The Effects of Gamification on Students' Gameful Experience According to Their Gender: A Quasi-Experimental Study

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***Abstract*—Contribution: In this full research paper, we offer a quantitative analysis of how gamification influences students' gameful experience within a mobile online learning gamified platform, specifically Duolingo. We explored how these effects vary based on students' self-declared gender, providing valuable insights into the intricate dynamics within gamified educational environments. Background: The use of gameful environments as educational tools has been acknowledged for its potential to yield diverse outcomes in students' learning achievements, encompassing both advantageous and disadvantageous effects. Among the hypotheses regarding the observed diverse outcomes is that gamification may influence individuals' experiences differently based on their inherent traits, such as gamer type, age, and gender. While recent research has made strides in exploring this hypothesis, knowledge regarding how gamification can affect users' experience in gameful environments remains limited. Research Questions: This study aims to address the following question: How does gamification affect students' gameful experience (*i.e.*, accomplishment, challenge, competition, guided, immersion, playfulness, and social experience) according to their self-declared gender? Methodology: To answer this research question, we conducted a quasi-experimental study (*i.e.*, involving the comparison of groups without random assignment), organized in three steps. In the first step, we invited technology students to utilize the gamified platform, Duolingo, for a minimum of 20 minutes. In the second step, participants completed the GAMEFULQUEST, a scale comprising 56 items across seven dimensions, designed to measure their gameful experience while using the platform. They also answered a demographic questionnaire to indicate their gender (following ethical recommendations, we included the options: "male", "female", "non-binary" and "I prefer to not disclose"). In the third step, we employed Structural Equation Modeling to analyze the effects of gamification on students' gameful experience, according to their gender. Our sample comprised 110 students, with 42 self-identified as females and 68 as males. Findings: Our results indicate that learners' gender did not affect any of the dimensions of the gameful experience. This result opens up space for several insights into how gamification can affect the learners' experience according to different variables.**

***Index Terms*—Gamification, gamified education, gender bias, gameful experience, quasi-experimental study**

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I. Introduction

Educating is a challenging task that requires dedication and the development of strategies to optimize the process [1]–[3]. Keeping someone's attention when transmitting content is complex since each individual has unique characteristics, which must be taken into account when planning what is intended to be transmitted [2], [4], [5]. In the last few years, gamification has been widely used as a strategy to solve this problem as a valuable tool, presenting good results, which has made its popularity increase more and more [6]–[8].

However, gamification has its points of attention, which can lead to a variation in the results obtained, sometimes making them negative [6], [9], [10]. While game-like elements have been successfully applied to increase user engagement, satisfaction, and task performance in different domains, the effectiveness has often been mixed, highly context-specific, and varied among individuals [5], [6], [11]. Sometimes, the type of activity that will bring satisfactory results in a portion of students (such as competitive students, who like challenges among their peers), will have the opposite effect on the rest of them (perhaps students who do not like rivalry, prefer activities are collaborative, not competitive) [12]. Despite this, even with several studies on gamification, the impact of users' gender on its effect is still unknown [13], [14].

To face this problem, we investigated (N = 110) how gamification affects students' gameful experience (*i.e.*, accomplishment, challenge, competition, guided, immersion, playfulness, and social experience) according to their self-declared gender (*i.e.*, male and female). This experiment took place with students from a high school technical course class at the Federal Institute of Education, Science and Technology of São Paulo, in Brazil, who were instructed to use the gamified platform Duolingo[1], answering after the experience the 56 questions of the GAMEFULQUEST [15] questionnaire, a self-report instrument that seeks to measure the user experience on playful platforms. Then, we used Structural Equation Modeling to

[1]https://pt.Duolingo.com/

identify the effects of the gamification design implemented in the platform Duolingo on the students' gameful experience.

Following data analysis, our findings revealed that student gender had no statistically significant impact on any of the gameful experience dimensions. This finding generated new perspectives on how gamification might or might not impact students' gameful experience dimensions. We contribute to different fields, especially education and gamification by providing the effects of gender on the gameful experience of language learners.

