

A CROSS-SECTIONAL STUDY ON THE PREVALENCE OF IMPOSTOR PHENOMENON IN ENGINEERING STUDENTS

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Abstract

Studies have shown that most mental health issues surface between the ages of 18 and 24. A large percentage of the population in this age group attend institutes of higher education during these critical years. Hence, colleges are well positioned to provide the appropriate support structures to create a positive effect on mental health. Undiagnosed mental health issues may have long-term detrimental effects on academic, professional, and social life. This paper investigates the prevalence of one such psychological condition, Impostor Phenomenon (IP), that can have a negative impact on the overall mental wellbeing of engineering students. IP is widely experienced by people from various backgrounds and socioeconomic status. While having high levels of IP does not necessarily translate to poor work performance, it can result in anxiety, depression, and dissatisfaction with life. Even though IP prevalence has been measured in various majors via the use of surveys, the data within engineering is sparse, despite it being one of the most competitive and stressful fields. For the current study, engineering students from freshman, sophomore, junior, and senior academic levels were surveyed using the Clance Impostor Phenomenon Survey; such a wide cross-sectional study in engineering is rare in the United States. A total of 184 students completed the anonymous survey voluntarily. Results indicate that our engineering students suffer from borderline moderate to frequent IP feelings ($59.8 < IP < 67.4$). The data was further analyzed by academic standing and gender. There was no significant increase or decrease in IP levels across the various academic standings except for seniors. Senior students demonstrated higher IP levels than juniors. Overall, female engineering students showed a higher level of IP prevalence compared to their male counterparts. The trifactor analysis indicated that fake in comparison to the other factors (discount and luck) is the most prevalent among the students irrespective of their class standing.

Keywords: Impostor Phenomenon, Mental Health, Engineering Education.

1 INTRODUCTION

Studies have shown that most mental health issues surface between the ages of 18 and 24 ([1], [2], [3]). A large percentage of the population in this age group attend institutes of higher education during these critical years. Hence, colleges are well positioned to provide the appropriate support structures to create a positive effect on mental health. Despite this, nationwide, university counseling centers are reporting an uptick in the number of students dealing with mental health and psychological problems ([4], [5], [6]). It is estimated that as much as 30% of college students suffer from some form of mental health issue [7]. In 2009, 96% of college students receiving treatment through campus counseling services were diagnosed with at least one mental disorder; depression and anxiety being the most common [8]. Undiagnosed mental health issues may have long-term detrimental effects on academic, professional, and social life. Mental health problems can affect a student's physical, emotional, cognitive, and interpersonal functioning [6]. Of the various psychological problems, depression and anxiety seem to be particularly on the rise ([9], [10]). Depression and anxiety can lead to isolation, social withdrawal, low self-esteem and motivation, and impaired decision making [6]. While mental health issues have adverse effects on students' success, it is recommended that colleges tailor their treatment for individualized needs [11]. Beiter et al. [11] conducted a survey on 374 undergraduate students between the ages of 18 and 24 to understand the factors that affect depression and anxiety. The survey used was the well-known Depression Anxiety Stress Scale. Through their study, they concluded that self-esteem, academic performance, pressure to succeed, and post-graduation plans were among the leading sources of depression and anxiety.

This paper investigates the prevalence of one such psychological condition, Impostor Phenomenon (IP), that can have a negative impact on the overall mental wellbeing of students. IP is widely experienced by people from various backgrounds and socioeconomic status. IP can be broken down to the following three basic components: not believing one deserves the success they achieve, a feeling of fraudulence about one's success, and a feeling of dread that one will be found out. While having high levels of IP

does not necessarily translate to poor work performance, it can result in anxiety, depression, and dissatisfaction with life. McGregor et al. [12] surveyed 186 students enrolled in a liberal arts course to investigate the relation between IP and depression. Their data indicated that imposter phenomenon sufferers experience symptoms similar to those suffering from mild depressive disorder. Similarly, other researchers have shown a positive relation between IP symptoms and depression and anxiety [13, 14]. Neureiter and Traut-Mattausch [15] conducted a study using two independent samples from 212 university students and 110 working professionals. They concluded that suffering from elevated IP levels can have a negative effect on career development and also inhibit high-achieving employees from climbing the ladder. In the medical field, studies have shown that having high levels of IP correlates to increased burnout which can result in reduced job satisfaction, low productivity, and job absenteeism [16]. For colleges to develop appropriate support structures to address this psychological phenomenon, a method of quantification is required.

