PERSONALIZATION OF GAMIFIC P IN EDUCATION

WHERE <u>AUGMENTED INTELLIGENCE</u> MEETS <u>PLAYFULNESS</u>

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Ana C. G. Santos M. Sc. Student Gamification in education, user types, personalization

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Acknowledgement

TEAM

2022-

2023

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Gamification in education,

educational technologies,

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Perspectives of AI to support gamification in Education

Perspectives of AI to support gamification in Education



TO AUTOMATE

Perspectives of AI to support gamification in Education



AUGMENTED INTELLIGÉNCE

Focus on the assistive role of Al to ease almost any activity in our lives

Vinton G. Cerf described augmented intelligence as:

An extraordinary partnership among humans, with their <u>curiosity</u> and <u>innovative</u> <u>intellect</u>, and <u>computers</u>, that bring their <u>speed</u> and ability to <u>deal with multidimensional</u> data.



One of the fathers of the Internet



Many topics related to AI in Education: Learning Analytics, Intelligent Tutoring Systems, user modeling, personalized learning, virtual reality in education ... 4. const int height = 100; 1'int constant 5. const float number = 3.14; /*Reaj const 6. const chaz lettez = 'A'; /*chaz con 7 const char letter sequence [10] = 8. const char backslash_char = \ ? 9 printf ('value of height :%] 10. printf (value of number :% f value of number :% f value of number :%

BUT, most research and development on AI in Education still focuses on the <u>AUTOMATING ASPECTS</u>

sequence





Molenaar, I. (2021). Personalisation of learning: Towards hybrid human-AI learning technologies. OECD digital education outlook, 57-77.

AUGMENTED INTELLIGENCE IN GAMIFICATION FOR EDUCATION

den in here in the second s



We aim to pave the ground for a symbiotic partnership between humans and computers to enhance our capabilities to better design personalized playful experiences for learning.

Such a symbiotic partnership requires consideration of both technological and human perspectives



1st part

Augmented intelligence

Focus more on the **human perspective**



Let's get started....

Let's get started....



Let's get started.... What is gamification?

Game PIN:

Join at **www.kahoot.it** or with the **Kahoot! app**





Gamification is *"the use of game design elements in non-game contexts"*.^[1]

[1] Deterding, S. et al.: From game design elements to gamefulness: defining gamification. In: Proc. of the 15th International Academic MindTrek Conf.: pp. 9–15 (2011).

Gamification in education is Using "game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems".^[2]

[2] Kapp, K. M. (2012) The Gamification of Learning and Instruction: Case-Based Methods and Strategies for Training and Education. New York: Pfieffer: An Imprint of John Wiley & Sons.

Gamification



Ludus (Rule-based)

1. Photo (https://goo.gl/R4fAwA) by Serious-Game.fr/CC 2.0

2. Photo (https://goo.gl/aAHg1t) © pacmanhattan.com

3. Photo (https://flic.kr/p/51xSd1) by Chris Messina/<u>CC BY-NC-SA 2.0</u>

Borges, S., Durelli, V. H., Reis, H. M., & Isotani, S. (2014). A systematic mapping on gamification applied to education. In *Proc. of the 29th annual ACM symposium on applied computing* (pp. 216-222).

Game design elements

Gamification uses **game design elements** such as:

- Narrative,
- Aesthetics,
- Avatars,
- feedback,
- Reputation systems,
- Rankings,
- Competition rules,
- Challenges,
- Points,
- Badges,
- etc, ...





4		FRANCISCO HU	 1800 XP
5		ALINE TELES CR	 1540 XP
6	P	PATRICIA GRAS	 1540 XP
7		JACQUELINE DE	 1530 XP
8	8	CIBELE ESTEVES	 1230 XP
9	8	TIAGO BIUSSE	 1220 XP
10	-	GEDEON SILVA	 940 XP

Rankings

Levels

Game elements in Duolingo

What happened over time?



Source: https://blog.duolingo.com/shape-language-duolingos-art-style/

Game elements in Duolingo

Cleaner interface



Source: https://blog.duolingo.com/shape-language-duolingos-art-style/

Game elements in Duolingo

Cleaner interface

Emphasis on game elements

- Aesthetics
- Levels
- Points
- context
- Social components



Source: https://blog.duolingo.com/shape-language-duolingos-art-style/

Why does research on gamification in education matter?

