

Developing a Toolkit for evaluation of gamification in educational environments

Vinícius Lopes¹, Seiji Isotani¹, Diego Dermeval Medeiros da Cunha Matos²

¹Institute of Mathematics and Computer Science - University of São Paulo
ICMC-USP - São Carlos, SP, Brazil

²Federal University of Alagoas – Maceió, AL – Brazil

lopesvinicius@usp.br, sisotani@icmc.usp.br, diego.matos@famed.ufal.br

Abstract. *Gamification has been achieving good results in the improvement of motivation and engagement of students compared to traditional teaching methods. However, there is still no consensus regarding the metrics, instruments, and procedures for validating and evaluating the gamification design and effects in these contexts. In this paper, we report the development of a Toolkit to assist in the evaluation of gamification design in learning environments. We intend to provide, through this Toolkit, a group of empirically validated evaluation instruments categorized by their evaluation criteria, such as motivation, engagement, system usability and user experience, in order to provide the most effective evaluation solution for each gamification scenario.*

1. Introduction

Gamification, the use of game elements in non-game contexts, has been gaining popularity as a method to enhance engagement and motivation in various fields, such as marketing, healthcare, as well as work and educational environments [Kapp 2012, Deterding et al. 2011]. The core concept of gamification is to incorporate the elements of games into real-world contexts, to encourage specific behaviors or outcomes [Werbach et al. 2012, Dicheva et al. 2015]. These elements range from levels, points and badges, to competition and cooperation systems, and even narrative and storytelling elements [Toda et al. 2019].

Several empirical studies have shown the positive effects of gamification on learners in the education and training contexts [Koivisto and Hamari 2019, Dichev and Dicheva 2017], while some studies also present negative effects, like indifference, loss of performance, undesired behavior and declining effects over time [Toda et al. 2017]. However, there is no consensus as to what factors provide the most effective gamification design and outcomes in educational contexts [Sailer and Homner 2020]. Furthermore, many studies on gamification in education tend to evaluate this effectiveness through the development of their own instruments, like surveys, interviews or by analyzing student data, making it difficult to compare results across different studies or to establish widely accepted standards for gamification in education [Klock et al. 2018, Reinheimer and Medina 2020].

1.1. Motivation and research questions

In the literature, few empirically validated instruments can be used to evaluate gamification, without the need for some context adaptation, like the Gameful Experience Questionnaire (GAMEFULQUEST) [Högberg et al. 2019], or the User Experience Questionnaire

(UEQ) [Laugwitz et al. 2008, Alhejaili and Ibrahim 2023]. Also, there is no empirically validated standardized approach for the evaluation of a gamified educational environment that personalizes different instruments and strategies according to its learning objectives and expected outcomes. The lack of a personalized approach for evaluation of gamification motivates the exploration of the following research questions:

- RQ1.** How to effectively evaluate gamification designs and outcomes in educational contexts?
- RQ2.** Which empirically validated instruments can be used or adapted to evaluate gamification designs and effects in educational environments?
- RQ3.** How to personalize an evaluation approach for a gamified learning environment according to its learning objectives and expected outcomes?

1.2. Research objectives and contributions

By answering these research questions, we intend to provide a standardized solution for the evaluation of gamification in educational contexts. Therefore, the main objective of this research is: **To develop and validate a toolkit for evaluation of gamification strategies in educational environments with personalized approaches for different expected learning objectives and outcomes.** In order to achieve this goal, we intend to accomplish the following specific objectives:

- *SO1 - To understand the state of the art on the evaluation of gamification, including metrics and constructs;*
- *SO2 - To identify validated instruments for evaluation of gamification or instruments that could be adapted to this purpose;*
- *SO3 - To develop a toolkit for personalized evaluation of gamification environments, according to the expected learning objectives and outcomes;*
- *SO4 - To empirically validate the developed toolkit, through case-studies and peer-evaluation;*
- *SO5 - To provide the developed toolkit as a resource for gamification designers providing personalized evaluation strategies for gamified educational systems.*

This PhD research is being performed under the supervision of Dr. Seiji Isotani and co-supervision of Dr. Diego Dermeval da Cunha Matos, at the Institute of Mathematics and Computer Science - University of São Paulo (ICMC-USP), and Federal University of Alagoas (UFAL), respectively. This research began in January/2021, with the deadline for its completion in December/2025. The next section describes the methodological steps adopted in this research.

2. Research Methodology

This research is divided into five main steps, as seen in Figure 1. The first step, that encompasses the two first specific objectives (SO1 and SO2), is a literature review to understand the current state of the art on gamification, elements, personalization strategies, evaluation approaches and metrics. Also in this step, we conducted a state of the art literature review on empirically validated instruments for psychometric and user evaluation through peer-reading and snowballing, in which we already found some instruments for an initial Toolkit draft and categorized them by evaluation criteria.




