Homogeneity and heterogeneity in personality traits of first year students in terms of academic specialities and entrance examination categories

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Shigeru Ono *

Abstract

This paper examines the relationship between personality traits and two different attributes of first year university students: academic specialities and entrance examination categories, aiming to examine whether a student's choice of an academic speciality and that of an entrance examination category are pertinent to personality traits. Personality traits are assessed by the Competency scores of the Progress Report on Generic Skills, which are composed of multi-tiers of evaluation elements: three realms and three components for each realm. The subjects are first year students enrolled for Faculty of Social Information Studies at Otsuma Women's University. The sample size is 625 and the selected are those who took one of four different categories of entrance examinations—two types of general examinations, a recommendation-based examination, and an Admissions Office examination—and were admitted to one of the three academic specialities of the faculty. The heterogeneity of the Competency scores across the three academic specialities and across the four entrance examination categories are evaluated by three statistic tests: Cochran's Q heterogeneity test, Kruskal-Wallis equality-of-populations rank test, and Kolmogorov-Smirnov test. The results show that the Competency scores across the examination categories are significantly heterogeneous whereas those across the academic specialities are rather homogeneous. Given the research reporting that personality traits influence learning styles and academic performance, the findings suggest the importance of admissions decision incorporating the heterogeneity in personality traits of applicants caused by the difference of the entrance examination categories.

Key Words : personality traits, academic specialities, entrance examination categories, heterogeneity, admission decision

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1. Introduction

Much has been written about the relationship between personality traits and academic performance in college. Personality traits have proved to be important predictors of academic achievement and account for a significant portion of variance in academic performance (e.g., Caprara, Vecchione, Allessandri, Gerbino & Barbranelli, 2011; Chamorro-Premuzic & Furnham, 2003; Furnham, Chamorro-Premuzic & McDougall, 2003; Furnham, Nuygards & Chamorro-Premuzie, 2013; Gillies & Bailleux, 2001; McCredie & Kurtz, 2020; Noftle & Robins, 2007; Vedel, 2014). Personality traits have also drawn the attention of researchers who have studied the relation of learning styles to academic achievement (e.g., Ibrahimoglu et al, 2020; Komarraju et al, 2011) and the factors influencing a student's selection of academic specialities (Azman, Yaacob, Yusoff & Noor, 2014; Noël, Michaels & Levas, 2003; Vedel, 2016).

While personality traits have provided an important research perspective for exploring college student behaviours, only few studies have been made at the relation to college admissions categories (e.g., Albanese et all, 2003; Mackenzie, Dowell, Ayansina & Cleland, 2017). Japanese universities offer mainly four types of entrance examinations: general examinations, recommendation-based examinations, Admissions Office examinations and special selection examinations (Kuramoto & Koizumi, 2018). The latter three types are interview-based examinations and do not impose academic tests; by contrast, in general examinations acceptance is judged only by scores of academic tests. Students admitted to universities through different examination categories are considered to vary in personality traits. As Hecker (2017) and Kreiter (2016) indicate, establishing methods to assess non-academic attributes including personality traits for admissions purpose is still challenging and needs further evidence-based research.

This paper aims to examine whether a student's choice of an academic speciality and that of an entrance examination category are pertinent to personality traits and whether they are interrelated with each other. Personality traits were assessed by the Competency scores of the Progress Report on Generic Skills, which are composed of multi-tiers of evaluation elements: three realms and three components for each realm. The subjects are freshwomen enrolled in Faculty of Social Information Studies at Otsuma Women's University. They were admitted to one of the three academic specialities of the faculty by applying for one of the four examination categories: two types of general examinations, a recommendation-based examination, and Admissions Office examination. The heterogeneity of the Competency scores across the three academic specialities and across the four entrance examination categories are evaluated by three statistic tests: Cochran's Q heterogeneity test, Kruskal-Wallis equality-of-populations rank test, and Kolmogorov-Smirnov test. The primary contribution of this paper is to provide quantitative evidence that the Competency scores across the examination categories are more heterogeneous compared with those across the academic specialities. The heterogeneity is also argued from the viewpoint of university admissions.

