

The Role of Gender in Students' Privacy Concerns about Learning Analytics

Evidence from five countries

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ABSTRACT

The protection of students' privacy in learning analytics (LA) applications is critical for cultivating trust and effective implementations of LA in educational environments around the world. However, students' privacy concerns and how they may vary along demographic dimensions that historically influence these concerns have yet to be studied in higher education. Gender differences, in particular, are known to be associated with people's information privacy concerns, including in educational settings. Building on an empirically validated model and survey instrument for student privacy concerns, their antecedents and their behavioral outcomes, we investigate the presence of gender differences in students' privacy concerns about LA. We conducted a survey study of students in higher education across five countries ($N = 762$): Germany, South Korea, Spain, Sweden and the United States. Using multiple regression analysis, across all five countries, we find that female students have stronger trusting beliefs and they are more inclined to engage in self-disclosure behaviors compared to male students. However, at the country level, these gender differences are significant only in the German sample, for Bachelor's degree students, and for students between the ages of 18 and 24. Thus, national context, degree program, and age are important moderating factors for gender differences in student privacy concerns.

CCS CONCEPTS

- Security and privacy; • Social aspects of security and privacy; • Computers in other domains;

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KEYWORDS

Learning Analytics, Privacy Concerns, Gender, Students

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1 INTRODUCTION

Digital platforms in higher education collect and store large amounts of information about the students who use them. These student data can be employed to improve teaching and learning, as demonstrated in recent learning analytics (LA) research (for an overview, see [1, 2]), but at the same time, processing all of these data can raise concerns related to the protection of students' privacy [3]. Understanding and effectively managing students' privacy concerns is critical for the successful implementation of LA applications at any scale [4]. Yet critics have stressed that public research institutions and private education technology companies working with LA systems “still rely on ad hoc, red-tape-heavy and inconsistent approaches to privacy protection” [5, p.1]. This has encouraged numerous research efforts focused on various aspects of privacy in the context of LA [e.g., 6–10]. However, these studies have not sufficiently investigated the factors that influence students' privacy concerns. A recently proposed and empirically validated model of student privacy concerns posits two antecedents (i.e., perceived privacy risk and perceived privacy control), and two behavioral outcomes (i.e., non-self-disclosure behavior and trust) of students' privacy concerns about LA applications [4]. The present study builds on this model, which is reviewed in the next section, and uses it to investigate how students' privacy concerns vary across a set of student characteristics.

Prior work on information privacy in information systems has found that when individuals are exposed to different scenarios that

involve the use of personal data, their reactions differ based on their age, gender, culture, and context (e.g. [11-13]). This study closely examines one of these underlying demographic factors by testing the role of gender in students' privacy concerns related to LA applications. Gender has been identified in prior work as a potential source of individual differences in individuals' self-disclosure behavior and privacy management online [13]. Two aspects of privacy management, release of data and protective measures, were specifically identified to be associated with gender differences [14]. Individuals' concerns about information privacy were found to be associated with gender differences to varying degrees in both educational settings [8, 13, 18] and other settings [14-16]. Prior work has found female students to be more cautious and less confident when making decisions involving some form of risk, and consequently, they may be more sensitive to situations involving risk [19, 20]. A meta-analysis of 150 studies comparing risk-taking behaviors of men and women in a variety of domains (e.g., financial and health risks) and tasks (e.g., hypothetical choices of self-reported behaviors) found that women exhibit higher risk perceptions and lower risk behaviors than men [21]. However, a number of studies in online networking and educational settings have shown no gender differences in privacy concerns [22-24]. Taken together, empirical evidence for how gender influences students' privacy concerns in different contexts is mixed. This study contributes new evidence on the influence of gender on students' privacy concerns about LA, building on an established model, a validated instrument, and multi-national survey data. We surveyed students in higher education across three continents and five countries: Germany, South Korea, Spain, Sweden and the United States. Specifically, we address the following research question: *How does students' gender affect their privacy concerns about learning analytics?* We also explore the potential influence of other factors including students' age, program of study, and field of study.