II. Background

In this section, we present the main topics addressed in this paper (*i.e.*, gamified education, gameful experience, and gender bias gamified education). We also present and compare recent related work.

A. Gamified education

The term "gamification" is usually associated with games by the vast majority of people, leading them to believe that its meaning is their inclusion in the educational process. However, the concept of gamification differs from such thinking, as it is not limited to something so simple [16]. The term "gamification" is a neologism derived from the digital media field [9] and is considered the "process in which services, activities, and systems are transfigured to promote similar motivational benefits as found in games" [6], [17]. Thus, gamifying a system, in practice, is the act of inserting game design elements into it, making it more attractive and dynamic to capture users' attention more efficiently and positively affect the users' experience [18].

In recent years, the popularity of gamification has skyrocketed and manifested in growing numbers of gamified applications, as well as a rapidly increasing amount of research [6], [19]. Due to its attractive properties, which can lead to positive results when applied efficiently, gamification can be efficient in diverse contexts [20]–[22]. Gamification is relevant to both, practitioners and academics [23], which leads to several studies on its application and efficiency [24]. The empirical research on gamification is mostly interested in how gamification implementations are perceived and experienced as systems, whether they are enjoyable or useful, and whether the users feel motivated by the systems [6].

However, just like any strategy in any area, there are points to be observed, since the application of gamification concepts can have very positive results, as long as it is done correctly [18]. Learners using gamified environments had significantly better learning outcomes than those who did not use gamification in their courses [9]. This demonstrates that, if personalized in the correct way, following the appropriate profiles for students, regardless of the teaching level or subject, the results can be positive, since effect sizes are not affected by student level (*e.g.*, elementary school students, high school students, university students), subject disciplines (*e.g.*, computer and information science, math, science), or by whether concrete or tangible rewards are provided [9]. On the other hand, while the research on the effectiveness of gamification in the context of education has been growing, there are blind spots regarding which types of gamification may be suitable for different educational contexts [25].

In this way, personalized gamification implements gamification designs based on user preferences to improve engagement [26]. Since different users are motivated differently by different game elements, designers must understand the relationships between game elements and their influence on users [27]. Elements and activities that positively influence some, may not have the same effect on others, and this may end up leading to controversial results, with improved results for a portion of users, but may even cause losses for others, which would end up making the use of such elements unfeasible [5].

B. Gameful experience

By applying gamification techniques, we seek to bring the feelings evoked by games to other contexts, using the advantages of an inviting and interactive atmosphere [28]. Gamification refers to the transformation of technology to become more game-like, to evoke similar positive experiences and motivations that games do, and to affect user behavior [15]. With these terms, we arrive at the definition of a "gameful experience", with all the advantages it can bring to the most diverse contexts, and we understand the reason for the desire to include gamification in them. The gameful experience is usually considered an experience composed of different dimensions [15]:

Accomplishment is experiencing the demand or drive for successful performance, goal achievement, and progress [15], **Challenge**, in turn, is experiencing demand for a great effort to be successful, thus the ability of the person is tested [15], **Competition** is related to experiencing rivalry towards one or more actors (self, another person, service, or group) to gain a scarce outcome that is desirable for all actors [15], while **Guided** means experiencing being guided on how (including what and when) to do, and on how to improve the target behavior [15]. **Immersion** is when all attention is taken over, and the person experiences being absorbed in what he or she is doing while having a sense of being dissociated from the real world [15], **Playfulness** is defined as the experience of being involved in voluntary and pleasurable behaviors that are driven by imagination or exploration while being free from or being under spontaneously created rules [15], and **Social experience** are the experiences emanating from the direct or indirect presence of people (both present in the real world and in the service), service-created social actors, and service as a social actor [15].

The gameful experience can be beneficial if applied correctly [15], [29], [30]. In an increasingly connected society, working with something that arouses the student's interest is not only desirable but necessary, thus, bringing into the teaching context something that is part of their everyday colloquial life can be an extremely useful tool [29], [31], [32]. Learners using gamification techniques had significantly better

learning outcomes than those who did not use gamification in their courses [9], and this shows how the gameful experience can be beneficial in everyday education, making the teaching environment more dynamic and enjoyable, which allows for better results [15], [31], [33].