Motivation crisis In learning settings

Particularly in Developing Countries (e.g., Global South)

Enjoyment of Science (2006-2015)



Source: PISA 2015, Technical Report (OECD, 2015).

Several inadequate behaviors are associated with the lack of engagement and motivation for learning in Brazil:

- Dropout
- . Truancy
- · Cheating
- Incomplete homework
- . Age-grade distortion
- Etc



Used properly, gamification can reduce the problems of lack of engagement/motivation and its negative effects on learning

Gamification

Engagement and motivation crisis



Published: March 31, 2017

Benefícios da gamificação

RESEARCH ARTICLE

Does gamification increase engagement with online programs? A systematic review

Jemma Looyestyn¹, Jocelyn Kernot¹, Kobie Boshoff¹, Jillian Ryan², Sarah Edney², Carol Maher²*

Results

1017 studies were identified from database searches following the removal of duplicates, of which 15 met the inclusion criteria. The studies involved a total of 10,499 participants, and were commonly undertaken in tertiary education contexts. Engagement metrics included time spent (n = 5), volume of contributions (n = 11) and occasions visited to the software (n = 4); as well as downstream behaviours such as performance (n = 4) and healthy behaviours (n = 1). Effect sizes typically ranged from medium to large in direct engagement and downstream behaviours, with 12 out of 15 studies finding positive significant effects in favour of gamification.



Published: March 31, 2017

Gamification Benefits

RESEARCH ARTICLE

Does gamification increase engagement with

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Educational Psychology Review (2020) 32:77–112 https://doi.org/10.1007/s10648-019-09498-w

META-ANALYSIS

The Gamification of Learning: a Meta-analysis

Michael Sailer¹ · Lisa Homner¹

Abstract

This meta-analysis was conducted to systematically synthesize research findings on effects of gamification on cognitive, motivational, and behavioral learning outcomes. Results from random effects models showed significant small effects of gamification on cognitive (g = .49, 95% CI [0.30, 0.69], k = 19, N = 1686), motivational (g = .36, 95% CI [0.18, 0.54], k = 16, N = 2246), and behavioral learning outcomes (g = .25, 95% CI [0.04, 0.46], k = 9, N = 951).



Gamification Benefits

Abstract

This meta-analysis was conducted to systematically synthesize research findings on effects of gamification on cognitive, motivational, and behavioral learning outcomes. Results from random effects models showed significant small effects of gamification on cognitive (g = .49, 95% CI [0.30, 0.69], k = 19, N = 1686), motivational (g = .36, 95% CI [0.18, 0.54],k = 16, N = 2246), and behavioral learning outcomes (g = .25, 95% CI [0.04, 0.46], k = 9, N = 951). Whereas the effect of gamification on cognitive learning outcomes was stable in a subsplit analysis of studies employing high methodological rigor, effects on motivational and behavioral outcomes were less stable. Given the heterogeneity of effect sizes, moderator analyses were conducted to examine inclusion of game fiction, social interaction learning arrangement of the comparison group as well as situational contextual valid for motivational learning outcomes. The results suggest that gamification as it is and currently operationalized in empirical studies is an effective method for instruction, even though factors contributing to successful gamification are still somewhat unresolved, especially for cognitive learning outcomes.

inalysis indicated that effects of competition augmented with collaboration might also be valid for motivational learning outcomes. The results suggest that gamification as it is currently operationalized in empirical studies is an effective method for instruction, even hough factors contributing to successful gamification are still somewhat unresolved, especially for cognitive learning outcomes.

Gamification **Benefits**



Educational Research Review Volume 30, June 2020, 100322



Does gamification improve student learning outcome? Evidence from a metaanalysis and synthesis of qualitative data in educational contexts

Shurui Bai, Khe Foon Hew 兴 쯔, Biyun Huang

Highlights

- Gamification can increase student learning performance (effect size of 0.504).
- Shorter gamified interventions have greater average effect sizes.
- Participants report four main reasons why they enjoy gamification.
- Participants report two main reasons why they dislike gamification.
- Two main unresolved questions in gamification research are highlighted.