Research Steps	 Literature Review	 Toolkit development	 Validation and release
Step 1	<p>Research on the state of the art on the evaluation of gamification (SO1)</p> <p>Ad-hoc research</p> <p>Identification of validated instruments for potential use in evaluation of gamification (SO2)</p> <p>Ad-hoc research Snowballing</p>		
Step 2	<p>Identification of validated instruments for potential use in evaluation of gamification (SO2)</p> <p>Systematic literature mapping Survey with gamification designers</p>		
Step 3		<p>Development of Toolkit for personalized evaluation of gamification environments (SO3)</p> <p>Collection of evaluation instruments Categorization of evaluation constructs</p> <p>Definition of context data Elaboration of context data extraction forms</p>	
Step 4			<p>Empiric validation of Toolkit (SO4)</p> <p>Evaluation with case studies Peer-evaluation with gamification specialists</p>
Step 5			<p>Release of Toolkit (SO5)</p> <p>Technical reports Publications in journals and events</p>

Figure 1. Methodological steps of this study in alignment with the specific objectives for this research. Source: elaborated by the author.

The second step also encompasses SO2, expanding towards the identification and categorization of potential instruments for evaluation of gamification factors, such as motivation, engagement, system usability and user experience. In this step we are conducting two parallel studies: a systematic literature mapping of gamification evaluation instruments to assist with the categorization process, and a survey with gamification designers to understand challenges and demands of gamification design and evaluation in educational environments.

The third step consists of the conceptualization, planning and development of the gamification evaluation toolkit (SO3), by associating the classified instruments in the previous steps with gamification design metrics, such as learning objectives and expected outcomes of a gamified learning environment.

The fourth step will involve the validation process, as defined in SO4. We plan to conduct different types of evaluation, with case-studies using the toolkit, and peer-evaluation of the toolkit's effectiveness with gamification designers and specialists. Finally, in the final step, following the last specific objective (SO5), the developed and validated toolkit will be released as a resource for gamification designers and researchers through reports and publications in academic events and scientific journals of the educational field.

3. Expected results and contributions

Currently, we are done with Step 1 and are advancing towards Step 2, with both studies in ongoing development. Through the systematic literature mapping we expect to identify and categorize evaluation criteria and potential evaluation instruments to assist in the development of a toolkit that helps in the evaluation of gamified learning environments. This study is already in the study selection phase, just before extraction and data analysis.

Additionally, the survey with gamification designers is also an ongoing study, with a questionnaire and a script for an interview already developed and in the polishing stages before release. Through this study, we expect to obtain relevant and current information about the real needs of gamification designers and will help, consequently, with assistance in the development of more effective gamification strategies in educational environments.

Parallel to this, we are also advancing towards Step 3, with the conceptualization of the evaluation Toolkit on its early stages. An initial model for this Toolkit, with its four different dimensions can be seen in Figure 2.

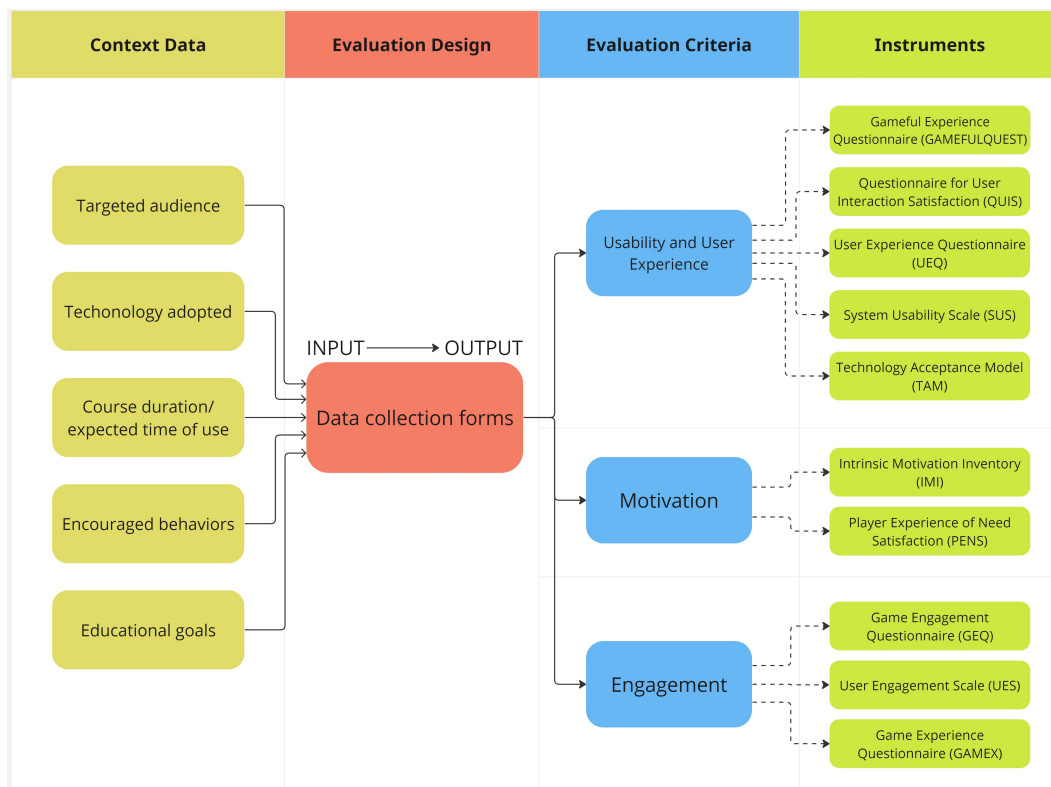


Figure 2. Initial Toolkit model. Source: elaborated by the author.