2 BACKGROUND

2.1 Students' privacy concerns in LA

Privacy concerns refer to individuals' worries about the possible loss of privacy resulting from information disclosure [25]. In the context of LA, students' privacy concerns have rarely been studied as a central construct [4]. Privacy has been predominantly examined through several related measures or proxies, including stakeholders' perceptions (e.g., [26]), preferences (e.g., [27, 28]), attitudes (e.g., [29]), as well as expectations (e.g., [30-32]). In contrast, Mutimukwe et al. [4] examined students' privacy concerns about LA in higher education. They proposed and empirically validated the SPICE model to explore the nature of students' *privacy concerns* [4]. The SPICE model considers privacy concerns as a central construct between two antecedents: *perceived privacy risk* (i.e., the perceived potential risk when information is disclosed) and *perceived privacy control* (i.e., the individual's beliefs in her ability to manage the release and dissemination of personal information), and two outcomes, namely *trusting beliefs* (i.e., the degree to which a higher education institution is dependable in protecting students' personal information) and *non-self-disclosure behavior* (i.e., such behavior includes revealing information about oneself to others) [4]. We used the validated survey instrument for the SPICE model in the present

study to measure students' privacy concerns in a multi-national survey sample. The evaluation of the model's validity for each gender group across this international sample was a goal of this study, though not a primary one.

2.2 Gender and individual privacy concerns

Individuals' concerns about information privacy have been both theoretically and empirically associated with gender in prior work [14, 16, 17]. We note that gender is neither a binary construct nor synonymous with sex, but research in this area has generally analyzed gender differences as binary (i.e., man and woman) and used gender and sex interchangeably (male as man and female as woman). Park [14] posits that privacy may mean "a different functioning norm to men and women because females are sensitive in establishing private boundaries", and men and women "tend to grow up in different social and institutional environments that tend to incubate different skills sets" (p.252). Other researchers explained gender differences based on personality differences in neuroticism and anxiety [17] as well as stress [13]. Women were found to have higher risk perceptions [31] and lower risk behaviors than men [21], such that women were able to detect risks that men did not notice [31].

Gender differences in privacy concerns and intentions to exercise privacy-related rights are expected to influence decisions to share information [13, 24, 34]. In one study, men were three times more likely than women to give up their phone number, because women wished to avoid unwanted attention [34]. Likewise, a recent survey study with 444 students at a Norwegian higher education institution found that men are more willing than women to share information in return for a reward, depending on the information in question [24]. Gender differences have also been observed in terms of privacy protective measures. Women tend to engage in more proactive protective behavior compared to a decade ago, and they consider third-party data usage beyond its original purpose and data-driven advertising to be a bigger concern than men [35]. Gender was also positively related to individuals' confidence in privacy protection: men were found to have more technical skills to protect their privacy and they were more confident in their ability to protect their privacy than women [14]. Thus, although women tend to be more concerned about privacy, they are less willing to adopt privacy protection behaviors than men [18, 36].

While several studies have presented evidence for the influence of gender on various constructs of privacy concerns, other studies have shown that privacy concerns remain unaffected by gender in certain contexts. Boyod et al. [22] found that gender differences may not be particularly salient on highly interactive social networking sites, such as Facebook. Sørnum et al. [24] found that respondents' concerns for privacy do not differ across gender, but men claimed to experience slightly more control over their personal information compared to women. Finally, Vu and colleagues [23] found no significant evidence of differences between men and women in terms of their awareness and concern about their privacy in online learning settings.

In LA contexts, few studies have examined gender differences in stakeholders' privacy concerns, for example, student concerns about giving consent for data use. Li et al. [8] have shown that

female students reported concerns about data collection but were also more comfortable with use of their data by instructors for learning engagement purposes. In contrast, Vu et al. [23] did not find evidence of significant gender differences in terms of students' awareness and concern about their privacy in online learning settings. Overall, considering the importance of protecting students' privacy in the settings of LA, and the existing body of research demonstrating the role of gender in privacy concerns across various domains, there are surprisingly few efforts to understand gender gaps in students' privacy concerns about LA. This study contributes new and nuanced evidence on this exact question by examining the presence and robustness of gender differences in students' privacy concerns in higher education.