There have been numerous attempts to quantify the severity of IP using various surveys such as the Clance Impostor Phenomenon Survey (CIPS), Harvey Impostor Scale, Perceived Fraudulence Scale, and Leary Impostor Scale. The most well-known and widely used survey is the CIPS. Clance, in collaboration with other psychologists, designed and developed a 20-question survey in 1985 to gauge IP levels and measure the relative intensity of IP [17]. This is a 20-question survey with each question assessed using a 5-point Likert Scale. The survey has been validated in other languages as well [18] and has been shown to demonstrate a high level of internal consistency while reliably differentiating impostors from nonimpostors [19]. The CIPS, along with other surveys, allows for a baseline measurement of IP levels while also allowing for other nuanced studies such as gender-based differences and variation with experience levels to be observed. For example, Sullivan and Ryba [20] conducted a study in 2020 to investigate the wellbeing of pharmacy residents. It was found that well over 50% of the residents have frequent impostor feelings, and the results highly correlated with increased work hours causing greater stress and reduced overall satisfaction for the individuals. Urwin [21] studied the prevalence of IP among social workers using the CIPS. The conclusions drawn were that IP occurs more frequently among social workers, and as the worker experience level increases, the IP levels reduce. Sims and Cassidy [22] used the CIPS to investigate IP levels among graduate students in music education. A total of 130 master's and doctoral students completed the survey, and interestingly, IP levels were roughly the same for master's and doctoral students indicating no variation with educational experience. Additionally, female students demonstrated higher IP levels compared to their male counterparts. However, literature contains several studies that report varying gender-based trends. For instance, Cokley et al. [23], through their survey of undergraduate students in the Southwest, concluded that no such differences in IP levels between males and females are observable.

While IP prevalence has been measured in various academic majors via the use of surveys, the data within engineering is sparse despite it being one of the most competitive and stressful fields. A recent study from California Polytechnic State University (developed own survey) showed that their engineering students are two times more likely to suffer from depression and anxiety than the average college population [24]. This clearly indicates a necessity to understand IP levels within engineering majors so that colleges can deploy appropriate support structures to address this pervasive issue. Also, there are other nuanced questions that are yet to be answered within engineering. For example, is there a difference in baseline IP levels between freshman, sophomore, junior, and senior engineering students? Do female engineering students have higher IP levels? Such questions have not been clearly answered due to lack of data in engineering. Furthermore, Chrisman et al. [19] proposed a trifactor model for the CIPS – fake, discount, and luck. Drawing on this, Brauer and Wolf [18] conducted further factor analyses to conclude that of the 20 CIPS questions, 6, 7, 12, 14, 15, 17, 18, and 20 were assigned to fake, while questions 3, 4, 10, and 16 were assigned to discount, and questions 5, 9, 11, and 19 were lumped under luck. Questions 1, 2, 8, 13 were avoided due to low inter-item correlations and statistical artifact. While a few researchers have examined the three-factor model, no study to date has examined how each factor scales with academic standing. This paper addresses the aforementioned gaps in knowledge through a wide cross-sectional study in engineering. A total of 184 students ranging from freshman to senior status were surveyed using the CIPS.

2 METHODOLOGY

First, appropriate permissions had to be obtained from Dr. Pauline Rose Clance to be able to use the Clance Impostor Phenomenon Survey (CIPS). This was obtained via e-mail correspondence at drpaulinerose@comcast.net. Following this, the authors had to secure the appropriate Institutional Review Board (IRB) approval within Grand Valley State University since this study involved human

subjects. Once all approvals were obtained, the authors deployed the CIPS in-person by contacting other instructors at various academic levels. A consent form was read out by the instructors near the end of the class, and the students were made aware that this was a completely voluntary survey which is anonymous (no names to be entered on the survey) and has no compensation. The instructor then stepped out of the class so that the students had ten minutes to complete the survey. Once the time was up, the students (those who chose to complete the survey and those who chose not to complete it) dropped off the forms in a box placed at the front of the classroom on their way out. In addition to the 20 questions on the CIPS, students could also fill in their academic standing and gender. For the analysis part, only the surveys that had all questions answered were considered, and the rest were discarded; a total of 184 responses were considered.

