the various game functions, indicating a satisfactory experience (S11).

At the end of the feedback questionnaire, we provided an optional open question for students to provide additional comments. While some participants expressed overall satisfaction with the dynamics, highlighting the opportunity to review various topics and create multiple artifacts, others raised specific concerns. Participants pointed out issues such as the size of the pieces about the available space on the card for building BPMN. These comments suggest that, although the proposal is considered excellent, there is still room for adjustments that could improve the flow of the game.

5.5. Lessons Learned and Improvement Points

Applying the BPM Wheel as an examination tool provided valuable insights and highlighted areas for improvement. Firstly, the *time management aspect was a significant challenge*. The allocated time for the game execution did not align well with the available space of the class, particularly regarding the movement of teams to spin the wheel. This resulted in the need to adjust the reward mechanism to ensure fairness among teams and maintain engagement throughout the game.

Additionally, *the balance between the learning and control question cards emerged as a crucial factor*. The equal distribution of these cards did not always result in an optimal game flow, as some teams faced delays in starting the modeling process due to consecutive receipt of learning cards. This distribution should be adjusted to facilitate a smoother gameplay experience for all participants.

The size of the notation elements provided for modeling was too large, incompatible with the poster board's size. Besides, *the dark color of some poster boards made it difficult for students to write the names of pools and lanes as well as to draw the connection of the notation elements*. This led to difficulties for students in carrying out the modeling, as they had to adapt the size of the notation elements and the connections.

Furthermore, *the use of candies as a reward mechanism proved effective in motivating student participation and performance*. Introducing candies as immediate rewards alongside notation elements enhanced motivation and engagement during the game. How-

ever, further refinement of the reward system could be explored to ensure a fair and balanced distribution of rewards across all teams.

Applying the BPM Wheel provided valuable insights into its effectiveness as an examination tool for undergraduate students. By addressing the identified areas for improvement and incorporating feedback from both instructors and students, future game iterations can be optimized to facilitate better learning and assessment in BPM education.

6. Conclusion and Future Work

Applying the BPM Wheel as an examination tool for undergraduate students in a BPM discipline provided valuable experience, revealing insights and challenges to be addressed. We provide the following take-away messages: 1) the use of a serious game as an examination tool provided a dynamic and interactive approach to learning, leading to greater student participation; 2) The results of RQ1 indicate that students are satisfied with the learning experience through the BPM Wheel game. Most students strongly agreed with the game's effectiveness in promoting learning, indicating high satisfaction. 3) Analyzing the results of RQ2, we can conclude that engagement is a positive aspect highlighted by the students. The learning cards and questions are perceived as engaging and motivating for participating in the learning process, as indicated by strong agreement in both statements. 4) Regarding RQ3, we found that students showed a positive reception towards the experience of using question cards, the proposed team interaction, and the easiness of playing the game. Additionally, the majority of participants found the advice provided by learning cards to be useful. However, there were some variations in responses, particularly regarding the quality of BPMN modeling notation elements, indicating that expectations may have differed among participants.

For future work, there are some directions for research and development to explore. One involves refining the reward strategies to ensure equitable and effective distribution, thus promoting continued student engagement and maintaining a stimulating learning environment. Another area of interest is evaluating the pedagogical effectiveness of the BPM Wheel. Conducting additional studies to assess its effectiveness compared to traditional teaching and assessment methods would be valuable. This analysis would better understand the game's impact on student performance and knowledge retention over time.

Acknowledgments Authors would like to thank all the students who participated in this study.

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