ABSTRACT

Despite the buzz around gamification as an exciting new method to engage students, evidence of its ability to enhance learning is mixed. In fact, gamification has attracted considerable controversy ("gamification is bullshit") and some derogatory labels such as "exploitationware." Therefore, in order to make the case for or against gamification in education, it is important to examine the effects (if any) of gamification on student learning achievements. This study is a meta-analysis of 30 independent interventions (3,202 participants) drawn from 24 quantitative studies that have examined the effects of gamification on student academic performance in various educational settings. The results show an overall significant medium effect size in favor of gamification over learning without gamification (Hedges' g = 0.504, 95% CI [0.284–0.723], p < 0.001). No publication bias is detected. An analysis of 32 qualitative studies reveals four reasons for learners' enjoyment of gamification: (a) gamification can foster enthusiasm; (b) gamification can provide feedback on performance; (c) gamification does not bring additional utility and (b) gamification can cause anxiety or jealousy. We conclude by highlighting two unresolved questions, and suggesting several future research directions concerning gamification in educational contexts.

ABSTRACT

Despite the buzz around gamification as an exciting new method to engage students, evidence of its ability to enhance learning is mixed. In fact, gamification has attracted considerable controversy ("gamification is bullshit") and some derogatory labels such as "exploitationware." Therefore, in order to make the case for or against gamification in education, it is important to examine the effects (if any) of gamification on student learning achievements. This study is a meta-analysis of 30 independent interventions (3,202 participants) drawn from 24 quantitative studies that have examined the effects of gamification on student academic performance in various educational settings. The results show an overall significant medium effect size in favor of gamification over learning without gamification (Hedges' g = 0.504, 95% CI [0.284–0.723], p < 0.001). No publication bias is detected. An analysis of 32 qualitative studies reveals four reasons for learners' enjoyment of gamification: (a) gamification can foster enthusiasm; (b) gamification can provide feedback on performance; (c) gamification can fulfill learners' needs for recognition; and (d) gamification can promote goal setting, and two reasons for their dislike of gamification: (a) gamification does not bring additional utility and (b) gamification can cause anxiety or jealousy. We conclude by highlighting two unresolved questions, and suggesting several future research directions concerning gamification contexts.
© Springer Nature Switzerland AG 2018 A. I. Cristea et al. (Eds.): HEFA 2017, CCIS 832, pp. 143–156, 2018. https://doi.org/10.1007/978-3-319-97934-2_9

The Dark Side of Gamification: An Overview of Negative Effects of Gamification in Education

Armando M. Toda^(⊠), Pedro H. D. Valle, and Seiji Isotani

comes. Based on our results, we found out that the game design may lead to a negative impact. For instance, Leaderboards are strongly associated to many negative effects mapped in this work. This result is corroborated by the psychology literature regarding ranking systems within learning environments. We believe our work may be useful to guide gamification instructors and specialists to avoid those negative effects in education contexts, by avoiding some game design elements settings.

Table 3. Negative effects and their respective gamified designs

Negative Effect	# •	f Elements Elements	Most Impacting Element
Indifference	8	Leaderboard, Badge, Level, Progression, Social Status, Point, Instant Feedback, Chal- lenge	Leaderboard and Badge
Loss of Performance	11	Leaderboard, Badge, Level, So- cial Status, Social Interaction, Point, Avatar, Progression, Instant Feedback, Challenge, Economy	Leaderboard, Badge and Point
Undesired Behavior	11	Leaderboard, Badge, Point, Level, Instant Feedback, Pro- gression, Social Status, Social Interaction, Avatar, Economy, Narrative	Badge and Leaderboard
Declining Effects	4	Leaderboard, Badge, Point, Level	Leaderboard and Point

Table 3. Negative effects and their respective gamified designs

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Declining Effects	4	Leaderboard, Badge, Point, Level	Leaderboard and Point



To augment the capabilities of teachers to design gamification scenarios for education, my group has worked in the past 10+ years:

Gamification Taxonomy
 Gamification Design Framework
 Personalization of Gamification

To do so, we need to understand how gamification works and why

Theoretical landscape: Relationships of theoretical foundations in research on gamification



Krath, J., Schürmann, L., & Von Korflesch, H. F. (2021). Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning. *Computers in Human Behavior*, *125*, 106963.