3 RESULTS

A total of 184 eligible survey responses were collected from freshmen through senior undergraduate engineering students. In the following subsections the data is summarized, analysed, and modelled to understand the prevalence of impostor phenomenon (IP) among engineering students.

3.1 Distribution and summarization

Statistical distribution of class-wise IP score was evaluated, and inter-class comparisons are made via descriptive statistics and visual depiction.

3.1.1 Summary statistics and normality Test

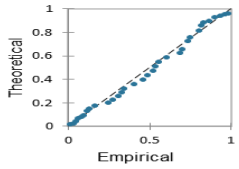
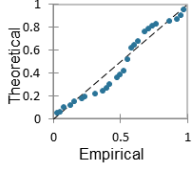
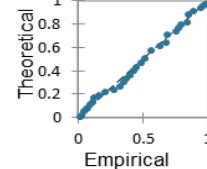
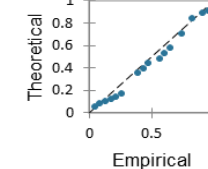
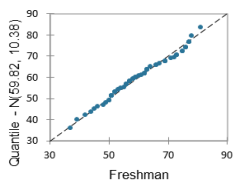
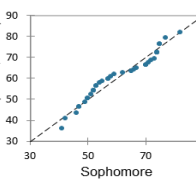
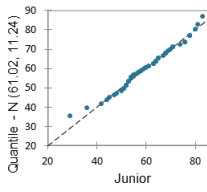
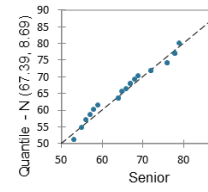
Table 1 summarizes central tendency of the class-wise data via descriptive statistics. Mean, median and standard deviation (Std. Dev) of freshman, sophomore and junior academic standings are close to each other. However, the senior class has comparatively higher mean and median with a smaller standard deviation. The preliminary observation is that senior students on average have higher baseline IP levels compared to their more junior counterparts.

Table 1. Summary statistics

	Sample Size	Mean	Std. Dev	Median
Total	184	61.5	11.1	61.5
Freshman	61	59.8	10.5	59.0
Sophomore	38	61.5	12.3	58.5
Junior	62	61.0	11.3	61.0
Senior	23	67.4	8.9	67.0

Subsequent statistical analyses make an implicit assumption that the data are normally distributed. To verify if this were true, four different normality tests were performed on each class data set. Additionally, P-P and Q-Q plots are shown in Table 2. Freshman, junior and senior data sets consistently show higher p-values for all the tests indicating that the null hypothesis (data are normally distributed) is *not* rejected. This implies that the data are normally distributed. For the sophomore data set, the only exception is the Anderson-Darling test which has a p-value of 0.026 ($< \alpha = 0.05$). However, for this particular data set, since the other 3 tests output higher values of P ($> \alpha = 0.05$), and the plots also are in support of normality, it will be assumed that the data for sophomore class is normally distributed.

Table 2. Normality test for class-wise IP score data.

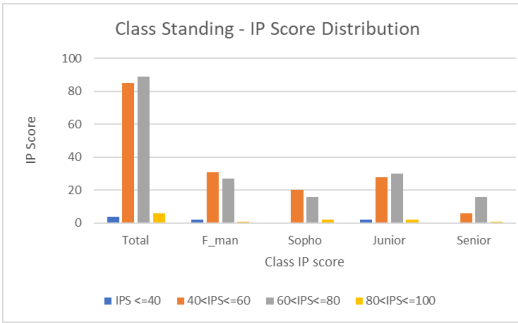
P-Values for Normality Tests at $\alpha = 0.05$				
Test	Freshman	Sophomore	Junior	Senior
Shapiro-Wilk	0.420	0.080	0.530	0.653
Anderson-Darling	0.389	0.026	0.605	0.642
Lilliefors	0.665	0.141	0.849	0.857
Jarque-Bera	0.557	0.413	0.789	0.727
P-P Plot				
Q-Q Plot				

3.1.2 IP score distribution

Clance Impostor Phenomenon Scale (CIPS) is divided into four categories with respect to scoring: few IP experiences ($\text{score} < 40$), moderate IP experiences ($40 < \text{score} \leq 60$), frequent IP experiences ($60 < \text{score} \leq 80$), and severe IP experiences ($\text{score} > 80$). Table 3 shows the distribution of each academic standing in these categories. It is interesting to note that most of the students fall into moderate and frequent categories. Only a very small number of students are in the extreme categories of few (4 students) and severe (6 students).