With all these concepts internalized, the need to implement true gameful experiences in gamified systems becomes easily understandable [15], [29], [30]. The potential of gamification lies in the restructuring of tasks and activities with game elements and gameful affordances [6], [23], [28], . This may be by dividing a larger whole into sub-tasks with clear goals and providing direct feedback for accomplishments, reframing an activity by establishing a meaningful narrative, or by gathering a social community to provide support [6].

C. Gender bias in gamified education

Gender bias can be defined as any one of a variety of stereotypical beliefs or biases about individuals on the basis of their gender [34], and is a pervasive issue with far-reaching consequences. It manifests in countless ways, from subtle microaggressions, like unequal pay or limited access to education, to blatant discrimination based on stereotypes and cultural norms that dictate gender roles and behaviors [35]–[37]. Recent studies highlight the persistence of this bias across various sectors [35]–[37]. A 2022 Harvard Business Review study found that gender biases in hiring processes continue to disadvantage women, particularly in male-dominated fields [38]. These findings underscore the ongoing challenges in achieving gender equality. Even seemingly objective tools, like AI algorithms, may present such biases [39]. This algorithmic bias can have real-world consequences, impacting everything from loan approvals [40] to hiring decisions [41].

Gender bias is also present in education (*i.e.*, in teacher interactions, or student self-perception) [42]–[44]. Students may have biased views that specific courses are more appropriate for men, such as STEM (Science, Technology, Engineering, and Mathematics), and eventually, this view may occur across both genders [45]. Studies demonstrate that like men and women STEM students exhibited significant pro-Men-STEM bias, while women also demonstrated a significant pro-Women-STEM bias, and both groups demonstrated a Male-STEM/Female-Arts bias [45]. Similarly, teachers may have biased attitudes, with different ways of treating boys and girls, which causes a discrepancy in the quality of teaching for students. The attention given by teachers can be different, suggesting that boys received more teacher attention than girls overall [42]–[44].

Likewise, gender bias can also influence the results obtained in gamified education [5], [30], [46]. Specific gamified features, such as leaderboards, can have different consequences depending on the student's gender [47], leading to better or worse performance. This can be observed specifically in women since most women did not actively enjoy or were motivated by the virtual points or leaderboard [5], [47]. With this, we can see that preferences for certain gamified tools tend to change, depending on the student's gender, and this has an impact on the success of the model applied [5], [30], [46].

Therefore, it is essential to reduce gender bias in gamified education, since gamification techniques seek exactly the opposite, which is to guarantee a more dynamic and efficient learning process. When we face changing factors, such as gender bias, during the processes of applying gamified elements, we have a loss in the gameful experience, as well as in the final results obtained. This fact can give a false impression that the gamification technique is ineffective or proven to be wrong.

D. Related work

This section will be dedicated to studies that also delve into the topic covered by this study. We concentrate on recent studies on gamification and gender bias in education. Initially, Khan *et al.*, [4] investigated the impact of using a digital game-based learning application and gamification on engagement, learning, and gender differences among 72 8th-grade students in a science class, from a low-cost private secondary school in Pakistan. Development of a game-based learning application specific to the science curriculum was performed, followed by an implementation of game-based learning with students divided into experimental and control groups, combined with observation of students' behavior and emotions during science classes.

Similarly, Zahedi *et al.*, [5], investigated the effects of gamification on 181 computer science students' academic performance and identity development, specifically focusing on potential gender differences. To this end, it was introduced an environment called SEP-CyLE, an online gamified tool that was designed to provide supplemental computing content to students, and a convergent mixed-methods study guided by social identity theory and self-efficacy to understand women's experiences with this gamified tool.

In turn, Denden *et al.*, [46] explored how student perceptions of game design elements in educational gamification vary based on both gender and personality traits. For this purpose, 189 undergraduate students of a public Tunisian university took three online gamified courses, based on the self-determination theory, during two academic years.

