SOCIAL ANXIETY IN ONLINE INSTRUCTIONAL DISCUSSION FORUMS: THE ROLE OF PARTICIPATION STYLES AND ICT INFRASTRUCTURE

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ABSTRACT

Examination of the personal characteristics (i.e., gender, participation styles) of participants and the technical infrastructure (i.e., device type, internet connection type) of Instructional Discussion Forums (IDFs) can provide functional clues for mitigating social anxiety in these settings. In this context, this research investigated variances in learners' participation styles and social anxiety in IDFs in terms of gender and ICT availability. In addition, it explored the predictive relationships between participation styles and social anxiety. A sample of 272 freshman undergraduate students discussed various topics related to Internet ethics for three weeks through an IDF. The results indicated that participation styles differed by gender and ICT availability in several respects. First, handheld devices and cellular internet connections exerted a medium-size effect on social anxiety. Further, "to get information" and "to fulfill requirement" purposes in the "Why" dimension of participation styles had a small predictive relationship with social anxiety, as did "analytical" and "practical" participation approaches in the "How" dimension. Of these, only the "to get information" purpose negatively predicted social anxiety. Overall, participation styles accounted for 19.1% of the variance in social anxiety. Based on the findings, future directions and practical implications are suggested for both researchers and practitioners.

Keywords: Asynchronous online discussions, social anxiety, participation styles, gender, device type, internet connection type.

INTRODUCTION

E-learning is defined as "the use of computer network technology, primarily over or through the internet, to deliver information and instructions to individuals" (Wang et al., 2010, p. 167). One of the fundamental learning experiences undergone by students in e-learning settings is discussion-based interactions (Tibi, 2016). These are mostly carried out in Instructional Discussion Forums (IDFs), which are questioning

environments specially structured to support the collaborative learning process (Wu, 2021). In IDFs, different perspectives are reflected on a special topic, facilitating the co-construction of common knowledge through asynchronous social interactions. As a basic type of such interactions, asynchronous instructional discussion involves sending messages and emojis to an online environment that supports communication and collaboration to facilitate the learning process (Lima et al., 2019; Onyema et al., 2019) and enhance the perception of social presence among learners (Dahlstrom-Hakki et al., 2020). According to many scholars, discussion interactions positively affect the learning process through dimensions such as knowledge construction (Ouyang & Chang, 2019), academic achievement (Galikyan & Admiraal, 2019), collaboration (Chan & Chan, 2011; Shan & Wang, 2021), creativity (Corfman & Beck, 2019), argumentation ability (Bucheli, 2021), self (Vonderwell et al., 2007) and peer assessment (Ertmer et al., 2010), and motivation (Kang & Zhang, 2020). However, not all learners benefit from these interaction opportunities to a similar extent. Certain demographic characteristics such as gender (Guiller & Durndell, 2007; Lin et al., 2019; Zhou, 2016) and psycho-educational characteristics such as social anxiety (Muilenburg & Berge, 2005; Yen et al., 2012) result in differences in learners' discussion interactions. While the cognitive aspects of learning in discussion environments have been extensively studied, an understanding of learners' affective characteristics remains at a theoretical level; the practical implications have not been considered. Further investigation of this topic is required to guide the development of well-designed interactions.

Social Anxiety in IDFs

In e-learning, IDFs, chats, and virtual classrooms are environments where learners socially coexist and interact. One of the important constructs affecting social interactions in these environments is social anxiety (Keskin, 2023; Leary, 1983). Social anxiety is a salient emotional state that adversely influences the social relations of an individual within a particular social context (Heimberg et al., 1999). Individuals with social anxiety are afraid of being rejected or criticized by others in their social circle. Research indicates that socially anxious individuals avoid interaction, performance, and behaviors (Leary, 1983) and exhibit lower self-confidence and a tendency to avoid risk (Purdon et al., 2001).

According to social role theory (Bem, 1981) and gender schema theory (Eagly et al., 2000), social anxiety is experienced differently according to gender. Corroborating these theories, a review of literature by Asher et al. (2017) revealed that social anxiety was observed more frequently in females. By contrast, Zhou (2016) found that social anxiety has a more determining effect on the interaction behaviors of male students. The impact of gender on social anxiety may also differ according to the medium in which social interaction takes place. For example, Pierce (2009) showed that females experienced less social anxiety in online communication than in a face-to-face equivalent. Moreover, females felt less social anxiety in online communication than males, although the opposite is the case for the face-to-face medium.

Technologies used in asynchronous discussion environments such as device type might also lead to decisive differences in interaction patterns as well as learning performance (Lan et al., 2012). In this respect, it is important to determine whether the ICT infrastructure influences socio-affective outputs such as social anxiety. Although there is a consensus among scholars that handheld devices enhance commitment to the discussions or increase student participation due to their ubiquitous nature (Mac Callum & Kinshuk, 2008), there is a paucity of practical understanding concerning how these devices affect discussion interactions and dynamics.