2. Method

Subjects and Procedure:

The sample size was 625 and the selected were freshwomen enrolled on the three academic specialities of the faculty for two years. It accounts for 92.5% of the faculty enrolments. About the half of the subjects (49.4%) were admitted to the faculty through non-interview-based examinations, i.e., the general examinations, and the rest (50.6%) through

Table 1a Correspondence between symbols used in the paper and components of the Competency test

T	Competency	R1	Teamwork skills	C11	Relating with others
				C12	Collaborating with others
				C13	Team management
		R2	Personal skills	C21	Self control
				C22	Self confidence
				C23	Behaviour control
		R3	Problem solving skills	C31	Problem identification
				C32	Planning solutions
				C33	Implementing solutions

Table 1b Description of symbols

Symbol	Description
ref	freshwomen of women's universities in the Tokyo metropolitan area
dpt	department
ac1/2/3	academic speciality
ec1/2/3/4	entrance examination category
-1/-2	year index
X	auxiliary attribute (high school rankings)

interview-based examinations. The sample sizes for the three specialities were 210 (33.60%), 212 (33.92%), and 203 (32.48%), respectively.

To assess personality traits of the subjects, this paper used the Competency test of the Progress Report on Generic Skills, which is designed to assess non-cognitive skills in building trust with others, controlling one's emotion and motivation as well as solving complex problems. (Matsumura & Tanabe, 2010). It is composed of three realms: teamwork skills, personal skills, and problem-solving skills. Each realm is divided into three components; e.g., the components of the components of teamwork skills are Relating with others, Collaborating with others, and Team management. A detailed description of the components of the competency test and the symbols corresponding to the components are listed in Table 1. Each realm and each component were measured at 7 levels on a scale of 1 to 7, one being the lowest and seven the highest. These symbols were served as variables for the static tests.

Table 2a and 2b summarise the descriptive statistics of the Competency scores for the academic specialities and those for the entrance examination categories, respectively. The upper parts of a row report means of the scores measured for the Competency components, and the lower parts do standard deviations of those scores. The row designated by the symbol ref is for scores of the freshwomen of other women's universities in the Tokyo metropolitan area; they were used as a reference for estimating the Cochran's Q heterogeneity test.

As auxiliary index, the high-school rank calculated by Digakutsushin Corp. was adopted. This attribute is fairly related to the entrance

Table 2a Descriptive statistics of the Competency scores for academic specialities

	size	stat.	T	R1	R2	R3	C11	C12	C13	C21	C22	C23	C31	C32	C33
ref	15,207	mean	2.89	3.27	3.03	3.21	3.71	3.44	2.82	3.02	2.94	3.19	3.25	3.11	3.37
		sd	1.51	1.70	1.47	1.54	1.83	1.86	1.67	1.59	1.55	1.60	1.66	1.74	1.55
dpt-1	306	mean	2.89	3.24	2.95	3.47	3.66	3.54	2.76	3.02	2.93	3.09	3.58	3.31	3.59
		sd	1.47	1.62	1.40	1.44	1.76	1.76	1.60	1.59	1.46	1.55	1.69	1.57	1.49
dpt-2	355	mean	2.93	3.37	3.02	3.27	3.88	3.68	2.76	3.01	2.97	3.13	3.39	3.12	3.42
		sd	1.52	1.63	1.43	1.52	1.76	1.79	1.64	1.59	1.59	1.56	1.69	1.67	1.50
ac1-1	107	mean	2.73	3.09	2.79	3.45	3.42	3.32	2.69	2.93	2.80	2.94	3.54	3.32	3.54
		sd	1.42	1.51	1.34	1.33	1.73	1.66	1.44	1.52	1.46	1.45	1.67	1.46	1.40
ac1-2	119	mean	2.74	3.22	2.83	3.29	3.81	3.50	2.61	2.85	2.80	3.03	3.30	3.18	3.53
		sd	1.51	1.59	1.42	1.44	1.71	1.78	1.51	1.46	1.51	1.56	1.77	1.60	1.39
ac2-1	102	mean	3.24	3.59	3.20	3.64	4.01	3.92	3.01	3.28	3.13	3.23	3.64	3.48	3.73
		sd	1.53	1.66	1.51	1.63	1.71	1.74	1.80	1.73	1.50	1.60	1.76	1.66	1.65
ac2-2	119	mean	3.05	3.57	3.09	3.24	4.02	3.83	2.92	3.01	2.97	3.30	3.31	3.19	3.43
		sd	1.44	1.50	1.53	1.49	1.66	1.61	1.72	1.72	1.59	1.66	1.57	1.74	1.49
ac3-1	97	mean	2.71	3.02	2.88	3.32	3.55	3.37	2.57	2.86	2.86	3.11	3.56	3.13	3.51
		sd	1.41	1.64	1.31	1.33	1.79	1.82	1.49	1.49	1.40	1.58	1.63	1.56	1.39
ac3-2	119	mean	3.00	3.33	3.14	3.28	3.82	3.72	2.77	3.19	3.14	3.00	3.56	2.99	3.31
		sd	1.58	1.77	1.32	1.62	1.88	1.95	1.67	1.56	1.64	1.45	1.73	1.66	1.59

