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Flow Experience, Performance Expectation and Performance: An LGBTQ+ Diversity Perspective on Gamified Systems

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Abstract

Cis-heteronormative stereotypes in STEM fields are responsible for making minority groups like LGBTQ+ people feel like they don't belong in these areas of science. To identify and analyze the effects of such stereotypes, we carried out a quasi-experiment with N = 70 participants in a gamified system. The results indicate that self-identified cis-heterosexual participants had better flow experiences in environments with stereotypes that disagreed with their sexual orientation. Regarding expected performance, stereotypes not aligned with sexual orientation were harmful. These results reflect the importance of developing socially inclusive educational technologies, with mechanisms that allow customization of the interface to avoid disadvantages of minority groups, and are also relevant to the scientific community as empirical evidence that sexual stereotypes must be taken into account. when designing gamified platforms to avoid negatively impacting individuals.

Keywords: *Education. Gamification. STEM. LGBTQ. Diversity. Computer Science*

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1 Introduction

Cis-heteronormativity is the dominant status in the fields of Science, Technology, Engineering, and Mathematics (STEM). These fields perpetuate the notion that anything that goes against this hegemonic status does not belong (Powell et al., 2020). STEM is a masculine culture (Miller et al., 2021). To comprehend the obstacles faced by minority groups such as Lesbian, Gay, Bisexual, Transgender, Queer and plus (LGBTQ+) in these scenarios, we must examine how oppressive standards are rooted in historical anti-LGBTQ+ policies (Alexander et al., 2022). This implies the need to recognize that LGBTQ+ struggles and history are often disregarded in the scientific community (Maguth & Taylor, 2014). With the COVID-19 pandemic, the popularity of virtual education has increased and promoted the interest in developing efficient tools for online learning (Dwivedi et al., 2020). New educational technology must seek to promote sexual diversity and avoid perpetuating cis-heteronormative stereotypes, especially in the fields of STEM.

Scientific studies have shown that including and amplifying queer voices with interactive technology design can lead to transforming reflections that can benefit game design and gamification (Hantsbarger et al., 2022). Replicating traditional teaching patterns to virtual learning settings may contribute to excluding minority LGBTQ+ groups in predominantly cis-heteronormative spaces. This concern becomes more relevant when considering virtual learning systems' development and gamification. Gamification is defined as using game design elements in non-gaming scenarios and is an approach that can motivate and improve students' learning results (Klock et al., 2020). In these platforms, cis-heteronormative stereotypes may be introduced. This may occur when the platform's design elements, such as exclusively male or female avatars, do not resonate with the LGBTQ+ participants' sexual orientations.

This study aimed to verify whether sexual stereotypes (cis-heteronormative and LGBTQ+ stereotypes) in gamified tutoring systems affect expected performance. The effects of stereotypes on flow state were also investigated. Flow state is a mental disposition sought by educators and educational technologies and consists of a state of complete immersion in a task (Alameda et al., 2022). In this sense, it is relevant to understand the effects of stereotypes in gamified platforms on expected learning performances (Shaw-Zirt et al., 2005), considering that such stereotypes have a negative impact on students (Monterrat et al., 2017).

1.1 Research Objective

Based on the premises indicated in the previous paragraphs, we formulated the following research question: Do sexual stereotypes affect flow experience, performance expectation, and learning performance of LGBTQ+ minority groups in gamified tutoring systems for the teaching of logic? To meet this research objective, we performed a quasi-experimental study, aiming to understand the influence of sexual stereotypes and their relationship with performance expectations of LGBTQ+ students in STEM fields. In a scenario in which technologies are used as innovative teaching methods, it is necessary to understand what are the boundaries of gamified technologies, so that they are positively aligned with better learning and performance of social minorities.

2 Related studies

2.1 Performance expectation and learning performance

The research of Khusaini and Mulya (Khusaini & Mulya, 2021) was aimed at measuring the expectations, gender, quality of learning, and performance of 1,898 students in a bachelor's program in Accountancy at the Muhammadiyah University of Tangerang (UMT) and the Islamic University of Syekh-Yusuf (UNIS). The study showed that expectations did not relate to performance, however, gender played a key role in performance. The analyzed performance variables confirmed that female students did not have perform as well as males, which can influence these students' academic performances, including career choice and learning motivation.

Another study that relates performance expectation to learning is that of Fatmasari et al. (Fatmasari et al., 2018). The participants of this study were 148 students in a bachelor's program of Economics Education at the Terbuka University. The UTAUT was applied to know which factors had an influence on students while using the M-learning technology. The study showed a significant correlation between performance expectation with the use of M-learning and the intention of using M-learning. There was no significant correlation between the intention of using M-learning and the behavior while using it. Thus, this means that using M-learning had a strong influence and correlation with participants' learning.

In the work of kbuga and Havan (Akbuga & Havan, 2021), an adapted instrument to measure performance expectations of students in calculus courses in higher education was proposed. In the study, the Expectancy-Value Theory of Eccles JS Wigfield (Eccles & Wigfield, 1994) was used as a basis to develop the assessment instrument. The findings of validity and reliability tests of this study led to the proposal of an instrument of the Likert type with 12 items comprising three dimensions: performance expectation, utility value, and interest. This instrument was named Calculus Motivation Research. The first round of data collection (research 1) for the instrument comprised 119 students actively enrolled in a summer course. For the second round (research 2), the sample size was of 178 students with active enrollment in the autumn semester. Each participant was invited to fill out the instrument at the beginning of classes. For performance expectation, the subscale was composed of three items and the reliability was Y = 0.91. The results of the study displayed initial evidence of an instrument that may be used by scientists, professionals, and program evaluators to understand three aspects of participants' motivation: performance expectations, interest, and utility value (Akbuga & Havan, 2021). This research could be cross-culturally translated to Brazilian Portuguese and validated, so that it could be applied to other cultures and regional realities.