Social anxiety significantly hinders the educational benefits of discussions (Sonmez, 2021). However, due to the widespread belief that students can generally cope with this, social anxiety is not adequately addressed in educational contexts (Topham et al., 2016). Therefore, although experienced less slightly in online environments (Pierce, 2009; Shalom et al., 2015), examination of social anxiety in terms of ICT infrastructure, participation behaviors, and student characteristics through academic discussions is likely to pave the way for new insights and perspectives.

Participation Styles in IDFs

Although asynchronous online discussions stimulate thinking processes and contribute to learning enhancement, ensuring students participate in these activities remains a key challenge for educators (Gaul & Kim, 2020). These have driven researchers to interrogate the dynamics of the discussions, including participation or interaction patterns, to enhance the existing body of knowledge. The participation styles of learners in online discussions are generally examined in the context of participation performance (e.g., Chiu et al., 2010; Naranjo et al., 2012; Ruthotto et al., 2020). Such performance is determined using page views, the number of messages, interaction time, and interpersonal interaction metrics. In most of these studies, participation is classified as active/passive, interpersonal communication-oriented/subject-oriented, or questioning/answering. Although the participation of students in asynchronous discussions has been handled in the literature in terms of class size (Afify, 2019), teacher and student roles (Ouyang & Chang, 2019) or facilitator/moderator types (Ghadirian et al., 2019), discussion environments/tools (Sun & Gao, 2017), instructional techniques (Ding et al., 2018) and participation patterns have not been adequately addressed. This impels us to reveal new insights that extend beyond how many comments students make in order to unravel the factors underlying participation behaviors. The determination of participation styles might also provide important feedback to practitioners that will enable them to support discussions in a more adaptive manner for students. In a study on the relationship between social interaction patterns and cognitive engagement in asynchronous discussions, socially active students were found to be more involved in knowledge inquiry and construction (Ouyang & Chang, 2019). Also, students engaging in in-depth inquiry were reported to participate more often in peer interaction and this was reflected positively in the co-construction of knowledge.

While students' participation styles have an impact on engagement in online academic discussions (Ghadirian et al., 2018; Ouyang & Chang, 2019), the styles are also likely to be affected by multiple other factors. For instance, device type might be expected to make a difference in terms of the possible effect of screen size on user-device interaction. Another issue is cellular internet data usage due to the shorter interaction time deriving from high procurement costs. In addition, the ubiquitous availability of mobile phones might change the way participants behave in IDFs (Lan et al., 2012).

Regarding gender, because Turkiye is a patriarchal society (World Economic Forum, 2020), gender roles may possibly influence interaction performance, even in e-learning environments (as per social role theory and gender schema theory) (Bem, 1981; Eagly et al., 2000). In this regard, several studies have identified differences according to gender in terms of participation behaviors and the length and number of messages written in discussion environments (Diep et al., 2016; Prinsen et al., 2007).

The Predictive Relationship between Participation Styles and Social Anxiety in IDFs

Social anxiety is influenced by the environment in which the individual communicates (Yen et al., 2012), types of communication (Cuming & Rapee, 2010), perceptions (Barnett et al., 2021), and behaviors (Pailing & Reniers, 2018). Moreover, Bolsoni-Silva and Loureiro (2014) revealed that students' social skills, which might include participation styles, have a decisive impact on social anxiety. In this regard, identifying the source of social anxiety will significantly guide practitioners and researchers in creating environments that engender less anxiety.

Research Questions

This study examined the participation styles and social anxiety of learners in an IDF in terms of gender, device type (e.g., PC, handheld device), and internet connection type (e.g., fixed connection, cellular connection). The predictive relationship between participation styles, which represent user behaviors, and social anxiety, which is an emotional state, was also examined to obtain a more holistic viewpoint. For that purpose, the following research questions were formulated and addressed:

1. Does participation style for online instructional discussion forums significantly differ by
    a. gender,
    b. internet connection type, and
    c. device used?
2. Does social anxiety in online instructional discussion forums significantly differ by
    a. gender,
    b. internet connection type, and
    c. device used?
3. To what extent do participation styles predict social anxiety in online instructional discussion forums?

METHOD

This research was inherently grounded in a correlational research design. In correlational research, the aim is to unearth the relationship between the variables in question (Fraenkel et al., 2019). Therefore, the current study explored the predictive relationships between participation styles and social anxiety in online instructional discussions.

Study Group

Because the data had to be collected online during the pandemic-period, a convenient sampling technique was employed as a practical way to recruit participants. A total of 387 undergraduate university students studying in various departments of the faculties of education from two universities were invited to take part. Both universities located in the Eastern Anatolia region of Turkiye. All students were enrolled on the online-taught "Information Technologies in Education" course. After cleaning the dataset for incomplete entries, 272 participants remained: 156 (57.4%) students from one university and 116 (42.6%) from the other.