3 METHOD

We collected survey responses from university students between November 2021 and August 2022 across five countries: Germany, South Korea, Spain, Sweden and the United States. The data collection process differed across countries to adhere to local institutional standards and regulations. The German sample was collected using LimeSurvey and participants were recruited and paid through Prolific [37], an online crowdwork platform for research; participants had to be German nationals and residents enrolled in higher education. The sample in South Korea was collected at a STEM-focused university using Qualtrics. Instructors of several large courses announced the survey study for voluntary participation to their students via email. The US sample was collected at a selective research university using Qualtrics; a cloud-based participant management system for students pursuing communication or information science degrees offered course credit for study participation. The Swedish sample was collected at a large technical university, mainly offering different kinds of engineering degrees; students completed the survey in paper format, following guidance from the IRB and the Swedish National Ethical Board (<https://etikprovningsmyndigheten.se>). The Spanish sample was collected via Microsoft Forms at a medium-size university by sending an email to all students that announced the online survey study for voluntary participation.

The survey instrument (available at <https://osf.io/f9xjc>) provided information about the study, collected informed consent, followed by a set of demographic and academic questions: gender, age, study program, and field of study. Respondents then answered twenty items on five-point Likert scales (coded from 1 "strongly disagree" to 5 "strongly agree") about student privacy concerns about LA (adopted from [4]), with the following five subscales: perceived privacy control, perceived privacy risk, privacy concerns, trusting beliefs, and non-self-disclosure behavior. The survey instrument was translated from English into German, Korean, Spanish, and Swedish. Translation into German was performed by a German native speaker and double-checked by a second native speaker. Translation into Korean and Spanish was performed by a native speaker and confirmed by a second native speaker for each language. Translation into Swedish was performed by two university lecturers who teach Swedish.

Table 1 presents the sample characteristics for each country and the full sample. Most participants were between 18 and 24 years

old, in a Bachelor's or Master's program in a STEM (i.e., "Natural Science, Technology, Engineering, Mathematics") or HASS (i.e., "Humanities, Arts, Social Sciences: Anthropology, Archaeology, Economics, Education, Geography, History, Law, Linguistics, Politics, Psychology and Sociology") field, with a skew towards female students except in South Korea and Sweden. Our analysis is restricted to students who identified as either male or female, as each sample includes only one to four non-binary students, an insufficient number for reliable inferences using regression analysis. The subscales for our key constructs have sufficiently high internal reliability (Table 2).

4 RESULTS

We first examine if the constructs of the SPICE model are correlated as expected, and whether the correlations differ by gender. To this end, we fit a series of linear regressions based on the SPICE model and include a main effect and interaction effects for gender (female is the reference group). Trusting beliefs is significantly predicted by privacy concerns ($t = -3.79, p < 0.001$), privacy control ($t = 6.33, p < 0.001$), and privacy risk ($t = -3.95, p < 0.001$) for female students, and these three coefficients are not significantly different for male students (all $|t| < 1.2, p > 0.25$). Likewise, non-self-disclosure behavior is significantly predicted by privacy concerns ($t = 8.76, p < 0.001$), privacy control ($t = 2.85, p = 0.005$), and privacy risk ($t = 4.78, p < 0.001$) for female students, and these three coefficients are not significantly different for male students (all $|t| < 1.4, p > 0.17$). Privacy concerns is predicted significantly by privacy risk ($t = 21.48, p < 0.001$) but not privacy control ($t = -0.71, p = 0.48$) for female students, and similarly for male students (all $|t| < 1.0, p > 0.33$). However, privacy control on its own (i.e., omitting privacy risk from the regression model) is also a significant predictor of privacy concern for female students ($t = -5.56, p < 0.001$), and similarly for male students ($t = -0.64, p = 0.53$). Finally, privacy control is significantly predicted by privacy risk for female students ($t = -6.83, p < 0.001$) and similarly for male students ($t = -0.85, p = 0.40$). These findings confirm the SPICE model structure and its independence from student gender.