The Toolkit works by considering different characteristics regarding the educational environment to recommend the best evaluation method for the gamification strategies adopted. This happens by considering **context data** in order to understanding the evaluation needs of the designer. This data can be collected from the designer through data collection forms or interviews, as part of the process for the **evaluation design**, therefore identifying which **evaluation criteria** should be prioritized. After establishing these criteria, the designer can use the recommended **instruments** for each criteria, as provided in the Toolkit to design the evaluation.

With this Toolkit we intend to assist gamification designers in the process of selecting the best evaluation strategy and instruments according to their learning objectives and expected outcomes. The main goal behind this Toolkit is to provide a personalized approach to evaluation of gamified environments, thus increasing the effectiveness of the evaluation process. Through this research, we expect to contribute to the following research fields:

- Gamification, by providing a standardized resource for evaluating gamification designs;
- Computer science education, through the construction of a systematic approach to understand gamification effectiveness on teaching and learning;
- Human-computer-interaction, by adapting and categorizing empirically validated instruments to evaluate usability and user experience of educational environments;
- Software engineering, by providing a collection of psychometric evaluation instruments to evaluate computer system designs.

References

- Alhejaili, M. H. M. and Ibrahim, R. (2023). Review of user experience models in the context of elearning setting. In *2023 5th International Congress on Human-Computer Interaction, Optimization and Robotic Applications (HORA)*, pages 1–5. IEEE.
- Deterding, S., Dixon, D., Khaled, R., and Nacke, L. (2011). From game design elements to gamefulness: defining” gamification”. In *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments*, pages 9–15.
- Dichev, C. and Dicheva, D. (2017). Gamifying education: what is known, what is believed and what remains uncertain: a critical review. *International journal of educational technology in higher education*, 14(1):1–36.
- Dicheva, D., Dichev, C., Agre, G., and Angelova, G. (2015). Gamification in education: A systematic mapping study. *Journal of educational technology & society*, 18(3):75–88.
- Högberg, J., Hamari, J., and Wästlund, E. (2019). Gameful experience questionnaire (gamefulquest): an instrument for measuring the perceived gamefulness of system use. *User Modeling and User-Adapted Interaction*, 29(3):619–660.
- Kapp, K. M. (2012). *The gamification of learning and instruction: game-based methods and strategies for training and education*. John Wiley & Sons.
- Klock, A. C. T., Ogawa, A. N., Gasparini, I., and Pimenta, M. S. (2018). Does gamification matter? a systematic mapping about the evaluation of gamification in educational environments. In *Proceedings of the 33rd Annual ACM Symposium on Applied Computing*, pages 2006–2012.

- Koivisto, J. and Hamari, J. (2019). The rise of motivational information systems: A review of gamification research. *International journal of information management*, 45:191–210.
- Laugwitz, B., Held, T., and Schrepp, M. (2008). Construction and evaluation of a user experience questionnaire. In *HCI and Usability for Education and Work: 4th Symposium of the Workgroup Human-Computer Interaction and Usability Engineering of the Austrian Computer Society, USAB 2008, Graz, Austria, November 20-21, 2008. Proceedings 4*, pages 63–76. Springer.
- Reinheimer, W. S. and Medina, R. D. (2020). Gamification in the educational context: A systematic mapping of literature with a focus on the evaluation of gamification. *RENOTE*, 18(2):398–407.
- Sailer, M. and Homner, L. (2020). The gamification of learning: A meta-analysis. *Educational Psychology Review*, 32(1):77–112.
- Toda, A. M., Oliveira, W., Klock, A. C., Palomino, P. T., Pimenta, M., Gasparini, I., Shi, L., Bittencourt, I., Isotani, S., and Cristea, A. I. (2019). A taxonomy of game elements for gamification in educational contexts: Proposal and evaluation. In *2019 IEEE 19th international conference on advanced learning technologies (ICALT)*, volume 2161, pages 84–88. IEEE.
- Toda, A. M., Valle, P. H., and Isotani, S. (2017). The dark side of gamification: An overview of negative effects of gamification in education. In *Researcher links workshop: higher education for all*, pages 143–156. Springer.
- Werbach, K., Hunter, D., and Dixon, W. (2012). *For the win: How game thinking can revolutionize your business*, volume 1. Wharton digital press Philadelphia.