Context of the Study

The students were already familiar with the concept of e-learning due to the COVID-19 pandemic, yet they had no substantial e-learning and instructional discussion experience. With respect to technological infrastructure, 189 (69.48%) reported using mobile phones to attend classes while 118 (43.38%) used a cellular data connection to connect to the internet. Demir (2015) reported that 89.2% of university students have a Personal Computer (PC). Demir's ratio is substantially larger than the ratio reached in this study. This is perhaps because Demir collected his data from a university located in a metropolitan city, while the data for this study were collected from two universities located in a much less developed region of Turkiye. Indeed, a considerable number of students have a low socio-economic status and dwell in rural areas with no, or a slow/unstable, internet infrastructure. This results in remarkably high ratios of mobile phone and cellular data connection usage. It is therefore imperative to note that the prevalent usage of mobile phones and cellular data connection was not a preference, but compulsory due to infrastructure and economic problems. According to the Turkish Statistical Institute (TUIK, 2020a), the specific sub-region of the Eastern Anatolia region where the two universities are located has the lowest average household usable income in Turkiye. Notably, 50.8% of households have fixed broadband internet connections whereas 86.9% have mobile broadband internet connections (TUIK, 2020b). These percentiles seem to explain why the students in this study used a mobile broadband connection instead of a fixed connection to attend online classes. In fact, they represent the overall situation in Turkiye, although studying at universities located in a less developed sub-region exacerbates the difficulties involved. Electricity outages and internet connection cuts are also frequent in the region, making e-learning even harder.

Data Collection Tools

Three data collection tools were employed in the current study. These were personal information forms, the learner-learner interaction part of the social anxiety scale for e-learning environments (SASE), and the participation style scale for online instructional discussions (PSOD). The personal information form included information related to university name, gender, device type (i.e., PC, handheld) used to participate in discussions, and the available type of internet connection (i.e., fixed broadband, cellular connection).

Social Anxiety Scale for E-learning Environments (SASE)

The SASE is a 7-point Likert-type scale developed by Keskin et al. (2023). It is a 46-item scale, of which the learner-learner interaction part contains 23 items. This encompasses three factors: "negative evaluation", "somatic symptoms", and "avoidance of interaction". The negative evaluation dimension deals with emotional states such as fear, anxiety, and shame that arise due to misunderstanding, criticism, or negative thinking about the performance of an individual. Somatic symptoms, on the other hand, refer to an individual's various physical symptoms such as sweating, uneasiness, and flushing, depending on the severity of social anxiety. Finally, avoidance of interaction means that an individual refrains from social interactions or avoids performing behaviors so that they do not have to experience social anxiety. The Cronbach's alpha reliability coefficients are .95, .92, and .95, respectively.

Participation Style Scale for Online Instructional Discussions (PSOD)

The 32-item PSOD, which is a 5-point Likert-type scale, was developed by Pala and Erdem (2020). In this more comprehensive study, the online participation styles of learners were divided into two basic categories to determine their participation motivations (Why) and behaviors (How). The goals of learners wishing to participate in an instructional discussion can be addressed using four basic factors: "to socialize", "to get information", "to discuss", and "to fulfill requirements". Learners with the "to socialize" participation style engage in discussion environments to interact with other individuals, to benefit from their views, and to attract attention. Learners with the "to get information" participation style think that discussions contribute to the effective learning process and participate in the social environment for learning. Learners with the "to discuss" participation style take part in discussions in e-learning environments in order to be exposed to different perspectives. Finally, the "to fulfill requirement" participation style refers to participation as a requirement or responsibility of the course. Learners' participation behaviors in online IDFs can also be explained in terms of four different factors: "connective", "analytical", "innovative", and "practical". These factors identify behavioral patterns such as communicating, dealing with details, analytical thinking, problem-solving, and completing tasks. Connective learners are individuals who like to be in contact with other participants and respond to their messages. Those exhibiting analytical participation styles are intensive-thinking and careful individuals who avoid making mistakes and pay attention to details. The innovative group characterizes learners who combine different perspectives, produce subjective and progressive solutions, and reflect on their own experiences, thus bringing authenticity to the medium. Finally, practical participants are individuals focused on quickly completing tasks that aim to fulfill a responsibility. The factors in each dimension can be merged, giving Cronbach's Alpha reliability coefficients of .81, .83, .85, .70, and .89, respectively. Pala and Erdem pointed out that "Why" and "How" dimensions can be employed separately. Following this recommendation, each dimension was investigated separately to scrutinize the simple relationships of the factors within each dimension with other variables.

Implementation Process

Permission to use the scales was obtained from the first authors of the corresponding articles. Ethical approval for this study was obtained from the ethical commission of Van Yuzuncu Yil university. Prior to data collection, the scales were transferred to the Google Form environment because the courses were delivered fully online. Because all students were freshmen and consequently had no substantial online