In the same direction, Şenocak *et al.*, [3] examined the distribution of Hexad user types among distance learners, and explored how these user types relate to factors like gender, game mode preference, and overall gamification experience. The research involved 2,292 students involved in the Anadolu University Open Education system, in the fall semester of the 2018-2019 academic year, aged between 18 and 68 years. Relationships between user types and gender, preferred game mode, and gamification experience were analyzed.

Last but not least, Oliveira *et al.*, [48] investigated the impact of personalized gamification on students' flow experience, motivation, and enjoyment in an online learning environment, considering participants' gender in the interpretation of the results. The study involved 121 students from an elemen-

tary school, comparing a personalized version against a non-personalized version of a gamified education system.

The studies' findings imply that gender might not have a determining role in how successful gamification is in the classroom, bringing an overall inconclusive result regarding how gamification affects students' experience according to their gender. The studies highlight the importance of making sure that gamification is successful and inclusive for all students, and how it is crucial to take into account the attributes of the target audience, the application's context, the kinds of gamification components employed, and the potential for customization. As far as we know, we are the first to investigate the effects of gamification on students' gameful experience.

III. Study Design

In this study, we aimed to answer how gender affects learners' gameful experience in a gamified app (*i.e.*, Duolingo). To achieve our goal, we conducted a quasi-experimental study. In this section, we present the study's design (*i.e.*, materials, method, participants, and data analysis).

A. Materials and method

To conduct the experiment, we used the platform Duolingo[2]. Duolingo is a free online language learning application with wide availability of languages [49]. The platform uses a gamification-based approach, prompting users to progress through interactive lessons and exercises, earning points and achieving levels as they progress, featuring an interesting and inviting user interface that helps keep the student's attention. For a user-friendly interface and universal accessibility [49]. Duolingo proved to be a suitable option for carrying out this study, being accessible and easy to understand, especially for the age group of the participants. Figure 1 presents an example of Duolingo's interface.

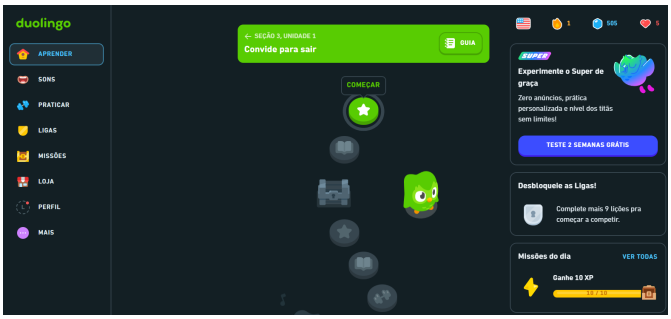

Fig. 1. Example of Duolingo's interface

To evaluate the participants' gameful experience on the platform, the GAMEFULQUEST scale [15] was used. The GAMEFULQUEST scale is a self-report instrument, developed by Högberg, Hamari, and Wästlund [15] aiming at capturing essential facets of gameful engagement, such as accomplishment, challenge, competition, guided behavior, and social interaction. In this study, we used a version of the scale in Brazilian Portuguese (due to the study being carried out in Brazil). The Brazilian Portuguese version of the scale had its psychometric properties analyzed by Oliveira da Silva Junior, Oliveira, and Hamari [50]. The scale has 56 items, that were presented on a 7-point Likert scale [51], with the items separated in the seven dimensions proposed by the original instrument, randomized within each section. Following the recommendations of Kung, Kwok, and Brown [52], as well as following the example of recent similar studies in this field [53]–[55], we inserted an "attention-check" item (*i.e.,* "**I feel good, but this is a question to check if you are paying attention to the form. If you read this question, select option 4**." | "*Me sinto bem, mas, essa é uma pergunta para checar se você está prestando atenção no formulário. Se você leu esta pergunta, marque a alternativa 4*." (in Brazilian Portuguese)) in the fourth section/dimension, to prevent responses made by inattentive participants from making their way to the final analyses.

