Anxiety and Digital Phenotypes as Diversity Markers for Selected Filipino University Students

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ABSTRACT

With the considerable multitude of distinct characteristics and backgrounds within the student population, their learning needs manifest in diverse forms. Apart from the commonly identified factors contributing to student diversity, such as age, ethnicity, language, and socio-economic status, this quantitative research examined anxiety and digital phenotypes as potential markers of diversity. The study investigated the relationship between these possible diversity markers and the demographic variables of gender, degree of higher education, living arrangement, and student employment status. The analyzed data came from 103 Filipino university students who successfully completed a self-report on anxiety and two-week recordings of smartphone activities. Results showed that the students' living arrangements are the most critical demographic variable. Anxiety and digital phenotypes may be diversity markers for students' living arrangements. In light of these findings, educational institutions should determine and implement inclusive strategies to further safeguard their students' mental health, particularly those living alone.

Keywords: student diversity, smartphone, post-pandemic, mobile applications

Introduction

Learners, being the central focus of any educational process, possess individual differences that contribute to student diversity. Although there is a multiplicity of definitions, the concept of 'diverse students' generally pertains to individuals from different racial, cultural, ethnic, linguistic, and socio-economic origins (Hishan et al., 2020). Current perspectives on diversity markers among students imply that learners exhibit inherent differences in their ancestral roots, attributes, way of life, dialects, and social strata, resulting in varying learning needs. The idea behind diversity has grown more all-encompassing, looking at it through wider lenses. According to Pineda and Mishra (2023), "diversity in itself is a broad and continuously evolving concept...the understanding of diversity has differed from an emphasis on race/ethnicity and gender to including religion, income, family characteristics, disabilities, chronic health conditions, and sexual orientation" (p. 865). These qualities, combined with students' lived experiences, may contribute to the persistent evolution of diversity markers.

For the last few decades, academic and social discussions on diversity markers have seen a noticeable increase. In higher education institutions, studies have already been undertaken to scrutinize the concept of diversity and its acceptance among students (Veccaro in Trolian & Parker III, 2022). The overwhelming conclusion from these studies is that there is a strong need for strategies to assist students in becoming more cognizant of and tolerant of their differences. For instance, Trolian and Parker III imply that higher education institutions should also be proactive in determining diversity markers, exploring beyond the commonly mentioned student backgrounds and characteristics. Likewise, for a more enhanced student learning experience, it is incumbent upon educators to acknowledge diversity markers to foster inclusivity in the classroom.

Diversity markers are identifiable attributes of learners that contribute to each of their unique learning experiences. These identifiable and measurable markers also establish a varying range of learning needs, and as Pozas et al. (2020) asserted, diverse learning needs call for an inclusive instructional approach that effectively incorporates varying strategies and methods. It suggests that educators, irrespective of the level of education they are entrusted with teaching, must give significant thought to student diversity, particularly to the educational demands arising from their unique characteristics and associated diversity markers. In this paper, we expand the concept of diversity markers by looking into student anxiety and digital phenotypes, or smartphone activities, to nurture greater learning comprehensiveness.

Local and global reports mention the upsurge in the number of anxiety-related cases among students (Acob et al., 2021; Jehi et al., 2022; Radwan et al., 2021; Son et al., 2020) and

smartphone usage (Mella-Norambuena et al., 2021; Serra et al., 2021), this research investigated potentially new diversity markers to help students thrive in post-pandemic times. This study focused on anxiety and digital phenotypes among selected university students as they made the necessary shift in learning modes. To achieve this, the researchers aim to find answers to the following research inquiries:

1. What is the level of anxiety of the participants?
2. What are the patterns of digital phenotypes of the participants, specifically in terms of:
    a. amount of time spent on smartphones and
    b. most frequently used mobile applications?
3. Are there significant differences in the level of anxiety of the participants when grouped according to the following demographic variables:
    a. gender;
    b. degree of higher education;
    c. living arrangement, and
    d. student employment status?
4. Is there a correlation between anxiety and each of the demographic variables?
5. Is there a correlation between digital phenotypes and each of the demographic variables?
6. Is there a correlation between anxiety and digital phenotypes of the participants?