instructional discussion experience, an intervention including a series of lessons and online instructional discussion questions were designed with the purpose of eliciting their social anxiety and participation styles in e-learning environments. Firstly, the authors prepared seven PowerPoint presentations in accordance with the curriculum of the ''Information Technologies in Education" course. The presentations were cross-checked and improved by the other authors. The topics covered were cyber-bullying, cyber-loafing, internet trolling, information ethics, digital addiction, cyber-security, and information pollution. These topics were already on the course syllabus and were covered over a period of three weeks. In these courses, direct answers to the instructional discussion questions were not given by the authors. Immediately before the start of online instructional discussions, an online discussion guideline explaining the rules to which students must adhere was shared in the Learning Management System (LMS) to create a more effective discussion experience. The guideline stressed six points such as "no copy-paste", "no inappropriate language", and "first, read everything written". In addition to these rules, the course lecturers strived to create a democratic discussion environment where different points of views were celebrated so as to reduce social anxiety and promote creativity. Furthermore, 24 instructional discussion questions related to cyber-awareness were created by the authors. Afterwards, subsequent to the elimination of questions that have a comparatively lower potential for igniting discussion among students, the number of questions was reduced to 10. One was used as a warm-up question to familiarize students with discussions. Three online instructional discussion questions were shared each week after the corresponding cyber-awareness subject was covered in the theoretical part of the lesson. The course was taught in six different sessions with a varying number of students. The students were given extra five points as an incentive for participating in the study. Regarding the role of researchers in the data collection process, two researchers taught the course as a faculty member. One of the two faculty members was present in the discussion environment; however, they did not intervene unless absolutely necessary. Finally, by the time the personal information form, social anxiety scale, and participation style scale were administered online during lessons between 16-31 December 2020, response rates in all discussions had saturated.

Data Analysis

MS Excel 2016 spreadsheet application and IBM SPSS Statistics 24 software package were used to analyze the data. There were no missing data. Multivariate outliers were checked using Mahalanobis distance, which revealed there were no outliers. Mean, standard deviation, frequency and percentile were used to describe the data. Social anxiety and participation styles scores were calculated by averaging all the items in the related factor/scale. "Why" and "How" dimensions of the participation styles scale were analyzed separately. In accordance with the Central Limit Theorem (Kwak & Kim, 2017), the data were normally distributed. Several independent sample t-tests were performed. First, Leneve's test was conducted for each independent sample t-test to assess the equality of variances. Gender, device ownership, and available internet connection type were the independent variables, whereas social anxiety for e-learning environments and participation style for online instructional discussions were the dependent variables. The threshold of statistical significance was accepted as .05. To determine their practical significance, Cohen's *d* effect size statistics were calculated and interpreted based on the recommendation of Sawilowsky (2009), whereby Cohen's *d* can be classified as very small ($d < .1$), small ($d < .2$), medium ($d < .5$), large ($d < .8$), very large ($d < 1.2$), and huge ($d < 2$). Next, multiple linear regression analysis was performed to explore the effect of participation types on social anxiety. First, the Durbin-Watson test for autocorrelation and VIF (Variance Inflation Factor) for multicollinearity were calculated. In line with Cohen's (1992) suggestion, f^2 was calculated to evaluate the effect size of the coefficient of determination (R^2). According to Cohen, f^2 values lower than .02 indicates no effect at all, between .02 and .15 indicates a small effect size, between .15 and .35 indicates a medium effect size and higher than .35 indicates a large effect size.

FINDINGS

The findings of the current study are presented in order of research questions.

Research Question 1: Does Participation Style for Online Instructional Discussion Forums Significantly Differ by Gender (A), Internet Connection (B), and Device Types (C)?

In this study, participation styles were examined separately through the dimensions "Why" and "How". To examine the effect of gender and technological infrastructure on participation styles for online instructional discussion, several independent sample t-tests were conducted and are reported in the Appendix section (Table A1-A3). Only five independent samples t-tests yielded statistically significant results and these are reported in Table 1 (19 results were not statistically significant and are therefore not reported).

Table 1. Differences in participation styles in terms of gender and technological infrastructure

RQ	Dimension/Factor	Group	Category	N	M[a]	SD	t	p	d_{Cohen}
1a	How/Connective	Gender	Male	94	2.24	.86	2.54	.012*	.32
			Female	178	1.99	.75			
1b	Why/To Socialize	Internet Connection Type	Cellular	118	2.58	1.12	2.14	.033*	.26
			Fixed	154	2.30	1.02			
	How/Connective		Cellular	118	2.19	.80	2.14	.033*	.26
			Fixed	154	1.99	.78			
1c	Why/To discuss	Device Type	Handheld[b]	193	3.73	.84	2.13	.034*	.28
			PC	79	3.49	.89			
	How/Practical		Handheld	193	1.92	.75	2.36	.019*	.33
			PC	79	1.69	.60			

**p < .05*

[a] The scale is 5-point Likert-type

[b] There were only four students using tablets in the handheld device category, the remainder comprised mobile phone users

Note 1: df = 270

Note 2: All effect sizes are at the medium level according to Sawilowsky (2009).

As indicated in Table 1, when participation styles are examined in terms of gender, there is a significant difference only in the "connective" factor under the "How" dimension ($p < .05$). Thus, males participate in instructional discussions in a more connective way than females ($t(270) = 2.54$, $p = .012 < .05$, $d = .32$). Students who participated in discussions for social interactions and exhibited connective characteristics mostly had a cellular internet connection ($t(270) = 2.14$, $p = .033$, $d = .26$ and $t(270) = 2.14$, $p = .033 < .05$, $d = .26$ for "to socialize" and "connective" factors, respectively, $p <. 05$). There were also significant differences in terms of device type in the factors of "to discuss" ($t(270) = 2.13$, $p = .034 < .05$, $d = .28$) and "practical" ($t(270) = 2.36$, $p = .019 < .05$, $d = .33$) in favor of handheld device users. All effect sizes were calculated to be at the medium level.