Aiming to make STEM fields more inclusive, improving learning, expectations, and engagement, NASA launched an equity action plan to make these environments more accessible to all (Administration, Accessed Jan 29, 2025.-b). The plan established the main focus areas that will allow the agency to progress toward more diversity, equity, inclusion, and internal and external accessibility to NASA (Administration, Accessed Jan 29, 2025.-a). The agency will also work to implement improvements to policies and programs that fill gaps and provide more opportunities at NASA, in the aerospace industry, and in STEM fields. This showcases a search to identify and remove barriers that limit opportunities for vulnerable and underrepresented communities in STEM (Administration, Accessed Jan 29, 2025.-b).

2.2 Sexual stereotype threat and its effect on performance expectation

Education is a field in which differences are aggravated, this may be hard to perceive without exercising perception (Ribeiro, 2011). Differences between genders and people of different sexual orientations are evident in STEM fields, such as in computer sciences programs, but are also within programs such as nursing and languages (Hughes & Kothari, 2023). It is easy to picture in which of these programs there are likely more males than females. Aspects such as stereotypes are strongly related to this inquiry, as a consequence, when minorities are not aligned with what their university program conventionally reflects regarding gender or sexual orientation, the feeling of belonging lessens, leading to evasion (Hughes & Kothari, 2023). It is worth highlighting that other aspects, such as race, when added to the sexual orientation factor, may aggravate even further the feeling of not belonging to these environments (Rainey et al., 2018).

The work of Powell et al. (Powell et al., 2020) demonstrates in detail the realities of six LGBTQ+ scientists in STEM fields, the effects of stereotypes in their careers, the fight against prejudice, how colleagues can be allies, and what policies institutions should adopt to make workspaces more inclusive. However, some gaps were left in relation to these studies, such as what institutions have agendas against racism and homophobia, as well as the incentive for social inclusion in the academic and ethical regiments. Also, in some cases, it is worth questioning whether these policies are actually implemented or only described in ethics regiments for the inclusion of minority groups within STEM fields? The work mentioned approached only a limited amount of people and focused on the environments of scientists and post-graduation students within STEM. As to high school and undergraduate students within STEM, what is the perspective for minority groups? Exercising perception may help to understand that social, sexual, and racial segregation in fact exceeds traditional barriers within STEM fields. Cech and Waidzunas (Cech & Waidzunas, 2021) asked whether female cisgender and LGBTQ+ professionals face parallel experiences of disadvantage in STEM. With data of 21 professional associations (N = 25.324; NLGBTQ+ = 1006), it was seen that female professionals were more likely to suffer career limitations, harassment, and professional depreciation. In the study, LGBTQ+ people reported more frequent health issues, as well as higher probability of evasion. These trends were similar in all disciplines and labor sectors of STEM. However, some limitations of the study were found. Regarding disciplines, the study did not cover all sub-disciplines of STEM or interdisciplinary communities. Are minorities in interdisciplinary scenarios within STEM more affected by stigmatized environments? Regarding the labor variable, the research did not include precise income measures or detailed histories of career advances, therefore, it is not possible to track disparities for LGBTQ+ people in regards to payment or promotions. Considering this gap, we may ask: do LGBTQ+ groups have the same chances for promotion and equal salaries as heterosexuals?

Pachankis and Bränström (Pachankis & Bränström, 2019) used the largest known set of data regarding men and women of minority groups in the world: the European Union's research on Lesbians, Gays, Bisexuals, and Transgenders (EU-LGBTQ+). The research comprises metrics such as quality of life, gender disparity, and religiousness, calculated by the United Nations Development Programme (UNDP), and found that 83% of sexual minorities worldwide hide their sexual orientation from all or most people. Thus, this countrywide structural stigma may be used as a useful indicator of the size of the non-declared minority population of each country. Even though the work inferred this generalized global in-the-closet estimation, specific data collection per degree of education could have been parameterized, which leads to the question: how many

social minorities such as LGBTQ+ are a part of this global closet considering education degree or STEM disciplines? Understanding in detail these gaps allow verifying which sector urgently requires intervention from policies aimed at the inclusion of minority groups.

In STEM environments, the stereotype that men are better than women at mathematics is present, while an additional stereotype suggests that women are better than men in English (Rosenthal et al., 2007). Within this context, Rosenthal et al., (Rosenthal et al., 2007) conducted a study to analyze performance expectations in mathematics and English tests within an intervention designed to reduce stereotype threat. The research predicted that students under stereotype threat would have lower performance expectations. Nevertheless, it was also predicted that such an effect could be reduced by giving participants the task of indicating characteristics shared by men and women regarding career choice. The experiment had 240 participants, with N = 120 men and N = 120 women, who were randomly assigned to three experimental test settings: experience 1, considered as the intervention group, comprised characteristics shared by men and women, experiences 2 and 3 comprised non-shared characteristics and were considered as the control group.

Female participants assigned to experience 1, namely, the shared characterstics setting, had less stereotyped career choices and also obtained more correct answers in the mathematics test compared to females in the control group, namely, experiences 2 and 3. Concerning the mathematics test, female participants had generally lower performance expectations, M = 61.64, while male participants had M = 69.25. However, since the experiment consisted of generating shared characteristics, female participants who had academic characteristic shared between genders improved their performance expectations. However, when confronted with stereotype threat, these participants had lower performance expectations.

In the study of Cadinu et al. (Cadinu et al., 2003), a few hypotheses of underlying processes that may cause stereotype threat for minorities were raised. In brief, it was seen that anxiety may play a role in stereotype threat and split attention was a hypothesis, that is, cognitive resources while executing a task may be split between the task's demands and the worry about reaffirming the stereotype. The concern with evaluation and change may entail excessive care while performing the task, which may decrease performance. Lack of motivation and effort were also considered underlying processes. Minorities may not identify themselves with the relevant performance domain. Another potential stereotype threat mechanism is the individual's expectation level concerning his performance. Stereotype threat may decrease performance expectations, which, in its turn, may lead to inferior performance. This last underlying process is the focus of the present study.