Literature Review

Anxiety as a Diversity Marker

Recent research on student diversity highlights the importance of implementing additional mechanisms in universities and colleges that aim to support the psychological welfare of students, recognizing anxiety as an emerging diversity marker. As a diversity marker, anxiety manifests in different ways and causes varying degrees of psychological unease and fear among university students, stemming from numerous reasons and factors. Individuals aged 18 to 24 experience the most mental health conditions, particularly during the pandemic (Panchal et al., 2023). Just as undergraduate and graduate students are individually unique regarding their academic abilities and learning potential, so are their responses to anxiety. A study by Basheti et al. (2023) describes a marked abnormality in the anxiety scores of university students, especially among female participants, younger students, and those on medication. Given the rising prevalence of student anxiety, there is a need for differentiated support and instruction (Liu & Shi, 2023). Comparably, Hall (2022) emphasized the significance of

seeking the assistance of mental health professionals, taking pauses, and engaging in self-care activities to improve one's mental condition.

Digital Phenotypes as Diversity Markers

To gain a better understanding of an individual's emotional and mental states, such as anxiety, digital phenotyping or smartphone behavior analysis is used as a contemporary and naturalistic mode of analysis since the "smartphone may be an unprecedented opportunity to measure real-world functioning and potentially to offer just-in-time interventions" (Insel, 2018). This enables digital phenotyping to be a novel way to facilitate more accurate identification and effective management of mental health conditions (Martinez-Martin et al., 2018). According to Onnela (2021), digital phenotyping centers on continuous observation and data collection from a digital device such as a smartphone without interrupting natural or actual behaviors. This makes smartphone behaviors the digital manifestations of an individual's environment, genotype, and phenotype (Harvard School of Public Health, 2019), thus representing the collection of continuously monitored digital behaviors throughout a timeframe. Hence, digital phenotyping becomes a diversity marker for learners because of the smartphone's feature of real-time monitoring of the user's digital behaviors and likely reflects the user's state of mind.

One coping strategy during the pandemic was to engage more with smartphones. The uses and capabilities of mobile technology, specifically that of mobile phones and smartphones, have grown exponentially in proportion in the past 40-plus years. Due to its omnipresence and popularity, these devices are used for a diverse roster of functions for longer periods of screen time (Kemp, 2020). In a recent survey, internet users, particularly the younger generation, have become more attached to their mobile phones due to lockdown effects (Sebire, 2020). This increased smartphone activity during the pandemic can indicate the need for information and the desire for any semblance of normality (Nortajuddin, 2020).

In a survey of ASEAN Post in 2020, mobile phone users in the Philippines are reported to spend more time on social media than in any other country, and compared to the global average of 47%, 64% of Filipinos in this survey claimed that their 'social time' has grown (Nortajuddin, 2020). Furthermore, during the initial lockdowns in the Philippines, during which social and psychological distress was high, Filipinos spent 9 hours daily on social media looking for information and breaking news. The increased smartphone use may have promoted strong well-being and made people feel more connected to others. An earlier study by Cho (2015) concluded that decreased levels of loneliness and increased sentiments of social capital can be linked to smartphone communication applications. This is supported by the

research of David and Roberts (2021), which concludes, among others, that using a smartphone reduces the detrimental effects of isolation on well-being and social connectedness.

The literature reviewed for this study led the researchers to develop a conceptual framework, presenting the two main variables in Figure 1—anxiety and digital phenotypes.

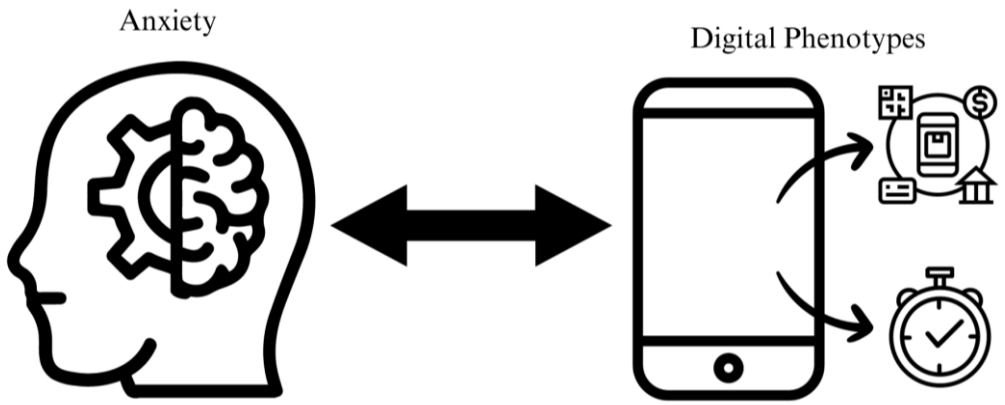

Figure 1: Conceptual Framework for Anxiety and Digital Phenotyping as Diversity Markers