Research Question 2: Does Participants' Social Anxiety Significantly Differ According to Gender (A), Internet Connection (B), and Device Type (C)?

Before addressing the second research question, the correlation coefficients between the constructs related to social anxiety were examined. The results revealed strong positive relationships (varying between .77 and .90 at the .001 significance level) between overall social anxiety score and its factors, which are negative evaluation, somatic symptoms, and avoidance of interaction. Accordingly, social anxiety was considered a single factor scale in the subsequent analyses. Table 2 presents independent samples t-test results regarding the differentiation of participants' social anxiety according to gender (a), internet connection (b), and device type (c).

Table 2. Differences in social anxiety in terms of gender and technological infrastructure

RQ	Group	Category	N	M[a]	SD	t	p	d_{Cohen}
2a	Gender	Male	94	3.01	1.17	.34	.738	NA
		Female	178	2.95	1.38			
2b	Internet Connection Type	Cellular	118	3.19	1.28	2.42	.016*	.30
		Fixed	154	2.80	1.30			
2c	Device Type	Handheld	193	3.12	1.31	3.09	.002**	.42
		PC	79	2.59	1.23			

*p < .05, **p < .01

[a]The scale is 7-point Likert-type

Note 1: df = 270

Note 2: All effect sizes are at the medium level according to Sawilowsky (2009).

The results demonstrate that all means are lower than the critical mid-value 4 of the scale, indicating that students experience relatively low social anxiety. In terms of gender, females and males did not differ in terms of social anxiety ($t(270) = .34$, $p = .738 > .05$). However, the social anxiety scores of participants differed significantly according to internet connection and device type. Accordingly, participants who used cellular connections ($t(270) = 2.42$, $p = .016 < .05$, $d = .30$) and handheld devices ($t(270) = 3.09$, $p = .002 < .01$, $d = .42$) felt more social anxiety in online discussions than those using fixed internet connections and PC. The magnitudes of both effect sizes were medium.

Research Question 3: To What Extent Do Participation Styles Predict Social Anxiety in Online Instructional Discussion Forums?

To answer this research question, a multiple linear regression analysis was performed. The results of the regression model are presented in Table 3.

Table 3. The prediction of social anxiety by participation styles in online instructional discussion forums

Dimension	Factor[a]	M[b]	SD	t	p	β[c]	R^2	f^2	Effect size
Why	To socialize	2.42	1.08	1.55	.123	.106	.011	.011	No
	To get information	3.81	1.01	-4.85	.000***	-.347	.120	.137	Small
	To discuss	3.66	.86	-.61	.540	-.042	.002	.002	No
	To fulfill requirements	3.06	1.11	2.62	.009**	.161	.026	.027	Small
How	Connective	2.08	.79	1.67	.097	.114	.013	.013	No
	Analytical	3.87	.79	3.31	.001**	.228	.052	.055	Small
	Innovative	3.41	.91	-1.78	.076	-.129	.017	.017	No
	Practical	1.85	.72	2.56	.011*	.154	.024	.024	Small

* Significant at.05, ** Significant at.01, *** Significant at.001.

[a]VIF (Variance Inflation Factor) ranged from 1.174 to 1.706, indicating no multicollinearity among predictors in the regression model (Hair et al., 2018)

[b]The scale is 5-point Likert-type

[c]Standardized regression coefficient

Note: The Durbin-Watson statistic was calculated as d = 2.059, which lies between acceptable intervals (Durbin & Watson, 1971).

In Table 3, two factors in both the "Why" and "How" dimensions of participation styles significantly contributed to the regression model. Of these, the "to get information" factor of the "Why" dimension negatively contributed. All of the significant predictors of social anxiety had small effect sizes ($f^2 < .15$). The multiple linear regression analysis revealed that participation styles for online instructional discussions account for 19.1% of the total variance of social anxiety in e-learning environments ($F(8, 263) = 7.785$, $p = .000 < .001$). Mean scores indicate that students mostly participate in IDFs in order "to get information" ($M = 3.81$, $SD = 1.01$) using an analytical approach ($M = 3.87$, $SD = .79$). Also notable is the relatively low mean of the "practical" factor of "How" dimension ($M = 1.85$, $SD = .72$).

DISCUSSION

The affective domain in e-learning literature has been widely neglected. To fill this gap, the purpose of this study was to identify the students' participation styles and their social anxiety levels in the e-learning environment and to reveal in detail the pattern between these two constructs. Specifically, participation style and social anxiety in an IDF were examined in terms of gender and individuals' access to handheld devices and Internet connections. A sample of 272 freshmen university students were recruited and experienced an IDF lasting three weeks, unearthing their participation styles and social anxiety.