Stereotypes are not entirely linked to gender or sexual orientation, which may be related to race, religion, ethnicity, among other social aspects. The influence of stereotypes may even be found according to age, in relation to memory. In the work of Hess et al (Hess et al., 2009), with the aim of understanding influences based on stereotypes and memory performance among older people, participants of age 60 or more were tested with the use of a memory task. The threat was manipulated with the use of a relatively simple procedure. The condition in which participants knew the test was being used to examine the effects of old age on memory was classified as the threat condition. Three primary factors were investigated: first, whether threats had a stronger impact on the performance of the younger half of the sample compared to the older portion; secondly, identifying whether the people who believed they or people of their group were being stigmatized would be more susceptible to threat; and third, noting whether an elevated conscience

and education on stereotypes regarding the aging process and memory could increase awareness of signals related to threat in the environment. The study's sample included 103 adults ranging from: young older people of 60 to 70 years of age, and older people of 71 to 82 years of age. As the main findings, it was seen that threat only affected performance among the young older people, while the impact of elevated conscience and education on stereotypes was stronger among older participants. Thus, the impact of stigmas and stereotypes was mostly seen within the sample of people with higher education levels.

Appel et al. (Appel et al., 2011) evaluated whether stereotypes also interfere with preparation for tests among women in STEM fields, which was done by conducting four studies. In study 1, stereotypes regarding women who prepare for exams of STEM fields were assessed. Study 2 predicted that stereotype threat would result in lower grades. Study 3 replicated and extended the grade results obtained in study 2, taking into account individual differences in the identification of the dominant group. Study 4 assessed grades of domains other than STEM. The results of study 1 confirmed the assumption that gender stereotypes directly influence the preparation for STEM exams. Study 2 showed that groups under stereotype threat had inferior grades. In study 3, it was assumed that the group under stereotype threat would have lower grades compared to participants in the control conditions and the results were consistent with the hypotheses. Lastly, in study 4 the same analyses conducted in the previous studies were done, but now with participants outside of STEM fields. The results were similar with those of the previous studies and indicated that social minorities tended to obtain lower scores in tests and that women tended to get lower grades within STEM.

Stereotyped settings do not have to highlight stereotypes by using stereotyped objects, images, or even words or phrases. We could call those flagrant or active stereotypes. Stereotyped environments may carry subtle stigmas, without necessarily showcasing the stereotypes. However, socio-psychological cognition leads to the understanding that the given setting is stigmatized and that non-dominant groups could be under stereotype threat (Stone & McWhinnie, 2008). In the work of Stone and McWhinnie (Stone & McWhinnie, 2008), it was indicated that subtle and flagrant stereotypes, when combined, may have an even greater negative effect. To verify the occurrence of this phenomenon, 110 undergraduate students from the University of Arizona were randomly selected. For manipulating flagrant stereotypes, participants were first instructed to read a booklet that described athletic abilities correlated with natural athletic ability. Thus, flagrantly imposing the stereotype that the abilities of athletes are more related to a person's natural capability of being a great shooter, having hand-eye coordination, throwing or hitting. Also, participants were exposed to stereotyped phrases that affirmed the existence of gender differences regarding performance in sports. For the manipulation of subtle stereotypes, a test was applied to verify participants' results in a golf match. The data suggested that flagrant and subtle stigmas induce a focus orientation in which the participants become more conservative in their approach to performing tasks. Also, it was seen that when both are present, this difference is even higher. The work concluded that sports, such as STEM fields, have a long history of conveying the message that women are less capable than men.

The study of Sekaquaptewa and Thompson (Sekaquaptewa & Thompson, 2003) consisted of an important investigation on women's expectations when they are the only female in the workplace, which is named solo status. A rising number of women are entering traditionally male-dominated fields, in this context, recent works on the solo status indicate that being the only

member of a gender within a group is an experience that is lived differently by men and women. To verify this prediction, a sample of 157 white students of an introductory psychology course were selected, out of which 77 were men and 80 were women. The experiment assessed participants according to the following classifications: solo and non-solo vs stereotype threat and no stereotype threat vs participants' genders. The results of the study showed that the solo status may harm women's performances even when gender stereotypes are irrelevant for performance. Women in the solo status developed lower performance expectations and this led to bad performance compared to non-solo men and women.

2.3 Stereotype threat in Gamification

Stereotyped elements in gamification may influence people's performances within these platforms. Gamification is being used as an alternative to teaching and has been attracting the interest of scientists on the effects of its use within education. The work of (Albuquerque et al., 2017) investigates whether gender stereotype threat in online gamified educational scenarios influences anxiety and performance. Similarly to our work, (Albuquerque et al., 2017) seeks to understand the impact of stereotype threat within a gamified setting. However, the study does not comprise performance expectation, also, it does not relate to sexual orientation or gender identity. Thus, this calls for a need for a thorough examination of these studies while taking into account social minorities. In the same study, it was seen that anxiety levels changed depending on gender and stereotyped setting. Changes in anxiety were higher among females who were under male stereotype threat.

2.4 Gamification and flow experience

The research of (Silva et al., 2019) adopts flow theory, which describes a state in which an activity is so pleasant that people perform it even if it comes at a great expense, as described by (Csikszentmihalyi & Csikszentmihalyi, 1992). In this theory, appreciation is an affective state between anxiety, boredom, and flow. While concentration is described as the challenge level and the user's skill level demanded by the activity (Ghani & Deshpande, 1994). Hence, optimal flow is situated between the states of anxiety and boredom. To determine whether gamified resources carry characteristics that increase flow experience and performance, (Silva et al., 2019) selected a random sample of accounting (N = 816) and marketing students (N = 195). A structural equation model was applied and used to analyze the direct effects of game elements on students' learning flow. The results show that, except for the resources of gamified feedback, all other dimensions were flow predictors. Moreover, by introducing games to the curriculum, motivation and interest increased, showing that games may be an effective way to learn.