Table 3. IP scale distribution for Freshman, sophomore, junior, and senior

IP Score	Total	Freshm.	Sophm.	Junior	Senior
IPS ≤ 40	4	2	0	2	0
$40 < \text{IPS} \leq 60$	85	31	20	28	6
$60 < \text{IPS} \leq 80$	89	27	16	30	16
$80 < \text{IPS} \leq 100$	6	1	2	2	1



However, sample sizes are quite different among the classes (see Table 1). Thus, distribution of data as a percentage of the whole class rather than the distribution of the absolute number portrays a clearer picture as shown in Fig. 1. It is clear that the percentage distribution of freshman, sophomore, and junior in various CIPS categories are very similar, whereas higher percentage of seniors suffer from frequent IP experience.

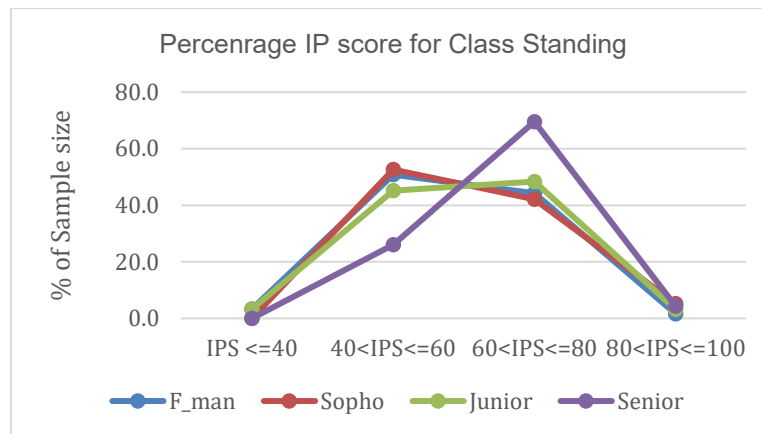


Figure 1. Class-wise percentage distribution

3.2 Comparison of IP among classes

A two-sample t-test is performed to compare the average IP scores based on class standing. The t-test assumes that both samples have equal variances. As a precautionary measure, equality of variances for each pair of samples is tested through an F-test. Table 4 shows the p-values for F-test checking the homogeneity of the sample variances. The null hypothesis is that the variances of a sample pair are the same. Since the P-value is higher than the α -value, we fail to reject the null hypothesis implying that the variances are indeed equal.

Table 4. Test of variance equality

Homogeneity of Variance: F-Test p-Values at $\alpha = 0.05$		
Freshman vs. Sophomore	Sophomore vs. Junior	Junior vs. Senior
0.270	0.574	0.207

Table 5 now compares the average IP scores for each academic standing. The left side of the table tests the null hypothesis that the mean CIPS scores between the classes are equal as opposed to them being not equal (alternate hypothesis). High p-values from freshman-sophomore and sophomore-junior pairs fail to reject the null hypothesis indicating that IP levels between freshman-sophomore and sophomore-junior are the same. However, P-value for junior-senior comparison is smaller than level of significance (α). Hence, the null hypothesis is rejected in favor of the alternate hypothesis such that the mean CIPS scores for these two classes are not equal. On the right side of Table 5, the null hypothesis is tested against the alternate that the mean score of juniors is less than that of the seniors with one-tailed t-test. Low P-value rejects the null hypothesis confirming that seniors suffer from greater IP levels.

Table 5. Comparison of mean IP among classes

$H_0: \mu_1 = \mu_2$ $H_a: \mu_1 \neq \mu_2$				$H_0: \mu_J = \mu_{SR}$ $H_a: \mu_J < \mu_{SR}$
Two-tailed t-test $\alpha = 0.05$				Lower-tailed t-test at $\alpha = 0.05$
	Freshman vs. Sophomore	Sophomore vs. Junior	Junior vs. Senior	Junior vs. Senior
95% CI	[-6.24, 2.93]	[-4.32, 5.23]	[-11.59, -1.16]	$[-\infty, -2.014]$
t_{crit}	1.985	1.984	1.989	-1.663
t-stat	-0.715	0.190	-2.432	-2.432
p-Value	0.476	0.850	0.017	0.009