Anxiety is an emotional experience exemplified by feelings of tension and worried thoughts, as well as accompanying physical changes. The digital phenotype, which arises from the interface between a person's cognitive and emotional processes and modern technology, refers to the digital manifestation of smartphone behaviors (in terms of time spent and the nature of mobile applications utilized) as influenced by a person's mental state. We hypothesize that anxiety and smartphone behaviors influence one another, wherein anxiety is manifested by the amount of screen time and type of mobile application one engages with as forms of checking or reassurance behaviors. Conversely, screentime duration and the nature of mobile applications used are affected by anxiety; likewise, anxiety leads to increased screentime and frequent use of specific mobile applications.

Methodology

Research Participants

The participants were selected Filipino university students who had satisfied the following inclusion criteria: (1) must be enrolled in any higher education institution in the Philippines; (2) must be between 18 and 35 years old; and (3) must own a mobile device that has (at least) Android operating system (AOS) version 10 or (at least) iOS version 13, which is capable of monitoring digital footprints. The term 'university students' refers to undergraduate and

graduate students enrolled in a Philippine higher education institution during the data collection period. To note, no specific Philippine university was specifically targeted in determining the sample size for this study, as long as the participant fits the inclusion criteria.

Research Instruments

Digital Phenotypes: Measurements of smartphone behaviors, particularly frequency of smartphone usage (in terms of minutes) and types of frequently used mobile applications, were recorded during a two-week period, which coincides with the timeframe covered by GAD-7.

Generalized Anxiety Disorder Assessment-7 (Spitzer et al., 2006): The GAD-7 is a self-report measure of clinically significant anxiety experiences for the past two weeks. GAD-7 includes seven components with equivalent points: nervousness, inability to stop worrying, excessive worry, restlessness, difficulty relaxing, easy irritation, and fear of something awful happening. Upon completing the assessment, the points for the seven components were totaled. To note, cutoff scores are 5, 10, and 15 for mild, moderate, and severe levels, respectively, while scores lower than 5 are categorized as minimal.

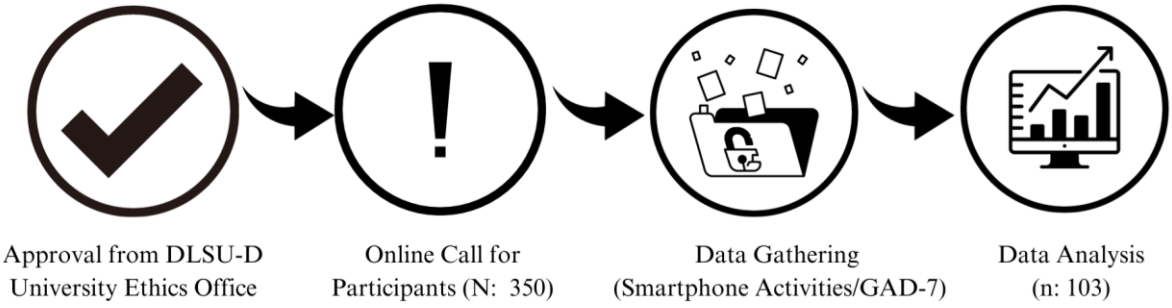

Figure 2: Research Framework

Data Gathering

A seven-month online call for university participants, both undergraduate and graduate students, was posted from October 2022 to May 2023. For the utmost protection of the participants, the researchers secured Informed Consent from them and an Ethics Certification from the Ethics Review Committee before data gathering. The consent obtained from the participants contains protocols for voluntary participation, potential risks and benefits, confidentiality, and the right to withdraw without any penalty. Participants who fulfilled the qualifications were given online access to a questionnaire for demographic profiling. They were requested to provide screenshots of their recent two-week smartphone activities, monitored using the Digital Well-Being (Android smartphones) or Screen Time (iOS smartphones) applications. Participants answered the GAD-7 on the day they submitted the completed two-week screenshots. Out of the 350 online participants who participated in the call, the researchers analyzed data from 103 participants who had successfully submitted the

required two-week screenshots and completed GAD-7.