3 Method

This quasi-experiment was performed to answer the research question: "do sexual stereotypes (cis-heteronormative and LGBTQ+ stereotypes) impact flow experience, expected performance, and performance in gamified tutoring systems?" With this intent, we formulated the following null hypotheses:

- H1: There is no significant difference in the flow state of participants according to their sexual orientation (cis-heterosexual and LGBTQ+) and environments with cis-heteronormative stereotypes (not.LGBTQ+) and LGBTQ+ stereotypes (stLGBTQ+);
- H2: There is no significant difference in the expected performance of participants according to their sexual orientation (cis-heterosexual and LGBT+) and environments with cis-heteronormative stereotypes (not.LGBTQ+) and LGBTQ+ stereotypes (stLGBTQ+);
- H3:There is no significant difference in the performance of participants according to their sexual orientation (cis-heterosexual and LGBT+) and environments with cis-heteronormative stereotypes (not.LGBTQ+) and LGBTQ+ stereotypes (stLGBTQ+).

3.1 Research Design

The study used a 2x2 factorial design with two conditions and two factors per condition. The factors are a gamified interface with LGBTQ+ stereotypes (stLGBTQ+) and a gamified interface with cis-heteronormative stereotypes (non.LGBTQ+). The participants were assigned to one of two conditions: the LGBTQ+ intervention group or the control heterosexual group. The LGBTQ+ and heterosexual conditions were associated with the type of interface factor: stLBTQ+ (intervention) and non.LGBTQ+ (control). The gamified tutoring system randomly assigned each participant to one of two factors: LGBTQ+ stereotype (stLGBTQ+) or heterosexual (non.LGBTQ+). In figure 1, the experiment's execution flow is seen. We used a web-based system that required only a link to access. After receiving the link to the experiment, the participant was asked to sign the free and informed consent term (TCLE), which the ethics committee requires for research with human beings. By agreeing to participate in the research, the participant was redirected to the pre-test phase, which consisted of answering the DFS-Short BR (dfs) and the sexual diversity questionnaires. Then, each participant was randomly redirected to one of the two interfaces (stLGBTQ+ or non.LGBTQ+). At this point, the exposure to stereotyped gamified elements began. The user was required to choose an avatar to move forward to the quiz, which was composed of 20 logic/mathematics questions. By finishing the quiz, the participant was directed to the post-test phase, which consisted of answering the FSS-2 (fss) and the socioeconomic questionnaire. No time limit was set for the completion of the questionnaires.

The control interface (non.LGBTQ+) had elements with heterosexual stereotypes, such as cis-heteronormative avatars. While the intervention interface (stLGBTQ+) was composed of LGBTQ+ stereotypes, such as avatars associated with sexual diversity. The control setting also presented stereotyped boost phrases, colors, sound effects, and bar graphs to convey the message that heterosexuals have better performances in logic/mathematics activities. As for the intervention setting, the stereotypes conveyed the feeling of sexual diversity and affirmed that LGBTQ+ groups perform better in logic/mathematics activities. The choice of these stereotypes was intentional and based on the literature Male-stereotyped posters and figures, such as Star Wars or Star Trek, and stereotyped colors, such as blue and gray, are traditional within STEM environments (Ferraz & Gama, 2019). Considering this, the control interface was designed based on social assumptions and perceptions prevalent within the STEM fields. As for the LGBTQ+ interface, it was conceived to include a broad array of sexual stereotypes.

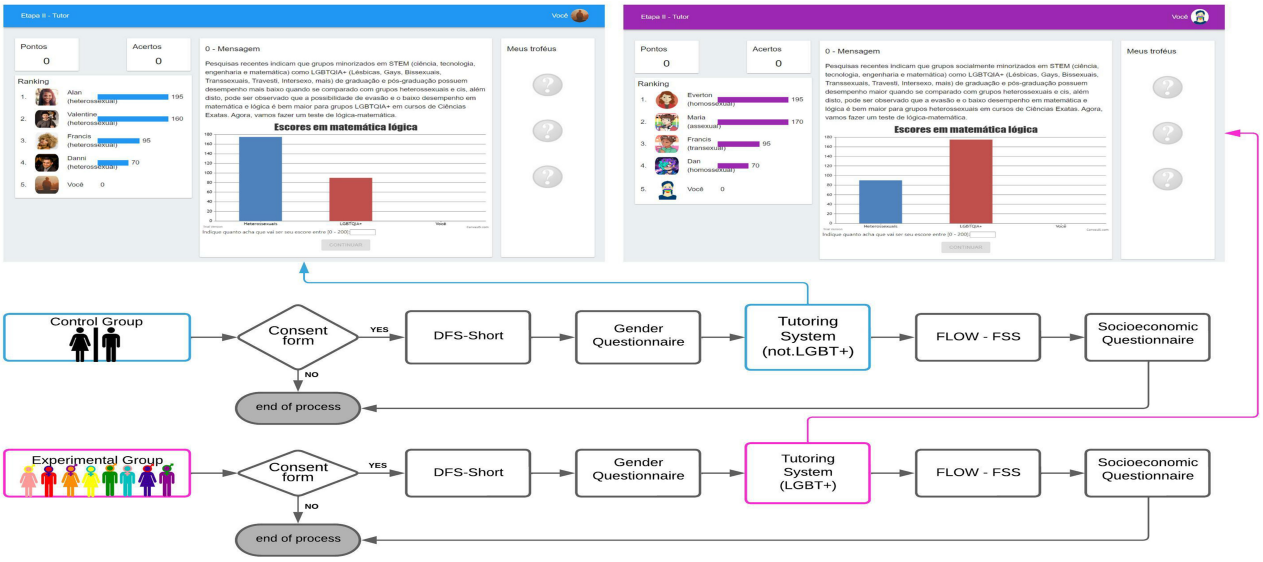

Figure 1: Study design and data collection procedures.