To analyze the results, we used the software IBM SPSS 27 [56], and JASP 0.18.3 [57]. The IBM SPSS 27 [56] software was used to conduct the descriptive analysis. In turn, JASP [57] was used to measure discriminant validity, gender relationship value with dimensions and *p-value*, with a robust diagonally weighted least squares, which is the most suitable for the questionnaire, since it presents the most widely used method for dealing with categorical data [58], and is stable even with deviation from normality, and samples of varying sizes [59], which uses a Likert response pattern.

The study was organized in three different steps, *i.e.*, *i)* participants' invitation, *ii)* platform utilization, and *iii)* responding to the GAMEFULQUEST scale.

In the *first step*, participants' invitation, invitations were extended to learners from the federal institute of São Paulo (IFPB). Prospective participants received information about the study's purpose and procedures through their teacher. Students were provided with details regarding the study's requirements and had the opportunity to voluntarily participate.

In the *second step*, platform utilization, students who agreed to participate were instructed to use the gamified platform, Duolingo, for a minimum of 20 minutes. Participants were encouraged to engage with the platform at their convenience and pace, with no restrictions on timing or frequency of usage. This phase aimed to allow participants to familiarize themselves with the platform and experience its gamification features.

In the *third step*, responding to the GAMEFULQUEST scale, participants who had engaged with the platform were directed to complete the GAMEFULQUEST scale. Additionally, participants were asked to provide demographic information, including their gender. To ensure inclusivity and sensitivity, gender options included "male," "female," "non-binary," and "I prefer not to disclose". This phase aimed to assess participants' perceptions of their gameful experience and explore potential differences based on gender identity. Figure 2 summarize the study's method.

[2]https://www.duolingo.com/

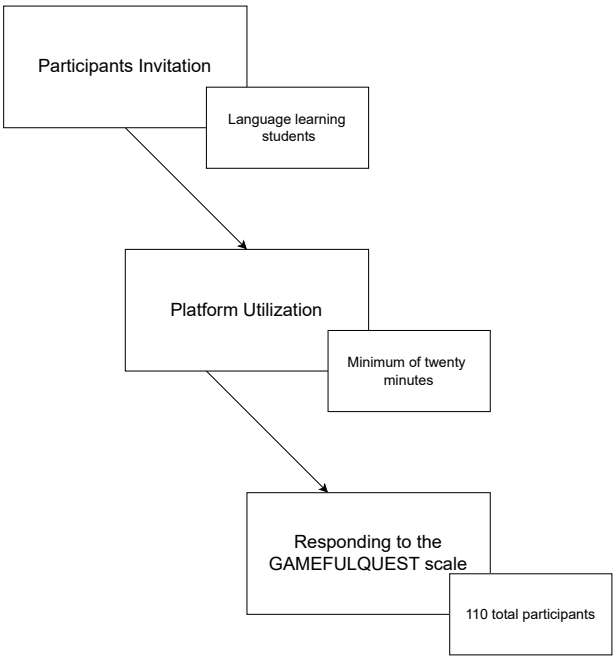

Fig. 2. Study's method

B. Participants and data analysis

For the Structural Equation Modeling (SEM), to ensure a sufficient sample to adequately measure effects, we used the *a-priori* sample size calculator method [60]. This method is based on the formulas proposed by Cohen [60] and Westland [61] to estimate required sample sizes on SEM. To estimate the sample size, we used the Online Calculator for A-priori Sample Size Calculator for SEM proposed by Soper [62]. This calculator uses the original formulas proposed by Cohen [60] and Westland [61], based on the number of observed (*i.e.*, in our study 57) and latent variables in the model (*i.e.*, in our study seven). Results indicate a minimum of 42 responses to an adequate model structure. This meticulous approach to sample size determination is grounded in the need to achieve sufficient statistical power, reduce Type II errors, and enhance the precision of CFA parameter estimates. By defining the number of participants a priori through established statistical methods, we aimed to uphold the methodological rigor of our study, ensuring that the obtained results are both reliable and generalizable to the broader population under investigation.