Data Analysis

Software programs, specifically *jamovi* Statistical Software and Microsoft Office Excel Software Data Analysis Toolpak, were utilized for data analysis. Descriptive statistics were used for the demographic description of the participants. Frequencies, means, and standard deviations were calculated to characterize GAD-7 anxiety scores and digital phenotypes. Mode identified participants' most frequently used applications. A t-test for independent samples and one-way analysis of variance (ANOVA) were used to determine significant differences between variables. Correlational statistics, specifically Pearson product-moment correlation (r), was applied to explore the links between GAD-7 scores and the average weekly smartphone usage. Point-biserial correlation (rpb) was used to check associations between demographic variables and anxiety scores and b) average weekly smartphone usage. Additionally, the associations between anxiety levels, demographic variables, and the category of applications used by the participants were determined by calculating the chi-square test of independence and the computation of Cramer's V for effect sizes.

Result

Table 1: Demographic Profile of the Participants (n: 103)

Variable	Frequency	GAD-7		
		M	SD	SE
1. Gender				
a. Male	76	8.87	5.40	0.62
b. Female	23	9.39	5.95	1.24
c. Others	4	9.00	4.32	2.16
2. Degree of Higher Education				
a. Undergraduate	82	9.12	9.00	5.53
b. Graduate	21	8.48	9.00	5.23
3. Living Arrangement				
a. Alone	5	13.80	6.38	2.85
b. With Family Members	96	8.92	5.24	0.53
c. With Others	2	0.50	0.71	0.50
4. Student Employment Status				
a. Non-Working	74	9.18	5.47	0.64
b. Working	29	8.52	5.47	1.02

The summary of the 103 participants' demographics is presented in Table 1. The gender of "Others" covers participants who identify themselves as non-binary. "Degree of education" refers to participants who are either taking up their bachelor studies (undergraduate) or pursuing a Master's or Doctorate degree (graduate). "Living with others" describes participants with non-relatives, such as friends and other students. "Student employment status" pertains to whether or not the participant is a full-time (non-working) or a part-time (working) student.

The majority of participants were males (73.79%), undergraduate students (79.61%), living with family members (93.20%), and non-working or studying full-time (71.84%). In terms of GAD-7 anxiety scores, the highest mean scores were obtained by female participants (mild to moderate range), undergraduate students (mild to moderate range), participants living alone (moderate to severe), and non-working or full-time students (mild to moderate).

Research Question 1: What is the level of anxiety of the participants?

Table 2 shows the frequencies of scores based on GAD-7's anxiety severity levels. The average score of the participants was 8.99 (SD=5.45; 38.8%), with a median of 9. This is equivalent to a minimal level of anxiety. As seen in Table 2, most participants (83.49%) experienced less severe anxiety symptoms.

Table 2: GAD-7 Anxiety Levels of the Participants

Level	Frequency	M	SD	% of Total	Cumulative %
Minimal	40	3.45	1.81	38.83	38.83
Mild	24	8.88	0.95	23.30	62.13
Moderate	22	12.45	1.18	21.36	83.49
Severe	17	17.71	2.02	16.50	100.00

Research Question 2. What are the patterns of digital phenotypes of the participants, specifically in terms of time spent on smartphones and most frequently used mobile applications?

Table 3: Time Spent Using Smartphones in Minutes

	Week 1							Week 2						
Day Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
M	463	472	474	485	508	518	533	521	506	500	496	507	487	400
Mdn	466	469	491	497	501	530	499	508	485	486	480	465	489	411
SD	229	216	217	223	214	226	234	224	219	212	222	212	198	199
Minimum time	0	0	0	0	0	0	0	0	0	0	0	19	65	32
Maximum time	957	954	915	1057	1162	1080	1440	1440	1440	1440	1440	988	970	899

Table 3 displays the number of minutes participants spent being engaged on their smartphones, including the time range spent per day (minimum and maximum time). Weekly, they spent an average of 3,458 minutes (57.63 hours) for Week 1 and 3,417 minutes (56.95 hours) for Week 2 on their mobile devices. The two-week total time spent was 6,870 minutes (114.58 hours). The daily average mobile phone usage was 490.71 minutes (8.18 hours).