mean: sample average
sd: standard deviation

Table 2b Descriptive statistics of the Competency scores for entrance examination categories

	size	stat.	T	R1	R2	R3	C11	C12	C13	C21	C22	C23	C31	C32	C33
ec1-1	84	mean	2.99	3.24	3.21	3.63	3.40	3.48	2.99	3.44	3.15	3.17	4.07	3.30	3.56
		sd	1.81	1.79	1.72	1.53	1.87	1.89	1.81	1.77	1.7	1.79	1.69	1.66	1.60
ec1-2	136	mean	2.92	3.32	3.01	3.26	3.84	3.66	2.70	3.03	3.01	3.02	3.50	3.07	3.46
		sd	1.44	1.53	1.37	1.45	1.69	1.70	1.66	1.57	1.48	1.51	1.73	1.59	1.51
ec2-1	35	mean	2.66	2.77	2.74	3.31	3.11	3.00	2.80	2.71	2.83	2.91	3.54	2.97	3.51
		sd	1.30	1.61	1.24	1.18	1.64	1.59	1.68	1.49	1.29	1.72	1.44	1.48	1.44
ec2-2	54	mean	3.06	3.48	3.13	3.19	3.81	3.72	2.94	3.17	2.89	3.41	3.59	2.83	3.37
		sd	1.50	1.72	1.39	1.57	1.77	1.76	1.76	1.51	1.48	1.58	1.71	1.71	1.48
ec3-1	31	mean	3.35	3.81	3.19	3.35	4.23	4.32	2.90	3.32	3.32	3.16	3.77	2.84	3.84
		sd	1.56	1.80	1.49	1.38	1.80	1.90	1.70	1.62	1.83	1.39	1.94	1.46	1.61
ec3-2	28	mean	3.32	3.75	3.64	3.00	4.07	4.21	3.32	3.50	3.71	3.54	3.11	2.86	2.79
		sd	1.66	1.62	1.47	1.61	1.59	1.89	1.79	1.73	1.90	1.29	1.57	1.78	1.57
ec4-1	135	mean	2.82	3.24	2.82	3.43	3.82	3.53	2.63	2.82	2.73	3.10	3.27	3.44	3.57
		sd	1.28	1.49	1.19	1.47	1.68	1.62	1.47	1.45	1.25	1.41	1.66	1.55	1.45
ec4-2	122	mean	2.75	3.19	2.75	3.43	3.79	3.48	2.40	2.70	2.61	3.02	3.26	3.39	3.44
		sd	1.56	1.70	1.48	1.58	1.93	1.88	1.54	1.62	1.55	1.64	1.66	1.72	1.51

mean: sample average
sd: standard deviation

examination categories; applicants for the general examinations would be from higher-ranked high schools.

Measures:

The heterogeneity of the Competency scores across the three academic specialities and across the four entrance examination categories were evaluated by three statistic tests: Cochran's Q heterogeneity test, Kruskal-Wallis equality-of-populations rank test, and two-sample Kolmogorov-Smirnov test.

・Cochran's Q heterogeneity test:

The group-comparison t-test was conducted, in which the null-hypothesis was that there should be no difference between the mean of the scores of the reference and that of each academic speciality or of each entrance examination category. To measure the strength of the difference between the means, Hedges's g was estimated as an effect size coefficient. The Cochran's Q heterogeneity tests were conducted based on the estimated effect size coefficients for the specialities and for the examination categories.

・Kruskal-Wallis equality-of-populations rank test:

The Kruskal–Wallis test was conducted to test for the equality of the Competency score distribution across the specialities and across the examination categories. The null hypothesis was that samples should be from the same population. Effect sizes were estimated by using the Mann-Whitney U test (the Wilcoxon rank-sum test).

・Two-sample Kolmogorov-Smirnov test:

The two-sample Kolmogorov–Smirnov test was conducted to check if there are any differences in the distribution of the Competency scores for all pairs of the specialities and for those of the examination categories, where the null hypothesis was that the two distributions should be the same.

3. Result

Table 3 shows the results of the Cochran's Q heterogeneity test. As shown in the columns of p-value, significant heterogeneities were founded in components of the realm of Personal skills across the entrance examination categories, especially in self-confidence; on the other hand, no significant heterogeneities across the academic specialities were observed in all the components. The results of Kruskal-Walls equality-of-populations rank test (Table 4) and two-sample Kolmogorov-Smirnov test for equality of distribution functions (Table 6) also indicated that heterogeneity in score across the entrance examination categories were more significant than that across the academic specialities. Although Kruskal-Wallis test reported salient heterogeneity in Teamwork skills across the academic specialities, heterogeneity in a component of Teamwork skills was common to both the academic specialities and the examination categories. According to Cohen's guidelines, however, the effect sizes estimated by using Mann-Whitney test were fairly small (Table 5).