Flow Theory

Nakamura, & Csikszentmihályi (2001)



https://gamedesign2016.wordpress.com/2016/01/27/week-2-flow-channel-endogenous-value-and-interaction-models/

Flow Theory

Oliveira et al. (2021) Does gamification affect flow experience? A systematic literature review. Proceedings of the 5th International GamiFIN Conference, p. 110-119.



https://en.wikipedia.org/wiki/File:Challenge_vs_skill.svg



https://farm2.static.flickr.com/1228/1385806571_c7a6bf2006.jpg

Understanding the impact of gamification over time on Students' behavior

Rodrigues, L'., Pereira, F. D., & Isotani, S. (2022). Gamification suffers from the novelty effect but benefits from the familiarization effect: Findings from a longitudinal study. International Journal of Educational Technology in Higher Education, 19(1), 1-25.

Inicio Arquivo Editar Buscor Executor Ferromentas Exercício 2 # Leandro 2 # 31 / 85 /2016 # Exercício 3 # Lab 0, Ex 1 5 print("Universidade Federal do Anatonas") Exercício 6 Exercício 7 Notas	Enunciado Meu primeiro programa Escreva um programa que imprim na tela do computador a seguinte mensagero Universidade Tederal de Asazonas Dicas Use a função print(), que exibe mensagene na tela do computado

Understanding the impact of gamification over time on Students' behavior

Rodrigues, L'., Pereira, F. D., & Isotani, S. (2022). Gamification suffers from the novelty effect but benefits from the familiarization effect: Findings from a longitudinal study. International Journal of Educational Technology in Higher Education, 19(1), 1-25.

Goal: understand the impact of a gamification design, featuring **fictional** and **competitive-collaborative** elements

Participants: CS1 courses taken by STEM students (N = 756; 62.3% males and 37.7% females)

Settings: 14-week period of time in an ecological setting (7 analysis)

Experiment: quasi-experimental design, where Brazilian students completed assignments in either a gamified or non-gamified version of the same system



LABORATÓRIO 0 - PRIMEIROS PASSOS COM O PYTHON

Introdução à Programação de Computadores, Leandro Silva Galvão de Carvalho

Página Inicial / Trabalhos / Laboratório 0 - Primeiros passos com o Fython

Inicio Trabalhos Materials Didáticos Mensagens Inicio Arquivo Editor Buscor Executor Ferromentas Enunciado Exercício 1 main py

✓ Exercício 2 2 # 31 / 85 /2016

Exercício 3

Exercício 4

✓ Exercício 5

Exercicio 6

✓ Exercicio 7

Notas

3 # Lab Θ, Ex 1

5 print("Universidade Federal do Anazonas")

Escieva um programa que imprima na tela do computador a seguinte mansagero Universidade Fadaral do Asazonas Dicas Use a função print(), que exbe mensagene na tela do computador.



Ferabéts, sex codigo esté corretui

Shell

Console



HOME TURMAS - IDE - SOBRE - 🙎 SE

Objetivos da disciplina

https://uspdigital.usp.br/jupiterweb/obterDisciplina?sgldis=SSC0600

Emblemas da gamificação

Você pertence ao grupo Bronze, representado pelo emblema abaixo. Existem três grupos: Ouro, Prata e Bronze. O seu grupo é determinado pela quantidade de pontos de experiência (Exp) que você adquiriu dentro do ambiente da gamificação.



Os emblemas abaixo representam o seu desempenho nas atividades da disciplina de programação. Os emblemas podem ser de Ouro, Prata ou Bronze. O primeiro emblema, de Ouro, representa a sua média nas avaliações (10) feitas até então; o segundo, de Bronze, representa a sua média nas listas de exercícios (0); e o terceiro emblema, de Bronze, representa a frequência com que você acessa o CodeBench.