The initial pull of participants was composed of 122 technical high school students from the federal institute of São Paulo (IFPB) in Brazil, all native speakers of Brazilian Portuguese. All Participants signed the informed consent form. As this was a study involving minors, the subject teacher was responsible for carrying out the study. Following the response collection period, we obtained 122 total answers. Five of the answers were deemed invalid (because an incorrect response was provided in the "attention-check" item), and the other seven were disregarded because they did not indicate male or female gender, since the aim of the study is to find evidence of different effects between individuals with these self-declared genders. As a result, the sample analyzed presented 110 responses. Participants are aged between 15 and 19 years old. The average age of the participants is 16.73, with a standard deviation of 0.95 and a variance of 0.90. 42 self-declared female students and 68 self-declared male students participated in the study.

To conduct the analysis, we used SEM, a powerful statistical technique used to analyze complex relationships between observed and latent variables within a comprehensive theoretical framework. SEM allows us to simultaneously examine multiple variables and their interrelationships, including both observed variables (participants' gender) and latent constructs (gameful experience dimensions). SEM allows for the inclusion of measurement error, providing more accurate estimates of model parameters. Thus, SEM offers a robust and flexible framework for analyzing the complex dynamics of gamification effects within a gender-specific context [63]–[65].

IV. Results

In this section, we present the results of our study, starting with the descriptive results and then presenting results later to the SEM. Initially, we measured the descriptive statistics (Mean, the standard deviation, and the data variances in each sub-questionnaire), the internal reliability analyses (Cronbach's α and McDonald's ω), and the factor correlation coefficients. Each GAMEFULQUEST sub-questionnaire has between 7 and 9 items, rated on a 7-point Likert scale. That way, the minimum value a sub-questionnaire can be is 7 and the maximum value a sub-questionnaire can be is 63. The internal reliability of each dimension of the adapted instrument was assessed using Cronbach's α and McDonalds ω coefficients. The analysis reported satisfactory fit indices, indicating that the model is correct. The results (presented in the Table I) indicate high levels of internal consistency across all dimensions.

TABLE I
INTERNAL RELIABILITY OF EACH DIMENSION

Dimension	α	ω	**M**	**Var**	**SD**
Accomplishment	.884	.884	40.72	67.819	8.235
Challenge	.898	.896	38.46	93.554	9.672
Competition	.920	.921	33.00	110.073	10.492
Guided	.927	.927	34.25	81.403	9.022
Immersion	.902	.902	29.83	141.814	11.909
Playfulness	.910	.907	39.91	127.221	11.279
Social Experience	.938	.939	29.70	135.955	11.660

Key: α: Cronbach's α; ω: McDonald's ω; M: mean; Var: Variance; SD: Standard deviation.

Next, we analyze the effects of gamification implemented in Duolingo in each dimension of the gameful experience according to participants' gender. The results indicate that the impact of gender on the dimensions of the gameful experience proved to be low, not showing considerable significance. None of the p-values are less than 0.05, indicating that none of

the coefficients are not statistically significant. Finally, as a complement, we also analyzed R^2 of the effects. R^2 measures the internal predictive power (*i.e.*, within the sample itself). The results indicate that the predictive power is low in all dimensions. Figure 3 presents the study' path model, Table II presents the Regression coefficients, and Table III present the R^2 results.