In summary, heterogeneity in the Competency scores across the entrance examination categories was observed in the components related to the realm of Personal skills. It was presented not only in the mean but also in the distribution of the scores, though the effect sizes were small. On the other hand, the Competency scores across the academic specialities were homogeneous in the mean of the scores.

4. Discussion and Conclusion

Heterogeneity in the Competency scores across the entrance examination categories were significant, which were contrast to the homogeneity scores across the academic specialities. Taking into consideration the fact that Faculty of Social

Table 3 Heterogeneity Test

	Academic Specialities					Entrance Examination Categories				
	Q	p-value	theta	95% Cof. Interval		Q	p-value	theta	95% Cof. Interval	
T	10.97	0.0520	-0.015	-0.128	0.099	8.25	0.3113	-0.014	-0.093	0.064
R1	10.45	0.0634	-0.021	-0.132	0.089	9.53	0.2171	-0.014	-0.092	0.065
R2	7.75	0.1704	0.020	-0.068	0.123	14.40	0.0444	0.011	-0.107	0.130
R3	5.05	0.4099	-0.100	-0.176	-0.023	5.83	0.5561	-0.103	-0.182	-0.025
C11	9.36	0.0955	-0.036	-0.140	0.069	10.95	0.1410	-0.022	-0.111	0.067
C12	9.48	0.0913	-0.093	-0.198	0.012	12.68	0.0803	-0.085	-0.164	-0.007
C13	5.75	0.3318	0.034	-0.047	0.115	12.00	0.1006	-0.030	-0.080	0.141
C21	6.73	0.2416	0.000	-0.088	0.088	18.24	0.0109	-0.020	-0.156	0.116
C22	5.59	0.3487	-0.007	-0.088	0.074	18.59	0.0096	-0.024	-0.163	0.114
C23	4.27	0.5113	0.056	-0.021	0.132	5.41	0.6098	0.047	-0.032	0.125
C31	4.20	0.5209	-0.137	-0.213	-0.061	17.43	0.0148	-0.157	-0.289	-0.024
C32	5.01	0.4147	-0.057	-0.133	0.019	10.45	0.1642	-0.031	-0.134	0.072
C33	4.36	0.4988	-0.085	-0.162	-0.009	8.26	0.3098	-0.069	-0.148	0.010

Q: Cochran's Q heterogeneity test statistic
p-value: p-value for heterogeneity test
theta: overall effect size
95% Cof. Interval: lower and upper confidence interval for overall effect size

Table 4 Kruskal-Wallis equality-of-populations rank test

	Academic Specialities		Entrance Examination Categories	
	χ^2 with ties	p-value	χ^2 with ties	p-value
T	6.037	0.0489	5.543	0.1361
R1	8.770	0.0125	5.743	0.1248
R2	2.728	0.2557	10.511	0.0147
R3	0.889	0.6412	2.149	0.5420
C11	5.529	0.0630	5.192	0.1583
C12	7.535	0.0231	8.954	0.0299
C13	1.742	0.4186	6.073	0.1081
C21	0.822	0.6629	12.155	0.0069
C22	1.803	0.4060	13.388	0.0039
C23	1.635	0.4416	2.598	0.4578
C31	0.932	0.6277	8.380	0.0388
C32	2.699	0.2594	11.386	0.0098
C33	3.555	0.1690	0.557	0.9062

Table 5 Effect-size estimated by the Mann-Whitney U test

	Entrance Examination Categories					
	ec1-ec2	ec1-ec3	ec1-ec4	ec2-ec3	ec2-ec4	ec3-ec4
T	0.002	-0.102	0.039	-0.132	0.036	0.133
R1	0.027	-0.120	0.020	-0.164	-0.008	0.131
R2	0.020	-0.096	0.091	-0.145	0.065	0.172
R3	0.052	-0.096	-0.011	0.002	-0.064	-0.059
C11	0.034	-0.114	-0.038	-0.176	-0.066	0.077
C12	0.039	-0.148	0.028	-0.216	-0.011	0.159
C13	0.039	-0.063	0.074	-0.063	0.076	0.122
C21	0.047	-0.063	0.129	-0.120	0.074	0.155
C22	0.050	-0.095	0.120	-0.168	0.061	0.176
C23	-0.039	-0.085	-0.003	-0.048	0.038	0.083
C31	0.033	0.066	0.128	0.050	0.086	0.035
C32	0.081	0.083	-0.078	0.012	-0.146	-0.141
C33	0.017	0.032	-0.009	0.018	-0.025	-0.037