3.2 Participants and context of the study

The participants were 70 undergraduate and postgraduate students from STEM fields at the Federal University of Alagoas (UFAL) in the Maceió campus in Alagoas, Brazil. Regarding gender, 74.28% (n = 52) of participants were men, and 25.72% (n=18) were women. Concerning sexual orientation, 80.28% (n = 57) were heterosexual, 5.64% (n = 4) were homosexual, 11.26% (n = 8) were bisexual, 1.41% (n = 1) were asexual, and 1.41% (n= 1) were pansexual. As for gender identity, 71.84% (n = 51) were cisgender men, 18.31% (n = 13) were cisgender women, and 9.85% (n = 7) did not answer. In relation to ethnicity, 45.07% (n = 32) of participants self-declared as Brown, 38.02% (n = 27) self-declared as White, 11.26% (n = 8) self-declared as Black, and 5.65% (n = 4) chose not to answer. Brown is a term used by the Brazilian Institute of Geography and Statistics (IBGE) that refers to one of the five racial groups that make up the Brazilian population: White, Black, Asian, Indigenous, and Brown (de Geografia e Estatística, Accessed Jan 29, 2025).

3.3 Data Collection and Analysis

We used the translated and validated Brazilian Portuguese versions of the DFSBR and FSS-BR. The version translated to Brazilian Portuguese uses a five-point Likert scale, ranging from 1 (never) to 5 (always). Developed and validated a nine-question short version of the original DFS-2, translated into Brazilian Portuguese (Bittencourt et al., 2021) (Jackson et al., 2008). In this study, we used the DFS-Short-BR version to optimize our experiment's execution.

The degree of expected performance was based on the work of Cadinu et al. (Cadinu et al., 2003). The expected performance assessment consisted of asking the student a previous estimation of how they would perform in the test, which could range from 0 to 200. The tutoring system was controlled to ensure participants were assigned to the interfaces according to their sexual orientations. The goal was to predict whether negative or positive information could affect

expected performance. The performance estimations made by participants were used to measure the expected performance deficit. Learning performance was measured with the number of points obtained using the platform. For each correct answer, 10 points were added to the participant's score. This scoring system allowed for checking participants' performances in the experiment and comparing the two types of interfaces. The participants had no knowledge of the existence of two types of settings. Thus, the study consisted of a single-blinded experiment and participation was voluntary. Due to the lack of knowledge as to who was performing the task, we also expected the absence of interactions between students within the two different settings. The experiment was approved by the human research ethics committee.

4 Findings

Table 1 presents the descriptive statistics and estimated marginal means (adjusted) for dispositional flow (dfs) and flow scale (fss), for expected performance and performances grouped according to sexual orientation (heterosexual versus LGBTQ+), and for setting type. The control environment was the non.LGBTQ+ (with heterosexual stereotypes), while the intervention setting was the stLGBTQ+ (with LGBTQ+ stereotypes).

Table 1: Descriptive statistics of student flow status, expected performance, and learning performance based on sexual orientation.

		DFS (before)			FSS (after)		Expected performance			Activity Points		
stType	**Orientation**	**N**	**M**	**SE**	**M**	**SE**	**N**	**M**	**SE**	**N**	**M**	**SE**
stLGBTQ+	LGBTQ+	9	3.452	0.192 3	3.656	0.244	9	118.444	9.149	9	127.222	17.836
	non.LGBTQ+	22	3.518	0.124	4.161	0.112	22	102.414	5.852	22	152.955	4.170
stHetero	LGBTQ+	8	3.764	0.142	4.107	0.159	8	123.719	9.704	8	118.125	16.901
	non.LGBTQ+	31	3.466	0.134	3.754	0.106	31	123.258	4.930	31	133.387	6.985

Table 2 ndicates the ANCOVA test results for flow experience and the ANOVA test results for expected performance and performance. The tests were conducted to assess whether there was a significant difference between participants in the stLGBTQ+ setting and participants in the non.LGBTQ+ one.

Table 2: Descriptive statistics of student flow state, expected performance, and learning performance based on environment stereotypes setting.

	DFS (before)			FSS (after)		Expected performance			Activity Points		
Condition	**N**	**M**	**SE**	**M**	**SE**	**N**	**M**	**SE**	**N**	**M**	**SE**
stThreat	30	3.566	0.102	4.077	0.099	21	107.810	6.183	30	143.667	6.990
stBoost	40	3.464	0.088	3.732	0.101	39	124.821	4.537	40	132.000	6.054

Figure 2 present the graphs of the ANCOVA test conducted to assess whether there was a significant difference in participants' flow experiences according to sexual orientation and type of gamified setting. There was a significant difference in participants' flow experiences according to sexual orientation.

Figure 3 presents the graphs for the ANOVA test conducted to assess whether there was a significant difference in participants' performance expectations according to sexual orientation and setting (not.LGBTQ+ versus stLGBTQ+). There was a significant difference in participants' performance expectations according to sexual orientation.