The Effect of Gender and Technological Infrastructure on Participation Styles in an IDF

The results indicated that males participate in the instructional discussions in a more connective way than females. Several studies in the literature refer to the effect of gender on online participation behaviors (e.g., Caspi et al., 2008; Diep et al., 2016; Prinsen et al., 2007). The participation patterns of (fe)male participants might differ in classroom discussions depending on the environmental modality (i.e., face to face and online) (Caspi et al., 2008). They adopt distinctly different roles in the online community, especially in terms of social and interaction behaviors. There are conflicting findings in the literature in relation to the contribution of females and males to the discussion environment in terms of the number and length of messages posted (Caspi et al., 2008; Diep et al., 2016; Prinsen et al., 2007). However, the findings in favor of females seem predominant in terms of message length per post. Finally, it should be noted that in the present study, seven other participation styles yielded no gender difference.

The results revealed that students who participated in discussions for social interactions and exhibited connective characteristics mostly had cellular internet connections. More connective individuals, who contribute to the discussions inferentially, try to influence others and engage them in discussions (Pala & Erdem, 2020). Also, handheld device users use IDFs in a practical way for discussion purposes. Discussion-oriented participants, who behave in accordance with their expectations and environmental conditions, tend to learn authentically, placing special emphasis on content and comments in these environments. Practical participants commonly participate in discussions according to external factors shaped by the course, lecturer, and other participants. These participants consider the discussions as a responsibility to be fulfilled, and hence try to fulfill their responsibilities in an optimal way with minimal effort. Handheld device users are likely to have greater agility to participate in discussions than PC users thanks to instant notifications. Thus, they have the opportunity to achieve their goals in a more practical way through the ubiquitous availability of handheld devices. In addition, handheld devices provide more consistent context-awareness. Lan et al. (2012) pointed out that learners exhibit different strategies in an asynchronous discussion environment according to the type of device used. They found that students with handheld devices exhibit a more content-oriented tendency, send more posts, and contribute more to the co-construction of knowledge within the group.

The Effect of Gender and Technological Infrastructure on Social Anxiety in an IDF

In this study, social anxiety as a psychometric construct was examined by gender, type of device, and internet connection used. The results indicate that social anxiety did not differ according to gender in IDFs. By contrast, Asher et al. (2017) and Alsudais et al. (2022) found that women were more prone to suffer from social anxiety. This might be related to the fact that females' online communication self-efficacy levels are

lower than those of males (Demir & Yurdugul, 2015). Another factor that might cause this differentiation in social anxiety is communication styles (Cuming & Rapee, 2010; Newman et al., 2008). Furthermore, when the factors underlying social anxiety are investigated, it becomes apparent that females are worried about emotionality, authority, and workplace, whereas males are anxious about dating and preciseness (Barnett et al., 2021; Xu et al., 2012). In the present study, students could not be provided with an IDF that includes components such as emotionality, certainty, and dating which may elicit gender differences.

Examination of social anxiety according to technological infrastructure revealed that cellular connection and handheld device users are more anxious. Whereas instant notifications are sent from an IDF to individuals who connect to the environment via a handheld device, individuals participating in the education environment via a PC and fixed internet connection become aware of the discussions when they enter the environment in a planned way. In the literature, social anxiety is mostly examined in terms of online and face-to-face interactions (e.g., Blaauw, 2018; Doorley et al., 2020). Social anxiety decreases in communications established in virtual environments. However, as time spent in the online environment increases, the social skills of individuals in normal life decrease, and their social anxiety increases (Karaca et al., 2020). Accordingly, it can be claimed that online platforms are environments where individuals experience less social anxiety, but these environments do not totally eliminate anxiety (Pitcho-Prelorentzos et al., 2020). Smartphone notifications in particular affect individuals negatively in terms of emotional aspects such as depression, anxiety, and boredom proneness (Elhai et al., 2019). Parallel to this, this study found that students who connect to IDFs via cellular connections and handheld devices exhibit more social anxiety than others. Instant notifications coming to these devices from other sources (i.e., social networks, instant messaging applications, and so on) may also cause digital distraction and shift an individual's attention to an off-topic task (Kurt et al., 2021). In the light of all this information, it is concluded that frequent instant notifications and messages sent to learners may be causing social anxiety by creating a Fear of Missing Out (FoMo) on crucial information.