Progresso Individual

TOTAL DE PONTOS GANHOS	10.0%
TRABALHOS COM 10.0	10.0%
MENSAGENS LIDAS	0.0%
MATERIAIS BAIXADOS	0.0%

	H						HOME	TURMAS +	IDE -	SOBRE -	SE SE
Enredos da gamificação:	Geral Capítulo 1	Capítulo 2	Capítulo 3	Capítulo 4	Capítulo 5	Capitulo 6	Final				
encontrar o sacerdote que e cadeados você precisa se ur recompensa. Faça exercício enigmas e lutará com o terr	està no templo trancado a nir aos outros aprendizes e s até destrancar todos os o ível Stuark . Corra! Ajude a	oito cadeados. S e juntos resolver cadeados. Após a libertar os povo	Só tem uma for rem os exercício abrir o templo, pados!	ma de vocë abri os de programa você percorrera	ir o templo: "des ção no CodeBen á o seu subterrâ	trancando os o ch. Após cada r neo, passará po	ito cadeados esolução de or provações	s na porta do t exercícios sen em uma escu	templo". Pa áo sorteac iridão assu	ara destrar das cartas c istadora, ei	icar os le ncontrará
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Most interesting result:

A statistically significant interaction between the effects of gamification and system usage, IDE usage and number of attempts.



Most interesting result

We found empirical evidence supporting that gamification likely Effect size suffers from the novelty effect but also benefits from the familiarization effect, contributing to an overall positive impact on students.



Rodrigues, L., Pereira, F., Pessoa, M., ... & Isotani, S. (2022). **Are they learning or playing? Moderator conditions of gamification's success in programming classrooms.** *ACM Transactions on Computing Education (TOCE)*.

> Jogo, D. A., Challco, G. C., ... & Isotani, S. (2022). Investigating how gamified syllabic literacy impacts learning, flow and inappropriate behaviors: a singlesubject study design. International Journal of Child-Computer Interaction, 33, 100458.

Santos, J., Andrade, E., & Isotani, S. (2022). Does gender stereotype threat affects the levels of aggressiveness, learning and flow in gamified learning environments?: An experimental study. *Education and Information Technologies*, 1-26.

How to select game design elements to support learning?

Most interesting result

We collected data from specialists to identify the most relevant game elements that can be used in educational contexts to improve participation, motivation and engagement.

Likert Scale									
Game element	1	2	3	4	5	Mean	SD		
Objectives	0%	0%	0%	23%	77%	4.77	0.44		
Level	0%	0%	8%	31%	62%	4.54	0.66		
Progression	0%	0%	15%	23%	62%	4.46	0.78		
Acknowledgement	0%	0%	15%	62%	23%	4.08	0.86		
Point	0%	8%	8%	54%	31%	4.08	0.64		
Competition	0%	0%	23%	54%	23%	4.00	0.71		
Novelty	0%	0%	15%	69%	15%	4.00	0.58		
Data	0%	0%	31%	46%	23%	3.92	0.71		
Puzzle	0%	8%	23%	38%	31%	3.92	0.95		
Classification	0%	8%	8%	77%	8%	3.85	0.76		
Scarcity	0%	8%	23%	46%	23%	3.85	0.9		
Sensation	0%	15%	15%	38%	31%	3.85	1.07		
Cooperation	0%	0%	31%	62%	8%	3.77	0.69		
Time pressure	0%	8%	23%	54%	15%	3.77	0.6		
Chance	0%	8%	31%	46%	15%	3.69	0.83		
Economy	0%	0%	54%	31%	15%	3.62	0.85		
Choice	0%	7%	50%	36%	7%	3.43	0.77		
Renovation	8%	15%	15%	54%	8%	3.38	1.12		
Social pressure	8%	15%	38%	38%	0%	3.08	0.95		



Taxonomy of game design elements that are commonly utilized in learning environments

Toda, A. M., Klock, A. C., ... Isotani, S. & Cristea, A. I. (2019). **Analysing gamification elements in educational environments using an existing Gamification taxonomy**. *Smart Learning Environments*, *6*(1), 1-14.

2nd part

Augmented intelligence

Focus more on the technological perspective



How to design gamification systems and activites to support learning?

Personalization matters

Santos, A. C. G., Oliveira, W., Hamari, J., Rodrigues, L., Toda, A. M., Palomino, P. T., & Isotani, S. (2021). **The relationship between user types and gamification designs.** *User modeling and user-adapted interaction*, *31*(5), 907-940.