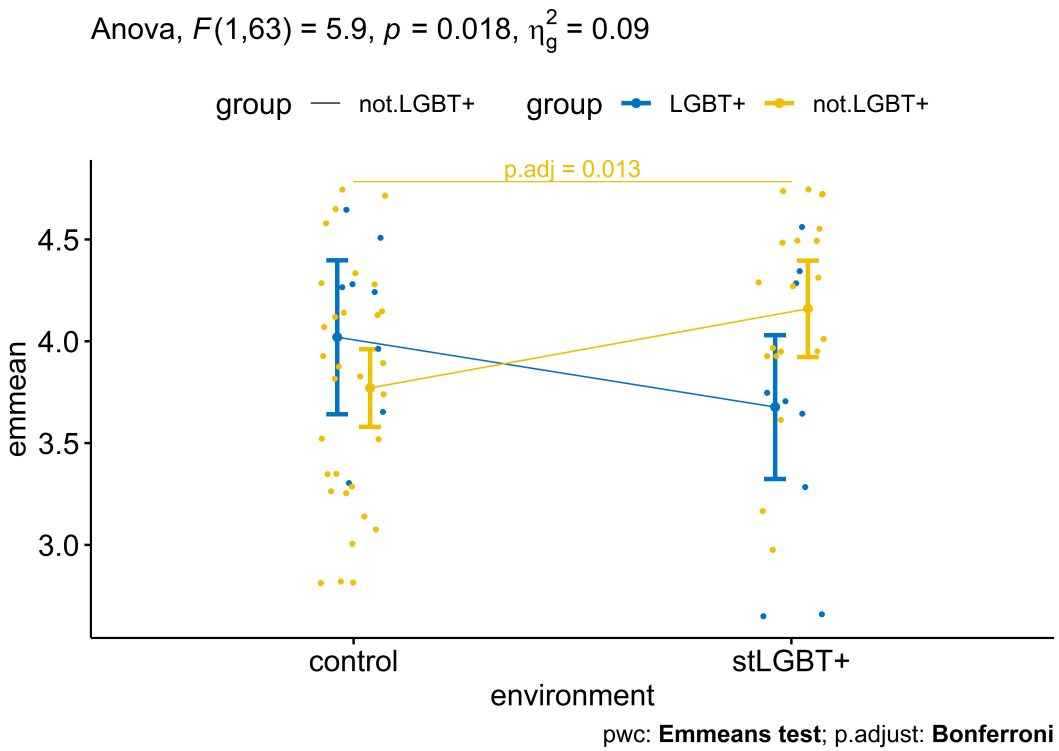

Figure 2: ANCOVA graphs for participants' flow state according to sexual orientation.

Figure 4 present the graphs for the ANOVA test conducted to assess whether there was a significant difference in participants' performances or learning according to sexual orientation and type of gamified setting. As mentioned, the test indicated no statistically significant effects. For hypothesis 1 according to the tables 1 and 2, after controlling the linearity of the "dfs" covariate, we performed ANCOVA tests with the independent between-subjects "setting"(non.LGBTQ+ and stLGBTQ+) and "group" (LGBTQ+ and heterosexual) variables to determine if there were statistically significant differences in the dependent "fss" variable. For the dependent "fss" variable, there were statistically significant effects in the "dfs" factor (F(1.63)=11.318, p=0.001, ges=0.152 [effect size]) and in the interaction between factors "setting:group" (F(1.63)=5.898, p=0.018, ges=0.086 [effect size]). Paired comparisons using Estimated Marginal Means (EMMs) were computed to find statistically significant differences between groups defined by the independent variables. The p-values were adjusted through the "bonferroni" method. For the dependent variable "fss", the mean for the setting="not.LGBTQ+" (adj M=3.771 and SD=0.589) was significantly different compared to the mean for setting="stLGBTQ+" (adj M=4.16; SD=0.502; p-adj=0.013). The mean for group="LGBTQ+" (adj M=3.677 and SD=0.731) was significantly different compared to the mean for group="not.LGBTQ+" (adj M=4.16; SD=0.502; p-adj=0.027).

For hypothesis 2 according to the tables 1 and 2, we conducted ANOVA tests with the independent between-subjects variables "setting" (non.LGBTQ+ and stLGBTQ+) and "group" (LGBTQ+ and heterosexual) to determine whether there were statistically significant differences in the dependent "expected performance" variable. For the dependent "expected performance" variable, we found statistically significant effects for the "setting" factor (F(1,66)=6,552; p=0,013; ges=0,09 [effect size]). Paired comparisons using Estimated Marginal Means (EMMs) were com-

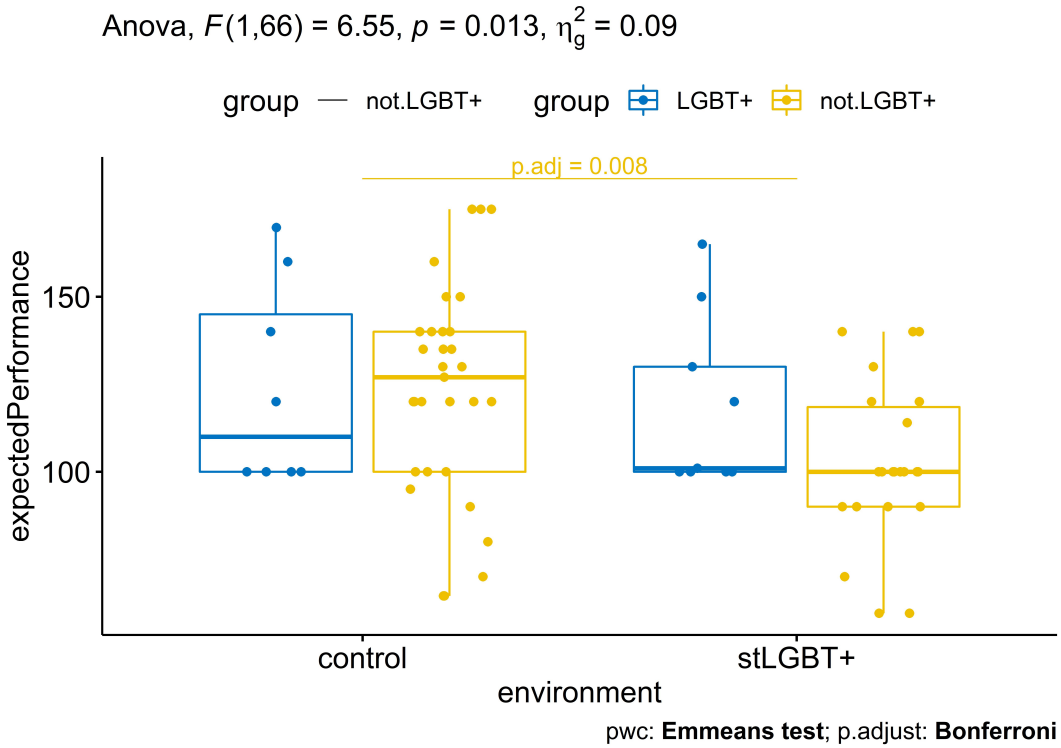

Figure 3: ANOVA graph for participants' performance expectations according to sexual orientation.