Table 4: Most Frequently Used Mobile Applications

Nature of Mobile Applications (Sample Applications)	Counts	% of Total	Cumulative %
1. Social Media (e.g., Facebook, Twitter, Instagram)	2000	38.19	38.19
2. Communication (e.g., Messenger, Messages, Viber)	838	16.00	54.19
3. Entertainment (e.g., YouTube, Spotify, Netflix)	723	13.81	68.00
4. Productivity (e.g., Clock, Drive, Notes, Office)	412	7.87	75.86
5. Browser (e.g., Chrome, Safari, Google)	294	5.61	81.48
6. Games and Apps (e.g., Clash of Clans, Call of Duty)	293	5.59	87.07
7. Creativity (e.g., Capcut, Canva)	187	3.57	90.64
8. Reading and News (e.g., Manga Reader, Wattpad)	153	2.92	93.57
9. Shopping (e.g., Lazada, Shoppee)	117	2.23	95.80
10. Education (e.g., NEO LMS, Cerebro LMS)	25	0.48	96.28
11. Dating and Networking (e.g., Bumble, Grindr, Tinder)	20	0.38	96.66
12. Health and Fitness (e.g., Fitcoach, Home Workout)	20	0.38	97.04
13. Transportation (e.g., Grab, Lalamove)	16	0.31	97.35
14. Finance (e.g., GCash, Maya)	9	0.17	97.52
15. Food (e.g., Foodpanda)	8	0.15	97.67
16. Religion and Spirituality (e.g., Bible)	3	0.06	97.73
17. Other	39	0.74	98.47
18. None	80	1.53	100.00
Total	5237	100.00	

"Counts" indicate the number of times participants accessed and used the mobile applications listed. According to Table 4, participants interacted with the listed applications 5,237 times and were monitored using Digital Well-Being or Screen Time applications. The top three frequently used applications fell under social media, communication, and entertainment—the least used applications related to finance, food, religion, and spirituality.

Research Question 3. When grouped according to demographic variables, are there significant differences in the participants' anxiety levels?

Table 5: One-Way ANOVA for Anxiety and Gender

	F	df1	df2	p-value
GAD-7 Total	0.0658	2	8.22	0.937

Table 5 presents one-way ANOVA results regarding whether there are significant differences in anxiety levels when grouped according to the four demographic variables. When grouped according to gender, it was determined that there is no significant difference at the $p<.05$ level for the three gender groups ($F[2, 8.22]=0.0658$; $p=.937$).

Table 6: T-Test for Independent Samples for Anxiety and Degree of Higher Education

	Statistics	df	p-value
GAD-7 Total	0.483	101	0.630

To determine if there is a significant difference in the level of anxiety between undergraduate and graduate student participants, a t-test for independent samples was used. Table 6 shows no significant difference in their anxiety levels ($t[101]=0.483$; $p=.630$).

Table 7: One-Way ANOVA for Anxiety and Living Arrangement

	F	df1	df2	p-value
GAD-7 Total	63.9	2	5.66	<.001

When grouped according to living arrangement, significant differences in the anxiety scores were noted in Table 7 using ANOVA ($F[2, 5.6]=63.9$; $p< .001$). As per the breakdown of the demographic profile in Table 1, participants living by themselves had the highest mean anxiety score ($M=13.80$; moderate to severe levels), followed by those living with family members ($M=8.917$; mild to moderate levels), and, lastly, those living with others aside from family members ($M=0.500$; minimal level).

Table 8: T-Test for Independent Samples for Anxiety and Student Employment Status

	Statistics	df	p-value
GAD-7 Total	0.550	101	0.584

As presented in Table 8, based on the t-test for independent samples, no significant difference in the anxiety level was noted between working and non-working students (t[101]=0.550; p=.584).

Research Question 4. Is there a correlation between anxiety and each of the demographic variables?