> Rodrigues, L., Palomino, P. T., Toda, A. M., Klock, A. C., Oliveira, W., Avila-Santos, A. P., ... & Isotani, S. (2021). **Personalization improves gamification: Evidence from a mixed-methods study.** *Proceedings of the ACM on Human-Computer Interaction, 5*(CHI PLAY), 1-25.

Oliveira, W., Hamari J. ... & Isotani, S. (2022). The effects of personalized gamification on students' flow experience, motivation, and enjoyment. *Smart Learning Environments*, *9*(1), 1-26.



Towards a framework to support personalized gamification designs in education

Design of a Gamification Framework 4 Pillars:

(1) The Hero's Journey (Vlogler, 2017)

(2) Bloom's Taxonomy (Anderson et al. 2001)

(3) Gamification Taxonomy (Toda et al., 2019)(4) ADDIE Model (Morrison, 2010)

VOGLER, Christopher. The Writer's journey. Michael Wiese Productions Studio City, 2007.

ANDERSON, Lorin W. et al. A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives. Longman,, 20

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Student's Journey and Experience + Learning Goals

Toledo, P. (2022) Gamification of Virtual Learning Environments: A Narrative and User Experience Approach. Ph.D. Thesis



Student's Journey and Experience + Learning Goals + Gaminfication elements

Toledo, P. (2022) Gamification of Virtual Learning Environments: A Narrative and User Experience Approach. Ph.D. Thesis



Student's Journey and Experience Learning Goals +-Gaminfication elements +Instructional design

Toledo, P. (2022) Gamification of Virtual Learning Environments: A Narrative and User Experience Approach. Ph.D. Thesis



Step by Step

Act 1: Call to Action

- Purpose and Meaning
- Immersion
- Autonomy and Creativity







Step by Step

Act 2: Crisis (Conflict)

take the student out of their
'comfort zone', and challenge them
to grow.

- Ownership and Rewards
- Scarcity
- Challenge and Competence



Step by Step

Performance Dimension



How to assign teachers to use our tools and augment their capabilities to design gamification scenarios?



GARFIELD

Gamification Automatic Recommender for Interactive Education and Learning Domains

- Data collected from 361 individuals from 19 different countries
- We investigate how to semi-automatically tailor gamification designs to users considering their geographic location, learning activity types (according to Bloom's taxonomy and gamification preferences/experience)

Rodrigues, L., Toda, A. M.,& Isotani, S. (2022). Automating gamification personalization to the user and beyond. *IEEE Transactions on Learning Technologies*, *15*(2), 199-212.


Fig. 1. Conditional decision tree for participants most preferred game element. Codes refer to preferred game genre (PGG), learning activity type (LAT), and experience researching gamification (ERG).



Fig. 1. Conditional decision tree for participants most preferred game element. Codes refer to preferred game genre (PGG), learning activity type (LAT), and experience researching gamification (ERG).



experience researching gamification (ERG).

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Age

18

Gender Female

Action

Rodrigues, L., Toda, A. M.,& Isotani, S. (2022). **Automating gamification** personalization to the user and beyond. IEEE Transactions on Learning Technologies, 15(2), 199-212.



- Publish +

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GARFIELD - Gamification Automatic Recommender for Interactive Education and Learning Domains







Data-driven

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GARFIELD - Gamification Automatic Recommender for Interactive Education and Learning Domains







Multidimensional

Data-driven

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GARFIELD - Gamification Automatic Recommender for Interactive Education and Learning Domains







Data-driven



Multidimensional



Transparent



War

Challenges

A

9

Challenges



How to maximize the benefits of gamification, so that students are simultaneously engaged in playing but also focused on learning?



How to better design augmented technologies to accurately guides teachers during to design and apply gamification in education?



How can we use data-driven gamification designs to promote equity and equality in education?

Palomino, P., Rodrigues, L., Toda, A., & Isotani, S. (2023). Enhancing Students' Learning Experience Through Gamification: Perspectives and Challenges. *Communications in Computer and Information Science, vol 1702. Springer, Cham. https://doi.org/10.1007/978-3-031-27639-2_6*