We investigate gender differences by fitting a regression model for each component of the SPICE model with gender as a predictor and age, field of study, program of study, and the country where the sample was collected as covariates (Table 3). We find a significant gender difference for two of the five outcome variables: female students have stronger trusting beliefs and are more inclined to engage in self-disclosure behaviors compared to male students. We also observe that older students tend to report stronger privacy concerns, though master's students are less concerned relative to bachelor's students. Master's students have stronger trusting beliefs and perceive privacy risks as lower relative to bachelor's students. While we also observe significant coefficients for students in medical studies and those enrolled in independent courses, these categories are sparse and skewed across samples (Table 1). Finally, we observe significant sample differences across countries for all constructs of the SPICE model. Comparing results between countries in our sample (Figure 1 shows covariate-unadjusted statistics), we find that the gender differences in trusting beliefs and non-self-disclosure that we observe in Table 3 are only significant in the German sample

Table 1: Participants characteristics in each sample and overall.

	Germany	South Korea	Spain	Sweden	USA	Overall
Sample Size	247	59	121	156	179	762
<i>Gender</i>						
Female	142	17	84	75	117	435
Male	101	41	36	76	59	313
Non-binary/NA	4	1	1	5	3	14
<i>Age</i>						
18-24	142	43	90	126	175	576
25-34	91	14	20	29	3	157
35-44/45-54/55+	14	2	11	1	1	29
<i>Program</i>						
Bachelor’s degree	145	39	105	56	168	513
Master’s degree	77	18	16	84	6	201
Indiv. Course/Other	25	2	0	16	5	48
<i>Field of Study</i>						
STEM	79	56	46	145	88	414
HASS	144	2	65	6	62	279
Medical Studies	12	1	10	0	1	24
Other	12	0	0	5	28	45

Table 2: Mean, standard deviation (in parentheses), and Cronbach’s alpha for each SPICE model construct in each sample and overall.

	Germany	South Korea	Spain	Sweden	USA	Overall
Perceived Privacy Control	3.0 (0.80), a=0.85	2.8 (1.0), a=0.88	2.8 (0.83), a=0.83	2.7 (0.85), a=0.82	2.6 (0.81), a=0.84	2.8 (0.85), a=0.85
Perceived Privacy Risk	2.5 (0.73), a=0.73	2.6 (0.89), a=0.82	2.7 (0.86), a=0.86	2.3 (0.72), a=0.74	3.0 (0.72), a=0.70	2.6 (0.80), a=0.78
Privacy Concerns	2.3 (0.85), a=0.86	2.8 (1.0), a=0.89	2.9 (0.97), a=0.89	2.0 (0.80), a=0.84	3.1 (0.85), a=0.83	2.6 (0.96), a=0.88
Trusting Beliefs	4.1 (0.60), a=0.84	3.4 (0.86), a=0.88	3.6 (0.86), a=0.88	4.0 (0.80), a=0.88	3.3 (0.81), a=0.87	3.8 (0.83), a=0.88
Non-Self-Disclosure Behavior	1.6 (0.58), a=0.77	2.0 (0.79), a=0.80	2.0 (0.81), a=0.87	1.3 (0.46), a=0.81	2.1 (0.8), a=0.86	1.7 (0.75), a=0.85

(trusting beliefs: $t = -2.78$, $p = 0.006$; non-self-disclosure behavior: $t = 3.54$, $p < 0.001$), but not in any other sample we collected (all $|t| < 1.70$, $p > 0.10$), when using the same covariates as in Table 3.

We also examine gender differences across age groups and programs. Comparing between age groups, we find that the gender differences for trusting beliefs and non-self-disclosure behavior are significant especially in the youngest age group: in fact, for 18-24 year olds, the coefficient on gender in the model displayed in Table 3 is significant for trusting beliefs ($t = -2.78$, $p = 0.006$) and non-self-disclosure ($t = -2.79$, $p = 0.005$), but not for older students ($t < 1.0$, $p > 0.35$). Comparing between the two main programs of study represented in the data, we observe significant gender differences for bachelor’s degree students in trusting beliefs ($t = -2.36$, $p = 0.019$) and non-self-disclosure ($t = 2.32$, $p = 0.021$), but not master’s degree students.