Table 9: Correlation Matrix of Anxiety and Demographic Variables

		GAD-7	Gender	Living Arrangement	Higher Education	Employment
GAD-7	*rpb*	—				
	p-value	—				
Gender	*rpb*	0.025	—			
	p-value	0.804	—			
Living	*rpb*	-0.284**	0.001	—		
Arrangement	p-value	0.004	0.991	—		
Higher	*rpb*	-0.051	0.314**	-0.222*	—	
Education	p-value	0.612	0.001	0.025	—	
Employment	*rpb*	-0.055	0.068	-0.180	0.485***	—
	p-value	0.584	0.492	0.069	< .001	—

Point-biserial correlations were computed to determine the association between the demographic variables and anxiety scores. As seen in Table 9, there are no significant relationships between anxiety scores and three of the variables, specifically gender (rpb=0.025), degree of higher education (rpb=-0.051), and student employment status (rpb = -0.130). A significant relationship exists between anxiety scores and living arrangements (rpb=-0.284), implying that students living alone tend to report higher anxiety.

Research Question 5. Is there a correlation between digital phenotypes and each of the demographic variables?

Table 10: Correlation Matrix of Digital Phenotype-Time Spent and Demographic Variables

		TS W1	TS W1+W2	Gender	Living Arrangement	Higher Education	Employment
TS W1	*rpb*	—					
	p-value	—					
TS W1+W2	*rpb*	0.938***	—				
	p-value	< .001	—				
Gender	*rpb*	0.034	0.083	—			
	p-value	0.736	0.404	—			
Living	*rpb*	-0.022	0.005	0.001	—		
Arrangement	p-value	0.826	0.962	0.991	—		
Higher	*rpb*	-0.094	-0.135	0.314**	-0.222*	—	
Education	p-value	0.349	0.175	0.001	0.025	—	
Employment	*rpb*	-0.232*	-0.235*	0.068	-0.18	0.485***	—
	p-value	0.019	0.017	0.492	0.069	< .001	—

Note. W1=Week 1; W1+W2= Weeks 1 and 2; *p< .05; **p< .01; ***p< .001

A point-biserial correlation was used to explore whether relationships exist between time spent and demographic variables. Looking at one-week smartphone usage, Table 10 shows no significant relationships between time spent on mobile phones and gender (rpb=0.034), degree of higher education (rpb= -0.094), or living arrangement (rpb= -0.022). However, a significant correlation exists between time spent and student employment status (rpb= -0.232).

Similar relationships were found for two weeks of smartphone use. No significant relationships existed between time spent on mobile phones and gender (rpb=0.083), degree of higher education (rpb= -0.135), or living arrangement (rpb=0.005). Nonetheless, a significant correlation exists between time spent and student employment status (rpb= -0.235).

Table 11: Chi-Square Test of Independence for Digital Phenotype-Most Frequently Used Applications and Demographic Variables

	Value	df	p-value
Gender			
X^2	179.4852	34	0.000
N	5237		
Higher Education			
X^2	96.27	17	0.000
N	5237		
Living Arrangement			
X^2	130.76	34	0.000
N	5237		
Employment Status			
X^2	233.32	17	0.000
N	5237		

In Table 11, a chi-square test of independence was performed to assess the relationship between the commonly used applications and demographic variables. It was found that significant relationships exist between the applications and demographic variables. Significant but weak relationships were found between most commonly used applications and gender (X^2[34; N=5237]=179.49; p=0.000; V=0.131) and higher education (X^2[17; N= 5237]=96.27; p=0.000; V=0.136). A moderately significant relationship exists between most commonly used applications and student employment status (X^2[17; N=5237)=233.32; p=0.000; V=0.211). Lastly, there is a strong correlation between commonly used applications and living arrangements (X^2[34; N=5237]=130.76; p=0.000; V= 0.764).

Research Question 6. Is there a correlation between anxiety and digital phenotypes of the participants?

Table 12: Correlation Matrix of Anxiety and Digital Phenotype-Time Spent

		GAD-7	TS W1	TS W1+W2
GAD-7	Pearson's r	—		
	p-value	—		
TS W1	Pearson's r	0.014	—	
	p-value	0.890	—	
TS W1+W2	Pearson's r	0.070	0.938***	—
	p-value	0.483	< .001	—

Note. W1=Week 1; W1+W2= Weeks 1 and 2; *p< .05; **p< .01; ***p< .001

Digital phenotypes are categorized into time spent on smartphone usage and the nature of frequently used mobile applications. Table 12 presents the correlation matrix for anxiety and time spent during one week and two weeks of smartphone usage. A Pearson product-moment correlation was computed to determine the presence or absence of a significant relationship between the two variables. Based on Pearson correlation coefficients, no significant correlations were found between anxiety and time spent on the mobile device in both one-week (r=0.014) and two-week (r=0.070) data.