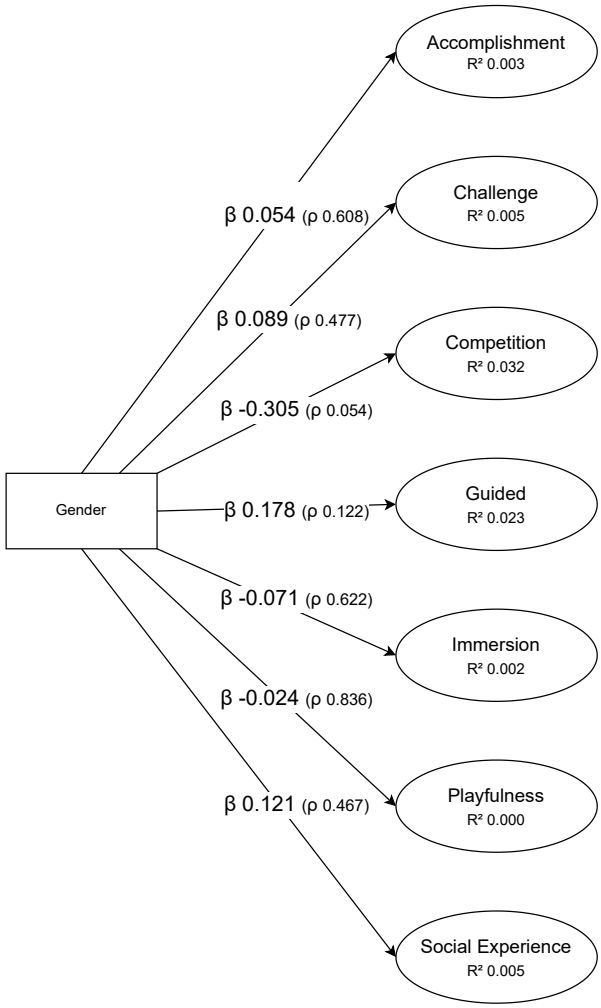

Fig. 3. Path model

In summary, the results indicate that the student's gender does not affect any of the gameful experience dimensions when using the Duolingo gamified platform considering the study parameters.

A. Discussion

Based on the lack of knowledge about how gender will affect students' gameful experience, in this study, we analyzed the impact of gamification on students' gameful experiences

TABLE II
REGRESSION COEFFICIENTS

					95% CI	
	β	**SE**	z	p	**Lower**	**Upper**
G → ACC	0.054	0.105	0.513	0.608	-0.152	0.260
G → CH	0.089	0.125	0.711	0.477	-0.156	0.334
G → CP	-0.305	0.158	-1929	0.054	-0.615	0.005
G → GD	0.178	0.115	1548	0.122	-0.047	0.404
G → IM	-0.071	0.143	-0.493	0.622	-0.351	0.210
G → PF	-0.024	0.117	-0.207	0.836	-0.253	0.205
G → SXP	0.121	0.166	0.728	0.467	-0.205	0.447

Key: G: gender; ACC: Accomplishment; CH: Challenge CP: Competition; GD: Guided; IM: Immersion; PF: Playfulness; SXP: Social Experience; SE: Std. Error; CI: Confidence interval.

TABLE III
R-SQUARED

	R^2
ACC	0.003
CH	0.005
CP	0.032
GD	0.023
IM	0.002
PF	0.000
SE	0.005

Key: ACC: Accomplishment; CH: Challenge CP: Competition; GD: Guided; IM: Immersion; PF: Playfulness; SE: Social Experience.

(*i.e.*, accomplishment, challenge, competition, guided, immersion, playfulness, and social experience) according to their self-declared gender. We carried out a quasi-experimental study organized in three steps, that involved group comparisons without random assignment. We asked technology students to spend at least 20 minutes using the gamified Duolingo program in the first stage. The GAMEFULQUEST, a scale with 56 items spread over seven dimensions, was administered to players in the second step as a means of gauging their gaming experience on the platform. Following ethical guidelines, we provided the following gender-specific answers to a demographic questionnaire: "male", "female", "non-binary" and "I prefer to not disclose". In the third phase, we used SEM to analyze the data. After analyzing the results (see Table II), the impact of gender on the students' gameful experience dimensions was not significant. Likewise, the estimate of the relationship between gender and the dimensions was low, with small variations in the dimensions of competition, immersion, and playfulness.

The study elucidates the absence of statistically significant gender differentials in students' experiential gameful experiences within the Duolingo platform. This revelation underscores the universality of appeal inherent in gamified pedagogical strategies, negating presumptive gender-specific predilections. Consequently, it highlights the pedagogical potential of gamification to foster an inclusive learning environment conducive to the diverse demographic spectra of contemporary educational cohorts.

Foregrounding the insignificance of gender as a determinant variable in students' gameful experiences, the study

augurs substantive ramifications for the iterative refinement of educational technology platforms, particularly those imbued with gamification attributes. By elucidating the universalizing tendencies of gamified features, developers are impelled toward the conceptualization and realization of versatile instructional interfaces, capable of accommodating heterogeneous learner cohorts. This presages a paradigmatic shift toward the conception of customizable pedagogical modalities, affording maximal adaptability and inclusivity.