It must be noted that the CIPS scale is based on twenty questions with a 5-point Likert scale response for each question. Therefore, data obtained from an individual question is inherently ordinal. There are suggestions to use nonparametric analysis in case of ordinal data [25]. On the other hand, it can be argued that CIPS score is the composite score of twenty questions and hence the above t-test to compare the class samples is valid [26]. Also, Winter and Dodou [27] showed that non-parametric Mann-Whitney U test and t-test show similar accuracy and statistical power on Likert scale data analysis. To remove any doubt about statistical inferences, the Mann-Whitney U test was performed to compare IP severity among the classes. Table 6 summarizes the test results and shows identical inferences as that from the t-test shown in Table 5. Therefore, it can be safely concluded that our senior undergraduate engineering students do indeed have higher IP levels and that IP levels on average are the same for freshman, sophomore, and junior undergraduate engineering students.

Table 6. Comparison of IP score with Mann-Whitney U test

H_0 : The difference of location between the samples is equal to 0 H_a : The difference of location between the samples is different from 0				H_0 : location between the samples is equal to 0 H_a : location of sample from Junior is lower than that of Senior
Two-tailed Mann-Whitney U test at $\alpha = 0.05$				Lower-tailed Mann-Whitney U test at $\alpha = 0.05$
	Freshman vs. Sophomore	Sophomore vs. Junior	Junior vs. Senior	Junior vs. Senior
U-stat	1103	1159.5	472	472
U-std	-0.400	-0.128	-2.381	-2.381
U-expected	1159	1178	713	713
p-Value	0.689	0.898	0.017	0.009

3.3 Comparison of IP between Genders

Gender based distribution of the responses is summarized in Table 7. As shown below, there is only one respondent identified as "other" gender. Because of the lack of data in this category, this data is eliminated, and further comparison is performed between male and female students.

Table 7. Gender based partition of data

	Freshman	Sophomore	Junior	Senior
Male	53	33	52	20
Female	7	5	10	3
Other	1	0	0	0

Because of the low number of female samples in each class, it was not feasible to perform an inferential intraclass comparison between the genders. Rather, comparison between the genders is done based on total responses, 158 male and 25 female responses. Unfortunately, our undergraduate engineering population lacks the desired gender diversity. Summary statistics from the two samples are presented in Table 8.

Table 8. Gender based summary statistics

	Observations	Minimum	Maximum	Mean	Std. deviation
Male	158	29.00	90.00	60.66	10.90
Female	25	45.00	87.00	66.12	11.20

Both data samples were tested for normality using the Shapiro-Wilk test (P-value for male=0.422 and female=0.507) and were concluded to have normal distribution. The samples were tested for equality of variances by F-test. The P-value from the test was 0.804 thereby concluding that there is no evidence to believe that the variances of male and female data are different. Comparison between the groups is

done with the null hypothesis that the mean IP score is same for both populations against the alternative hypothesis that the female population has a higher IP score. Both parametric (one tailed t-test, p-value = 0.011) and nonparametric (one tailed Mann-Whitney U test, p-value = 0.012) reject the null hypothesis. These tests lead to the conclusion that our female engineering students suffer from higher impostor phenomenon in comparison to their male counterparts. Fig. 2 shows the distribution of respondents in different IP category. As evident from the plot, female sample is skewed towards in the higher IP category.