The Prediction of Social Anxiety by Participation Style in an IDF

The predictability of social anxiety by participation styles for IDFs was also tested. It was found that there was no predictability of "to socialize" and "to discuss" factors in the "Why" dimension nor was there predictability of "connective" and "innovative" factors in the "How" dimension. Regarding the socialization factor, participations exhibiting this kind of participation style like interaction, receiving attention, and feedback on their comments (Pala & Erdem, 2020). Nonetheless, the LMSs utilized in the current study had no emoji feature and had a primitive reply system. This substantially limited the ways in which the impact of a particular post could be measured. In addition, the overwhelming majority of students preferred to directly reply to questions rather than to the comments of other participants. Such shortcomings of the LMSs used and the participation patterns of students might have directed social participants to professional social networking sites to socialize, as these have the features they desire. As a result of not being able to measure the impact of their posts and compare it with others, in contrast to professional social networking sites, users seem to experience little or no social anxiety. Regarding the "to discuss" and "innovative" factors, individuals who aim to engage in discussion feel the need to make comments when they identify a different perspective in the discussions and view the latter as an authentic source of learning (Sansone et al., 2018). Discussion-oriented and innovative individuals disengage from the discussion as a result of repetition of similar views (Pala & Erdem, 2020). Merely posting a message to a discussion forum does not always mean that students are engaged in a dialogue or discussion (Salter & Conneely, 2015). In line with the above interpretation of results in relation to the socialization factor, the large number of responses sent directly to discussion questions rather than others' posts may have limited the emergence of conflict or provocation. It may also have mitigated the effect of social anxiety as the main motivation of students in this participation style is the emergence of conflict points and provocative comments.

The results revealed that two factors in each dimension of "How" and "Why" significantly predicted social anxiety, despite yielding small effect sizes. The analytical and practical participation behaviors and the purpose of fulfilling requirements positively predicted social anxiety, whereas the purpose of obtaining information in IDFs negatively predicted it. Information-oriented individuals have a tendency to make conceptual interpretations. These individuals typically focus on details in the subject area to become competent in discussions. The presence of the lecturer in the environment and the density of informative posts have a

positive effect on the participation of students in this group. Nonetheless, not giving feedback to posts is likely to affect the social anxiety levels of students with this participation style. Individuals with an analytical participation style peruse posts and ponder before posting as they are afraid to make mistakes (Pala & Erdem, 2020). Because they are focused on quality, they prefer to participate less in online discussions in order not to make errors (Wise et al., 2014). However, when they do engage, they seem to be confident about their posts, not heeding how others might receive them. Moreover, the authors created a democratic and respectful atmosphere in IDFs. In addition, it was concluded that in IDFs, practical participation behaviors and the aim of fulfilling the requirements also predict social anxiety. Practical learners are focused on quickly completing tasks that aim to fulfill a responsibility. The users in this group mostly participate in discussions due to extrinsic motivation factors, and are generally unwilling participants (Pala & Erdem, 2020; Phirangee et al., 2016). These extrinsic motivational factors are also thought to be the primary source of social anxiety in this kind of learner. The fact that participation in IDFs was voluntary seems to lessen the impact of these extrinsic motivation factors on social anxiety.

CONCLUSION

In sum, it was concluded that handheld devices and cellular internet data, create more social anxiety while connecting to IDFs. In addition, ICT availability or preferences for accessing the discussion platform played a determining role in some participation styles. Students who participated in discussions to complete course tasks experienced social anxiety, while those whose aim was to gain knowledge and to discuss were not exposed to such anxiety. It is important to note here that Pala and Erdem's (2020) "Why" dimension of participation styles for IDFs can be classified into two theoretical sub-dimensions: Extrinsic and Intrinsic motivators to participate. With regard to the current study, it was found that students' participation in discussions as a result of an extrinsic motivator or necessity ("to fulfill requirement") caused social anxiety. In essence, they cause a feeling of avoidance (Anjomshoa & Sadighi, 2015). Conversely, intrinsic motivators ("to socialize" and "to discuss") did not cause social anxiety. In short, the results of this study emphasize the crucial role of intrinsic motivation in encouraging people to participate in IDFs. Thus, the current study has vital implications for both researchers and practitioners in an extraordinary period when the formal dimension of learning is becoming more intertwined with our daily lives due to the e-learning activities we are all partaking in during the pandemic period. Awareness of the participation style and social anxiety of students can produce fruitful inferences that will help determine appropriate types of interventions for students who are low-achieving and at risk of drop-out.

LIMITATIONS AND SUGGESTIONS

Limitations

This study has several limitations that need to be addressed. First, social anxiety in e-learning environments was measured on a self-report scale. Such measures cannot accurately reflect learner behaviors and characteristics. Second, the LMSs (or IDFs in this context) used in this study were not as interactive and usable as the social networking sites students are familiar with. They did not support emojis and had reply systems with some usability problems. Third, the relatively small sample did not allow two-way ANOVA to be conducted between device type and internet connection type due to the low number of observations in the crosstabs.

Avenues for Future Research

Further scholarly attention may focus on measuring participation styles for an IDF through actual participation data such as log records. For instance, it would be instructive to compare participation styles obtained through self-report and log records. In addition, although the study sample was scattered across six different classes varying in size from 21 to 150, the effect of class size on participation behaviors was not examined. Yet group size possibly affects participation styles. Studies have reported that a large group size decreases active participation and increases passive follow-up in discussions (Ruthotto et al., 2020). In this research, students used handheld devices simply because they could not afford to purchase PCs. This begs

the question: "Do income levels impact social anxiety and participation styles for IDFs over device type?" In short, "is device type mediating this relationship?" The authors could not collect income levels as this is sensitive data. Complicating this possible relationship, the authors came to realize that a small number of students attended classes with handheld devices merely because they were ubiquitous, despite having a PC. This raises another question: "What are the roles of mandatory and volunteer hand-held device usage in IDFs". Mixed-research design studies can therefore be carried out to shed light on these issues.