puted to find statistically significant differences between groups defined by the independent variables. The p-values were adjusted through the "bonferroni" method. For the dependent "expected performance" variable, the mean for setting= "not.LGBTQ+" (adj M=123.258 and SD=30.362) was significantly different from the mean for setting= "stLGBTQ+" (adj M=102.414; SD=23.032; p-adj=0.008). For hypothesis 3 according to the tables 1 and 2, the ANOVA tests with the independent between-subjects "setting" (not.LGBTQ+ e stLGBTQ+) and "group" (LGBTQ+ and heterosexual) variables were performed to determine whether there were statistically significant differences for the dependent "points" variable. There were no statistically significant effects for the dependent "points" variable. These test results indicate no statistically significant effects for the "orientation" factor (F(1,66)=6,932; p=0,056; ges=0,105 [effect size]).

5 Discussion

In this quasi-experimental study, we addressed flow experience, performance expectation, and learning performance of LGBTQ+ minorities in STEM fields. As the main findings, we found significant influence of stereotypes on flow experience and performance expectation. However, significant differences in performance were not identified.

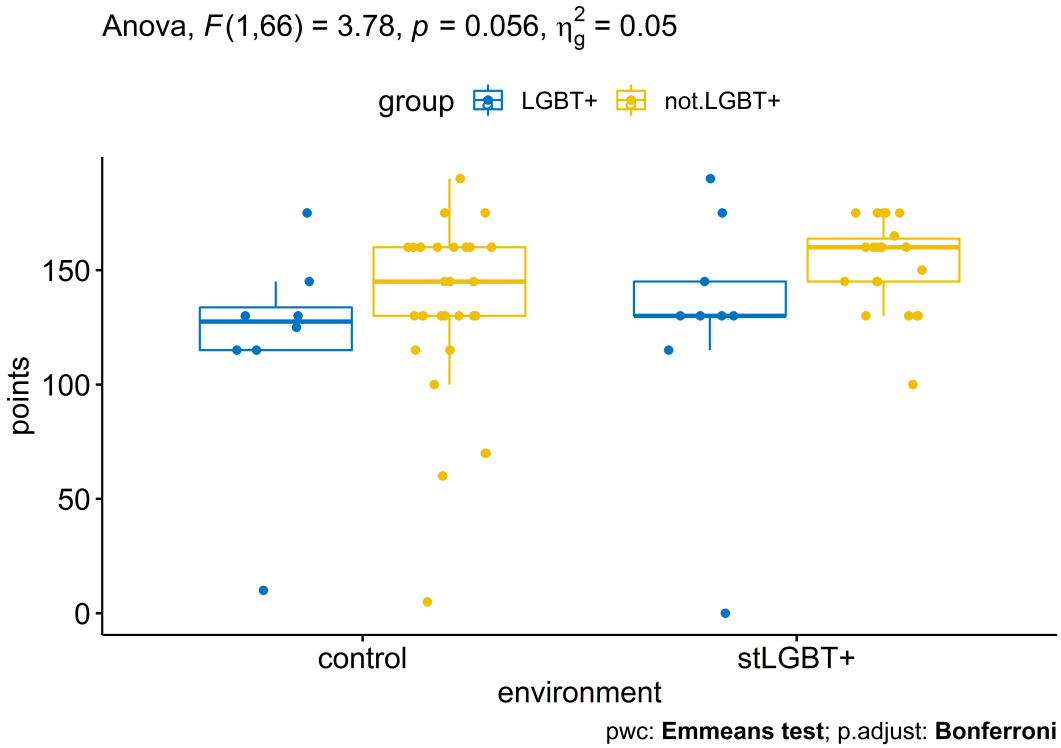

Figure 4: ANOVA graph for activityPoints obtained by participants according to sexual orientations.

5.1 H1: Flow experience per sexual orientation and gamified settings

The study of Albuquerque et al.(Albuquerque et al., 2017) revealed that gender or sexual orientation stigmas may lead to anxiety when stereotypes are not aligned with the individual's gender, also causing lower flow experience. Flow experience is understood as the mental state in which individuals find themselves in a setting in which the challenge proposed is proportional to their abilities to perform the task. It is a state of excellence, characterized by high levels of motivation, concentration, energy, and performance, that is why it is also called maximum or optimal experience (Mirvis & Csikszentmihalyi, 1990). It is possible that when under stereotype threat, participants refuted the stereotyped setting, resulting in a higher immersion in the system. However, self-declared heterosexuals had a higher flow variation when under threat compared to LGBTQ+ participants. Based on the literature, we assume this may reflect the "global closet" (Pachankis & Bränström, 2019). When in a stereotypethreat environment, self-declared heterosexual participants could, in fact, have been in a setting that corresponded to their sexual orientation, despite having concealed it. The similar variations in flow state within the non.LGBTQ+ among heterosexuals and LGBTQ+ participants obtained in the study support this assumption. In the stLGBTQ+ setting, the variation in flow levels was higher for self-declared heterosexuals. Thus, null hypothesis H1 was rejected.