5 DISCUSSION AND CONCLUSIONS

Addressing students’ privacy concerns in the context of LA is critical for the successful implementation of LA data infrastructures, dashboards, and other LA systems in higher education. This study advances an international understanding of university students’ privacy concerns about LA, building on the SPICE model [4] and focusing on identifying potential gender differences. Our focus on gender differences is motivated by prior research that has found women to be more concerned about their privacy and less inclined to share personal information compared to men [16-18]. However, the literature contains mixed findings for gender differences in data privacy concerns and most studies are conducted only in a single country or across multiple countries without examining national variation. Our study addresses these shortcomings and contributes to the literature on privacy in LA by systematically examining

Table 3: Regression output for each component of the SPICE model.

	Perceived Privacy Control	Perceived Privacy Risk	Privacy Concerns	TrustingBeliefs	Non-Self-Disclosure Behavior
(Intercept)	3.03 ^{***} (0.09)	2.43 ^{***} (0.08)	2.31 ^{***} (0.09)	4.05 ^{***} (0.08)	1.50 ^{***} (0.07)
Gender: Male	-0.02 (0.06)	0.07 (0.06)	-0.02 (0.07)	-0.16 ^{**} (0.06)	0.14 ^{**} (0.05)
Age: 25-34	-0.13 (0.08)	0.12 (0.08)	0.18 [*] (0.09)	-0.06 (0.08)	0.10 (0.07)
Age: 35+	-0.01 (0.16)	0.14 (0.15)	0.34 [*] (0.17)	0.16 (0.15)	0.20 (0.13)
Field: HASS	0.09 (0.08)	0.04 (0.07)	-0.01 (0.08)	0.10 (0.07)	0.05 (0.06)
Field: Medical	-0.19 (0.19)	0.36 [*] (0.17)	0.45 [*] (0.20)	-0.14 (0.17)	0.16 (0.15)
Field: Other	0.20 (0.14)	0.06 (0.13)	0.02 (0.14)	-0.02 (0.13)	0.06 (0.11)
Prog.: Indep. Crs.	0.13 (0.28)	-0.42 (0.26)	-0.76 [*] (0.30)	0.48 (0.26)	0.05 (0.23)
Prog.: Master	-0.08 (0.08)	-0.15 [*] (0.07)	-0.17 [*] (0.09)	0.20 ^{**} (0.07)	-0.06 (0.07)
Prog.: Other	-0.07 (0.15)	-0.20 (0.14)	-0.18 (0.16)	0.11 (0.14)	-0.20 (0.12)
Sample: Korea	-0.17 (0.13)	0.13 (0.12)	0.44 ^{**} (0.14)	-0.55 ^{***} (0.12)	0.39 ^{***} (0.11)
Sample: Spain	-0.28 ^{**} (0.10)	0.14 (0.09)	0.54 ^{**} (0.10)	-0.44 ^{***} (0.09)	0.35 ^{***} (0.08)
Sample: Sweden	-0.26 [*] (0.10)	-0.13 (0.09)	-0.16 (0.11)	-0.11 (0.09)	-0.29 ^{***} (0.08)
Sample: USA	-0.54 ^{***} (0.09)	0.52 ^{***} (0.08)	0.79 ^{***} (0.10)	-0.74 ^{***} (0.08)	0.54 ^{***} (0.07)
Sample size	748	748	748	748	748
R ²	0.06	0.12	0.19	0.18	0.20
F statistic	3.31	7.39	13.42	12.37	14.07
p-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Table notes: Statistical significance levels indicated by ^{***} $p < 0.001$, ^{**} $p < 0.01$, and ^{*} $p < 0.05$.