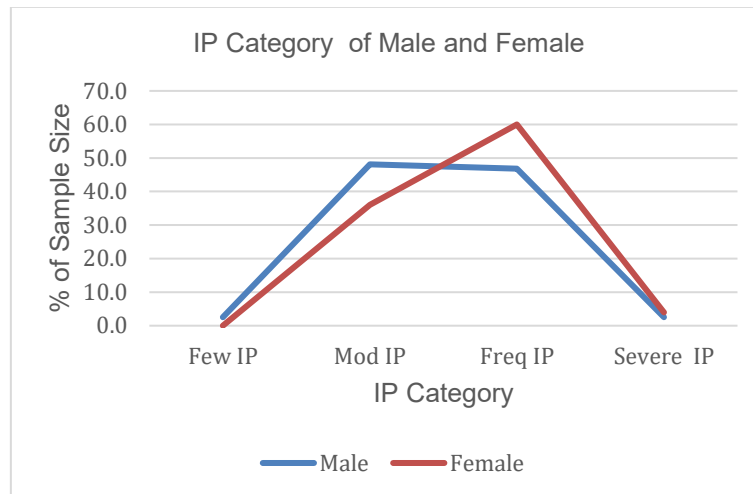


Figure 2. Gender based percentage distribution

3.4 Breakdown of IP using the trifactor approach

Studies have shown that the Clance IP scale can be divided into three major factors ([19], [18]) by grouping the highly correlated items in the survey instrument. The factors are as follows: fake, discount, and luck. Sample data in this study was broken down accordingly as suggested in the literature. Fig. 3 shows the class-wise distribution mean scores in each factor.

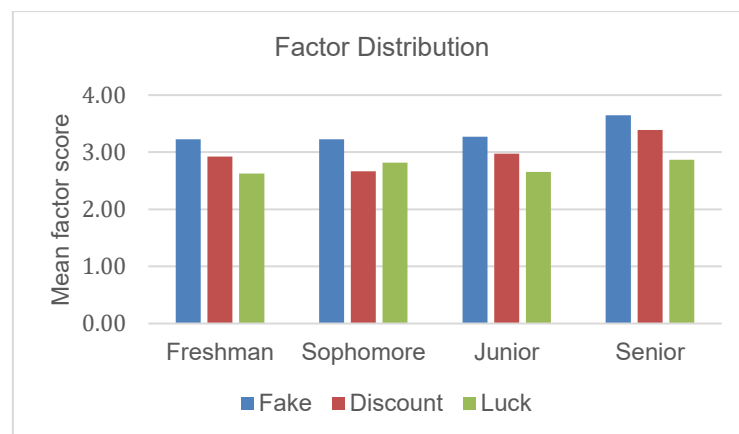


Figure 2. Gender based percentage distribution

It can be concluded that “fake” is higher than the other two factors for all class standing. Fake is the only factor for which mean scores for all classes exceeded 3.0. This indicates that the students strongly believe that they feel more like a phony as opposed to discounting their success or attributing it to sheer luck. Though statistical inference with only four data points is not feasible, it can be broadly stated that, for the given sample of engineering students, fake is the dominant IP experience. Also, with the exception of sophomores, all other class standings indicated that discount was the second most dominant factor. This data is very useful as it establishes the fact that addressing the fake factor through appropriate support structures will help create a significant impact on lower IP levels and potentially reducing depression and anxiety. Another observation is that for freshman, sophomore, and junior students, all 3 factors, for the most part, appear to hold relatively consistent resulting in the outcome of similar overall IP averages for these students.

3.5 Limitations of the study

It should be noted that data collection timing was not carefully controlled. Data for freshman, sophomore, junior, and senior classes were collected during different points of the semester. Hence, responses can be influenced by the academic pressures at the time of data collection. Overall population of female students is relatively small, and there was not enough data to compare intraclass IP between male and female genders. At our institute, we do not have the sufficient gender diversity so caution should be exercised when extrapolating the conclusion in the gender-based data in section 3.3. Also, the senior class had low participation resulting in a much smaller sample size compared to other classes.

4 CONCLUSIONS

In recent years, mental health well-being of students in higher education is gaining tremendous amounts of attention. Impostor phenomenon is a well-known psychological issue faced by students and faculty in academia. Despite this, a study on the IP prevalence among engineering undergraduate students with respect to academic standing and gender has not been done. A cross-sectional study of existence of IP among engineering students was carried out by deploying the Clance Impostor Phenomenon Scale. A total of 184 responses from students were analysed. The sample was divided according to the class standings of the students. Statistically, data was normally distributed for each class and variances for each class was deemed to be equal. Over half the student population suffered from frequent to severe impostor phenomenon. Also, seniors experience higher impostor phenomenon than the rest of the students. Though underlying factors are not scientifically evaluated, it can be stipulated that prior to entering the workforce, they feel more self-doubt and remain in fear of being discovered as a phony/fake resulting in higher IP levels. Overall, the female engineering student population experiences more impostor phenomenon when compared to their male counterpart. Data also show that feeling of fake in comparison to the other factors (discount and luck) is the most occurring phenomenon among the students irrespective of their class standing.

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