Table 13: Chi-Square Test of Independence for Anxiety and Digital Phenotype-Most Frequently Used Applications

	Value	df	p-value
X^2	343.945155	51	0.000
N	5237		

A chi-square test of independence was used to determine the relationship between anxiety and the type of mobile applications used. Table 13 shows a statistically significant relationship between the variables. However, after applying Cramer's V to determine the effect size of this relationship, it was determined that the association between anxiety and frequently used mobile applications, although significant, is weak (X^2[51; N=5237)=343.94; p=0.000; V=0.148).

Discussion and Implications

Our study aimed to identify possible learning diversity markers among selected university students in the post-pandemic times, specifically anxiety and digital phenotypes or smartphone behaviors regarding the amount of time spent and most used mobile applications.

Anxiety as a Diversity Marker

In recent years, there has been a surge in scholarly investigations that center on anxiety among students in higher education and its associated determinants, such as gender, level of education, and residence (Jehi et al., 2022). While the general level of anxiety varies among our study participants, it nonetheless shows that higher education students experience anxiety. This pattern of anxiety is supported by Eisenberg et al. (2023) for the years 2021 and 2022.

Three of the four demographic variables we focused on, namely gender, degree of higher education, and student employment status, were not correlated with anxiety. It implies that our student participants generally experience similar anxiety levels regardless of these variables. Although we did not find evidence of an association between "student employment status" and anxiety, participants who identified as non-working or full-time students nevertheless obtained higher anxiety mean scores. Since most of the participants in this employment status category were relatively early in their university education and came from varying socio-economic backgrounds, they might not have fully adjusted to college life. Additionally, the pandemic hit as they were starting or about to begin their tertiary education, which might have compounded their adjustment challenges.

"Living arrangement" was found to have an inversely significant correlation with anxiety. Students who live alone or alone are prone to higher levels of anxiety, while students who live with their families or others tend to experience lower anxiety levels. According to Edwards et al. (2022), living situation significantly predicts anxiety levels. Support from peers, family, and other social individuals plays a significant role in predicting the level of anxiety (Ortenburger et al., 2021). As Edwards et al. (2022) and Szkody et al. (2020) stated, having a

support system may be a mitigating factor in safeguarding a better state of mental health. In addition, it is important to emphasize the influence of residing in solitary living arrangements or possessing limited social support systems on cautiousness and outlook toward danger (Szkody et al., 2020). Thus, Philippine educators must consider students' living arrangements as part of their learning experience. MacDonald and Schermer (2021) examined the relationship between the subjective experience of social isolation, loneliness, and technology. They also looked into anxiety as a potential predictor variable. After evaluating how dwelling situations are associated with experiences of social isolation, they concluded that people living alone tend to experience higher levels of loneliness than those living with roommates or family members.

Digital Phenotypes as Diversity Markers

Similar to recent studies on the ubiquitousness of smartphones in day-to-day functioning, smartphone usage has become a crucial part of participants' daily routines, as seen in the temporal patterns of digital behaviors, whether daily or weekly. In our study, the reported daily average time spent on smartphones, which is 8.18 hours, is close to the range mentioned by Lacificar (2019), which is 5 to 8 hours. Our research data shows a significant and weak relationship between the average time spent and student employment status. Correspondingly, the significance of time allocated to smartphone engagement emphasizes the need to find a balance that allows them to engage in other important offline activities.

Furthermore, data provided by participants' Digital Well-Being or Screen Time applications presented valuable insights into their preferences for mobile applications. Social Media applications, such as Facebook and Instagram, had the highest frequency of engagement, suggesting the weighty role these applications have in their daily lives. Meanwhile, the second and third-highest frequencies were observed for Communication and Entertainment applications, respectively, indicating the importance of messaging platforms like Messenger and video content like YouTube. These top three mobile applications potentially impact participants' social interactions, information consumption, and overall well-being. This is supported by the similar findings of Lacificar (2019). Additionally, Pajarillo-Aquino (2019) mentions that a greater percentage of Filipino university students utilize their mobile devices to communicate with their peers and teachers. Cabrera et al. (2019) noted that many Filipinos use Facebook or Messenger applications regularly.