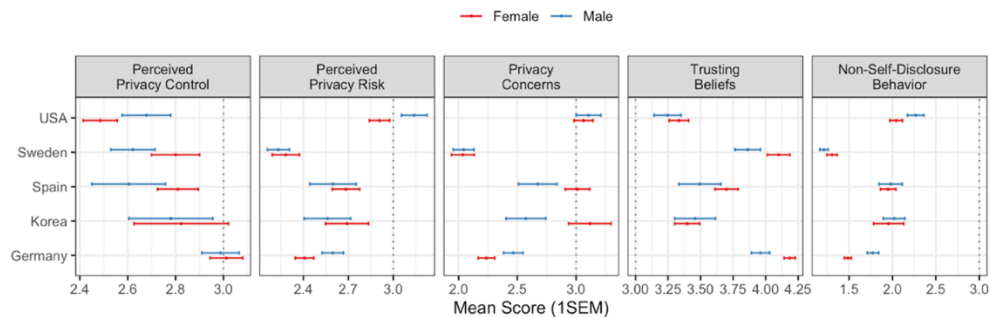


Figure 1: Mean and standard error bars for each SPICE model component by gender and country.

university students' privacy concerns about LA across five countries using a validated survey instrument. We present three main findings which have implications for theory and practice.

The first main finding is that the SPICE model appears to be robust for different gender groups. We specifically tested the theorized correlation structure between the constructs constituting the model separately for male and female students. The finding, which confirmed the structure of the SPICE model and its independence from student gender, suggests that the model is a valid theoretical and empirical approach for investigating students' privacy concerns regardless of a sample's gender composition and across different national contexts of higher education.

The second main finding is that, across the full sample of five countries, female students have stronger trusting beliefs and are more willing to engage in self-disclosure behaviors compared to male students in the context of LA. These represent the two direct antecedents of students' privacy concerns in the SPICE model. This gender difference notably points in the opposite direction than several prior studies in the literature that have found women to be less trusting and willing to share information than men [16-18]. However, as noted above, there is mixed evidence, including other studies in which female students were more willing than men to share personal information (i.e., self-disclosure behavior) both in education [8] and on social networking sites [13]. Some prior work also found females to be more trusting than men in the context of virtual environments [39]. The gender differences we observe in this study imply that women may be more susceptible to privacy threats due to their higher levels of trust and self-disclosure, which presents a potential source of gender-based inequality [38] in LA applications.

The third main finding, qualifying the scope of the second finding, is that the gender differences for trusting beliefs and self-disclosure behavior are limited to specific subpopulations: (i) students in the German sample, (ii) students in a Bachelor's degree program, and (iii) students between the ages of 18 and 24. These subgroup effects are identified and confirmed as significant in the presence of all other covariates. Conversely, no significant gender differences in students' privacy concerns are found for other subpopulations in this study. This implies that national context, degree program, and age are moderating factors for gender differences in student privacy concerns about LA. The subgroup effect for German students suggests that there may be cultural differences in students' trusting beliefs and self-disclosure behavior. Given the influence of culture on individuals' privacy concerns in various information systems [40, 41], future research could investigate cultural differences in students' privacy concerns about LA. Besides cultural differences, the German sample also included more students studying a HASS than STEM field. The subgroup effect for Bachelor's students and for 18-24-year-olds suggests that younger generations of university students, who exhibit lower levels of trusting beliefs and self-disclosure behavior in general, also show a gender difference. This could be related to differences in the experience of growing up with more LA in previous educational programs and increased self-efficacy for data privacy management, but this requires further study.

We note three limitations of this study. First, this multi-national study collects samples from five countries that differ not only in their geography but also culture. Cultural differences can matter

for how students view privacy in general, beyond gender differences. The country-level heterogeneity we identified in this study stresses the importance of additional research (including qualitative methods) that focuses on how students understand privacy and their privacy concerns in different countries. Second, while this study focused on gender differences as a factor in students' privacy concerns, there may be other student characteristics, including attributes related to social norms, to consider as potential sources of variation in students' privacy concerns about LA. Third, while we sampled similar student populations from specific institutions in most countries, participants recruited in Germany were approached differently and included students enrolled at many institutions, which may have affected the results. Stakeholders such as educators or designers of LA systems and applications should be aware of the potential for significant gender differences in privacy-related beliefs and behaviors, which are a potential source of gender-based inequality. To reduce this risk, educators can focus on providing information to mitigate privacy concerns overall.

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