Directions for Practitioners

Practitioners of e-learning should be taking a number of precautions to reduce the social anxiety students experience in IDFs. They are supposed to stress that sending "comprehensive and well-thought" answers in IDFs are more valuable and beneficial than sending "quick and unprobed" answers and that students will be graded not on the number of posts they send, but on the quality so that they feel less pressure due to the instant notifications of handheld devices. This will help to reduce levels of social anxiety. This study puts forward several suggestions for the construction of IDFs based on its findings. Some students have difficulty reading all the comments in the discussion thread and so returning to the forum poses a challenge for them (Walji et al., 2016). Discussion threads include many different types of posts and interaction patterns. Categorizing the posts in the IDFs (e.g., in accordance with a knowledge building perspective) might alleviate the anxiety levels of students with different participation types (e.g., analytical style) by filtering out posts more suitable for them (Scardamalia & Bereiter, 2006). Such epistemological markers or tags to posts will give students an opportunity to preview the posts in the course of a general discussion. Similarly, statistics about affective responses and discussion metrics will stimulate students to approach the discussion topic or problem in accordance with their preferred approach. The aforementioned suggestions might constitute a basis for creating a discussion environment that adapts itself to the pre-measured participation styles of learners in order to reduce levels of social anxiety.

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APPENDIX

Table A1. The effects of gender and technological infrastructure on participation style

Dimension	Factor	Gender	*N*	*M*[a]	*SD*	*t*	*p*	d_{Cohen}
Why	To Socialize	Male	94	2.55	1.03	1.47	.144	NA
		Female	178	2.35	1.10			
	To get information	Male	94	3.65	1.02	1.91	.057	NA
		Female	178	3.89	.99			
	To discuss	Male	94	3.73	.85	.87	.387	NA
		Female	178	3.63	.87			
	To fulfill requirements	Male	94	2.99	1.08	.72	.469	NA
		Female	178	3.09	1.12			
How	Connective	Male	94	2.24	.86	2,54	.012*	.32
		Female	178	1.99	.75			
	Analytical	Male	94	3.78	.86	1.29	.197	NA
		Female	178	3.91	.75			
	Innovative	Male	94	3.44	.89	.45	.197	NA
		Female	178	3.39	.92			
	Practical	Male	94	1.94	.73	1.45	.147	NA
		Female	178	1.81	.71			

[a] *It is the mean item scores of a 5-point Likert-type scale. df = 270, *p < .05.*

Table A2. The effects of Internet connection type on participation style

Dimension	Factor	Internet connection type	N	M[a]	SD	t	p	d_{Cohen}
Why	To Socialize	Cellular	118	2.58	1.12	2.14	.033*	.26
		Fixed	154	2.30	1.02			
	To get information	Cellular	118	3.91	.93	1.40	.161	NA
		Fixed	154	3.73	1.06			
	To discuss	Cellular	118	3.74	.78	1.27	.206	NA
		Fixed	154	3.61	.92			
	To fulfill requirements	Cellular	118	3.03	1.15	.33	.742	NA
		Fixed	154	3.08	1.07			
How	Connective	Cellular	118	2.19	.80	2.14	.033*	.26
		Fixed	154	1.99	.78			
	Analytical	Cellular	118	3.94	.73	1.23	.220	NA
		Fixed	154	3.82	.82			
	Innovative	Cellular	118	3.49	.83	1.24	.217	NA
		Fixed	154	3.35	.97			
	Practical	Cellular	118	1.88	.74	.46	.644	NA
		Fixed	154	1.83	.70			

[a] *It is the mean item scores of a 5-point Likert-type scale. df = 270, *p < .05,*

Table A3. The effects of device type on participation style

Dimension	Factor	Device Type	N	M[a]	SD	t	p	d_{Cohen}
Why	To Socialize	Handheld	193	2.50	1.10	1.79[b]	.075	NA
		PC	79	2.24	.98			
	To get information	Handheld	193	3.86	1.01	1.27[b]	.206	NA
		PC	79	3.69	1.01			
	To discuss	Handheld	193	3.73	.84	2.13[b]	.034*	.28
		PC	79	3.49	.89			
	To fulfill requirements	Handheld	193	3.12	1.13	1.42[a]	.156	NA
		PC	79	2.91	1.05			
How	Connective	Handheld	193	2.12	.77	1.48[b]	.141	NA
		PC	79	1.97	.84			
	Analytical	Handheld	193	3.89	.75	.75[c]	.454	NA
		PC	79	3.81	.86			
	Innovative	Handheld	193	3.43	.90	.56[b]	.576	NA
		PC	79	3.36	.93			
	Practical	Handheld	193	1.92	.75	2.36[b]	.019*	.33
		PC	79	1.69	.60			

*[a] It is the mean item scores of a 5-point Likert-type scale. [b]df = 270, [c]df = 129.15, *p < .05,*