Frequently used mobile applications have significant and weak correlations with gender, degree of education, and employment status. Buctot et al. (in Albursan et al., 2022) have pointed to the existence of a gender disparity when it comes to the types of mobile

applications. In contrast, Filipino male students use their smartphones for entertainment, such as playing games. Filipino female students prefer using smartphones to foster connections through social networks and engage with multimedia applications. In terms of the degree of education, undergraduate students appear generally more inclined towards intensive utilization of smartphone technology when juxtaposed with older social groups, presumably with higher educational attainment. Albursan and colleagues (2022) looked into smartphone addiction among university students and found a higher mean score for undergraduate students than for graduate students.

The most notable and robust correlational finding is between participants' living arrangements and their preferred mobile application category. Participants who lived alone were more engaged in using mobile applications, primarily social media, followed by communication and entertainment. While social media and communication applications focus on connecting people, sharing information, and initiating and maintaining social connections, entertainment applications (such as gaming, video streaming, and music) highlight leisure activities and relaxation.

Correlation Between Anxiety and Digital Phenotypes

Our initial hypothesis is that anxiety and digital phenotypes, or smartphone behaviors, affect one another. Findings are split in support of this hypothesis. Based on data collected regarding time spent with smartphones, there is no significant correlation between anxiety levels and the amount of smartphone usage time. This result adds to the growing scientific consensus that screen time does not reflect the state of mental health among university students (Rozgonjuk et al., 2018; Shaw et al., 2020), inferring that using screen time or smartphone usage as a stand-alone tool to determine anxiety may not be beneficial.

On one hand, a significant, albeit weak, relationship was found between anxiety and the type of mobile application used. This implies that participants tend to gravitate toward certain mobile applications when feeling anxious. According to Ryu et al. (2021), individuals experiencing clinical anxiety demonstrated higher levels of engagement with social networking applications than communication applications, as observed in their investigation of social media usage patterns during the pandemic. This finding supports our data that participants living alone (with the highest level of anxiety) have higher engagement with social media and communication mobile applications.

Conclusion

The living arrangements of the university students participating in this study appear to be the most critical demographic variable. Anxiety and digital phenotypes may be diversity markers for students' living arrangements. In light of these findings, educational institutions should adopt more inclusive strategies, such as regular monitoring, peer support, teacher-student mentoring programs, and remote counseling services, to promote their students' mental health, particularly those living alone. Moreover, anxiety or digital phenotypes may or may not universally affect individuals within varied demographics. Still, higher education institutions need to foster an atmosphere that nurtures the success of all students, regardless of their unique or generalized responses to anxiety or patterns of digital engagement. Although screen time or time spent with smartphones was not associated with anxiety, it might be better to consider the type of mobile applications used since this digital phenotype was correlated with anxiety.

Recommendations

Life in a tertiary educational institution can be daunting, especially after the pandemic. Students from all levels must maneuver academic requirements, mental health challenges, and adjustments. Since it has been established that mental health affects academic performance, it would benefit higher learning institutions to invest in their students' psychological and emotional well-being. Mental health programs should be consistently implemented to monitor student well-being, particularly paying special attention to those considered most vulnerable psychologically. Since results show that social media and communication mobile applications are the top digital applications, mental health program developers may consider incorporating such applications for monitoring and as an additional and reliable mechanism that students needing psychological assistance may explore. Furthermore, helping students build more self-awareness can better inform them of their mental health status and make them more cognizant of how their well-being and digital behaviors impact one another.

There is a need to further examine the link between mental health and digital phenotypes to obtain a more balanced perspective on the role of smartphones among university students. Continued research efforts should be considered to involve more diverse populations, explore other variables, and scrutinize specific contexts when mobile devices can positively impact mental health. These future research endeavors may similarly hold practical significance for

scholars, advocates, mental health professionals, and university instructors who intend to promote the welfare of students in an ever-growing digital society.

Limitations

Due to the sample size and characteristics of the participants, generalizability is limited. In addition, smartphone behaviors were monitored using specific smartphone versions, and therefore, there is a bias toward those who can afford the more current smartphone models. The study did not explore other serious mental health consequences of excessive smartphone use, such as smartphone addiction. While the study did not delve into the benefits and drawbacks of smartphone usage, the findings can inform the development of essential mechanisms to promote healthier and more balanced smartphone usage habits.

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