5.2 H2: Expected performance per sexual orientation and gamified setting

The LGBTQ+ and the heterosexual groups, when in a setting aligned with their sexual orientation, had higher performance expectations rates. However, when in an environment in disagreement with their sexual orientation, both groups obtained lower expected performance rates. Nevertheless, the variations in mean expected performance for LGBTQ+ groups were lower in both conditions (boost and threat), but were higher in a setting in agreement with their sexual orientation, which reinforces the importance of inclusive gamified environments. Hence, we concluded that the null hypothesis H2 was rejected. The LGBTQ+ and the heterosexual groups, when in a setting aligned with their sexual orientation, had higher performance expectations rates. However, when in an environment in disagreement with their sexual orientation, both groups obtained lower expected performance rates. Nevertheless, the variations in mean expected performance for LGBTQ+ groups were lower in both conditions (boost and threat), but were higher in a setting in agreement with their sexual orientation, which reinforces the importance of inclusive gamified environments. Hence, we concluded that the null hypothesis H2 was rejected. Hypothesis 2 was rejected through the observation of significant differences in performance expectation per sexual orientation and stereotyped setting. Individuals who identified as LGBTQ+, when in settings aligned with their sexual orientation, had better performance expectations. However, when these individuals were in the setting opposed to their sexual orientation, performance expectations were lower. These results were equivalent to the ones concerning the heterosexual control group. Such findings corroborate with the literature on stereotypes and performance expectation, which states that individuals under stereotype threat tend to present lower performance expectation and, consequently, lower performance (Albuquerque et al., 2017).

Results concerning the gamified setting's stereotypes indicate that these can have a greater impact on self-declared heterosexual individuals compared to LGBTQ+ individuals, which may suggest that the latter deal with heterosexual patterns more often. The variation of performance expectation means for LGBTQ+ individuals in stereotyped settings was lower, indicating that when LGBTQ+ participants were under boost (stLGBT+), expectation was closer to the mean, which was not the case for self-declared heterosexuals. Nonetheless, when LGBTQ+ individuals were under threat (control) performance expectation was lower, but still higher than that of self-declared heterosexuals. It is evident that minority groups within STEM programs, such as LGBTQ+, have lower expectations, which reflects a lack of inclusive characteristics within these fields. According to the UTAUT (Venkatesh et al., 2003), behavior intention is supported by four pillars, social influence and facilitating conditions are two of those. STEM fields are traditionally cis-heteronormative and male-dominated environments. As such, these environments are subject to stereotypes and social constructs aligned with cis-heteronormative and male groups. Thus, refuting or accepting these facilitating conditions or social influences has not been considered as important as preserving the status quo that privileges heterosexuals within these fields (Powell et al., 2020).

5.3 H3: Learning performance per sexual orientation and gamified setting

Null hypothesis H3 was accepted. Therefore, we concluded that there were no significant differences in learning performance according to sexual orientation. The literature proposes that specific characteristics of a virtual setting can negatively affect minority groups' psychological

mediators. Such effects do not always impact learning results but could become an obstacle for these groups (Powell et al., 2020). It is important to note that performance is directly related to learning, which was assessed in this study exclusively through the scores obtained by participants. Participants' final learning results can serve as reference for the performance expectations that were previously estimated, by comparing these with participants' actual scores. The performance of participants in this study is intrinsically linked to the learning process, which was evaluated exclusively through scored activities. However, it is essential to highlight that these final scores are not only indicators of acquired knowledge, but can also serve as a benchmark for previously established performance expectations. Comparing the performance expectation score with the scores actually obtained from the participants allows a more accurate assessment of the effectiveness of the gamified environment. Although the results indicate the absence of significant differences in learning performance, it is crucial to continue exploring ways to promote an inclusive and welcoming environment for all students. This may involve implementing specific support strategies, developing more diverse educational resources, and continually raising awareness about the unique needs of minority groups within the virtual educational context.

6 Limitations

An important point concerns the challenges in recruiting LGBTQ+ participants. The sample included a relatively small proportion of LGBTQ+ participants, which may have limited the ability to conduct detailed and meaningful comparisons between groups. However, we highlight that we achieved population parity between the groups, which helped reduce the risk of statistical errors in the analyses performed. The participants were exclusively undergraduate and graduate students from STEM fields at the UFAL, which may not reflect the diversity of individuals in other institutions, regions, or educational contexts. This factor may restrict the applicability of the findings to other groups or scenarios. The generalization of the results should be approached with caution due to the aforementioned limitations, especially regarding the representativeness of the sample and the specific characteristics of the gamified system used. External factors, such as participants' prior familiarity with gamified environments or implicit biases, may also have influenced the results and were not fully controlled in the study design. Furthermore, the gamified system employed in the experiment has unique characteristics that may not be representative of other gamified scenarios in distinct regions and cultures. This limits the extrapolation of findings to other technological configurations or applications in varied contexts. Finally, the study does not explore how other intersecting identities, such as race and socioeconomic status, may interact with sexuality to influence participants' experiences and performance in gamified environments. This limitation highlights the need for future studies that incorporate a broader intersectional analysis.

7 Conclusions

Analysis of the results from a historical-cultural perspective underscores the significance of this research in fostering the inclusion of underrepresented groups in STEM areas within the framework of educational gamification. The utilization of gamified elements holds the potential to cultivate

an empathetic learning environment, both within gamified and traditional educational settings. The experimental findings revealed that sexual stereotypes exert an influence on the levels of flow experience and performance expectation. However, intriguingly, the study elucidated that regardless of sexual orientation, participants' learning performance remained unaffected. Moreover, a noteworthy observation emerged indicating that individuals facing perceived threats exhibited enhanced flow experiences, irrespective of their sexual orientation. This intriguing aspect warrants further empirical and qualitative investigations to deepen our understanding of the underlying phenomena. In practical terms, the study accentuates the imperative of developing gamified interfaces that consciously account for sexual stereotypes to ensure the optimal performance expected from users. Given the pervasive influence of cis-heteronormative stereotypes in STEM fields, the design of gamified learning technologies must diligently steer clear of perpetuating these entrenched stigmas. Instead, there is a pressing need to cultivate learning environments that are inclusive, supportive, and conducive to the diverse identities and experiences of all learners. By embracing this approach, educators and designers can contribute to dismantling barriers to entry and fostering a more equitable and empowering educational landscape in STEM disciplines.

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