While gender emerges as a non-significant variable, the research portends fertile prospects for the advent of personalized pedagogical configurations within gamified educational environments. By prospectively discerning alternative factors or variables operative in shaping students' gameful engagements, educators are encouraged to adopt bespoke instructional approaches attuned to learners' idiosyncratic predilections, proclivities, and cognitive exigencies. This heralds a salient epoch characterized by the fusion of data-driven insights and adaptive instructional methodologies, precipitating augmented learner outcomes and experiential enrichment.

The study's revelations precipitate a cascade of prospective inquiries on the nuanced interplay between gamification, gender dynamics, and educational efficacy. Future scholarly endeavors may pivot upon the elucidation of additional demographic parameters, such as age cohorts or socio-cultural contingencies, and their correlative influences on students' gamified learning experiences. Furthermore, longitudinal inquiries and cross-cultural comparisons are posited to furnish granular insights into the enduring impact and contextual variability of gamified pedagogical interventions across disparate educational landscapes.

B. Threats to validate and limitations

This study faces threats to validate and limitations (most of them inherent to the characteristics of the study) that we aimed to address throughout the research process. Initially, because participants were not randomly assigned to groups, inherent differences between the groups (*i.e.*, males and females) could potentially bias the results. For instance, students who volunteered to use Duolingo might exhibit different motivations or characteristics. Another point of limitation found was the inability to maintain more detailed control over the interaction of participants with the Duolingo platform. Despite the guidance to answer the questionnaire only after at least 20 minutes of using the platform, it proved impossible to effectively monitor whether this rule was followed to the letter.

Given the quasi-experimental nature of our study, external events or changes over time may have influenced participants' experiences with the gamified platform and their responses to the GAMEFULQUEST scale. These factors could confound the study results. Additionally, changes in participants' characteristics or behaviors over time (such as increased familiarity with the platform) might impact their gameful experience scores independently of the gamification intervention.

The reliability and validity of the GAMEFULQUEST scale may affect measurement accuracy. Inconsistent interpretation or response biases could also influence the study outcomes. Furthermore, participants may have provided responses they perceived as socially desirable, especially regarding sensitive topics like gameful experience and gender identity. We mitigate these threats using an instrument with its psychometric properties previously analyzed and including an attention-check item.

Duolingo's gamification design may vary from user to user, and it is impossible to control factors related to which each user sees gamification elements. Participants' self-identified gender categories may not fully capture the complexity of gender identity. Due to the quasi-experimental design, we cannot confirm causal relationships between gamification and gameful experience. The generalizability of our findings may be limited to technology students or other gamified platforms. The relatively homogeneous demographic composition of our sample (predominantly male participants) further restricts the applicability of the results.

C. Practical implications

The finding that learners' gender did not affect any dimensions of the gameful experience suggests that gamification interventions, such as those implemented in Duolingo, can be equally effective and engaging for both male and female students. This implies that educators can use Duolingo without concerns about gender disparities in gameful experience dimensions, thus promoting inclusivity and equity in educational settings.

The study opens up space for insights into how gamification can affect learners' experience across different variables beyond gender. By demonstrating the gender-neutral effects of gamification on the gameful experience of language learners, our study encourages further exploration of how other factors, such as age, cultural background, or educational level, may influence the effectiveness and perception of gamified learning environments.

V. Concluding Remarks

Our study sheds light on the effects of gamification on the gameful experience of language learners according to their gender. We found no significant differences in the gameful experience dimensions between male and female students using the Duolingo platform. Our findings contribute to education and gamification by providing empirical evidence that supports the inclusivity and efficacy of gamified learning environments. Furthermore, our study opens up avenues for future research to explore the influence of other variables, such as age, cultural background, and educational level, on the effectiveness and perception of gamified learning platforms. By leveraging the insights gained from this study, educators, researchers, and developers can work towards creating more inclusive and effective learning environments that empower learners to thrive. In future studies, we aim to investigate the effects of different demographic variables on the students' gameful experience.

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