Table 6 Two-sample Kolmogorov-Smirnov test for equality of distribution functions (p-values)

	Academic Specialities			Entrance Examination Categories					
	ac1-ac2	ac1-ac3	ac2-ac3	ec1-ec2	ec1-ec3	ec1-ec4	ec2-ec3	ec2-ec4	ec3-ec4
T	0.279	0.981	0.178	0.991	0.545	0.190	0.336	0.750	0.205
R1	0.053	0.945	0.058	0.907	0.440	0.997	0.444	0.983	0.282
R2	0.566	0.686	0.887	1.000	0.286	0.305	0.399	0.974	0.035
R3	0.741	0.898	0.904	0.490	0.900	0.956	0.934	0.402	0.067
C11	0.095	0.985	0.178	0.996	0.174	0.939	0.232	0.829	0.556
C12	0.085	0.765	0.058	0.972	0.149	0.787	0.053	0.989	0.037
C13	0.239	0.983	0.895	1.000	0.515	0.168	0.918	0.150	0.289
C21	0.477	0.427	0.695	0.908	0.472	0.055	0.219	0.707	0.053
C22	0.518	0.947	1.000	0.893	0.438	0.248	0.125	0.648	0.019
C23	0.775	0.997	0.768	0.929	0.120	0.998	0.310	0.892	0.115
C31	0.947	0.827	0.959	0.971	0.782	0.012	0.996	0.303	0.998
C32	0.850	0.584	0.310	0.606	0.725	0.401	1.000	0.042	0.154
C33	0.668	0.495	0.463	1.000	0.567	0.985	0.754	1.000	0.462

Table 7a Two-way ANOVA for the placement test scores

	Partial SS	df	MS	F	p-value
Model	3141915.70	11	285628.70	33.53	0.0000
ac	22990.19	2	11495.09	1.35	0.2601
ec	2880943.00	3	960314.33	112.74	0.0000
ac * ec	133258.17	6	22209.70	2.61	0.0167
Residual	5212902.40	612	8517.81		
Total	8354818.30	623	13410.623		

Sample size: 624, Root MSE: 92.292, R^2: 0.3761, Adj. R^2: 0.3648

Table 7b Effect size

	Ω^2	df
Model	0.36447	11
ac	0.00114	2
ec	0.35241	3
ac * ec	0.01534	6

Table 7c Breusch-Pagan/Cook-Weisberg test for heteroskedasticity (H_0: constant variance)

χ^2	7.890
p-value	0.005

Table 7d Marginal effects: maximum and minimum

	term	Margin	Std. Err.	t	p-value	95% Conf. Interval	
maximum	ac1 * ec2	555.214	24.666	22.51	0.000	506.774	603.655
minimum	ac3 * ec4	341.634	9.952	34.33	0.000	322.095	361.184

Information Studies is multidisciplinary, this result would be reasonable. Nonetheless, this finding should have an important implication for university admissions, because it implies that different type of entrance examinations should appeal to different personal type of students.

Table 7 summarises the results of two-way ANOVA for detecting whether a placement test score varies by the academic specialities and the entrance examination categories. The results show that there was statistically significant difference between the entrance examination categories with a medium effect size, but that there was no significant difference between the academic specialities. It is also observed that the 36.1% of the variance of the placement scores was explained by the entrance examination categories and the interaction between the entrance examination and the academic specialities, in compared with 0.3% by the academic specialities. In short, heterogeneity in the

Table 8a Kruskal-Wallis equality-of-populations rank test for the auxiliary attribute

	Academic Specialities		Entrance Examination Categories	
	χ^2 with ties	p-value	χ^2 with ties	p-value
X	4.226	0.1209	98.196	0.0001

Table 8b Two-sample Kolmogorov-Smirnov test p-values for the auxiliary attribute

	Academic Specialities			Entrance Examination Categories					
	ac1-ac2	ac1-ac3	ac2-ac3	ec1-ec2	ec1-ec3	ec1-ec4	ec2-ec3	ec2-ec4	ec3-ec4
X	0.255	0.609	0.987	0.005	0.000	0.000	0.000	0.000	0.315

Competency score across the entrance examination categories should reflect that in academic skills. As another related aspect, Table 8 shows the results for evaluating heterogeneity in high school rank across the academic specialities and across the entrance examination categories. This results again shows the heterogeneity across the entrance examination categories was more significant than across the academic specialities. According to Ibrahimoglu et al (2020) and Komarraju et al (2011), personality traits have influence on learning styles and academic achievement. Therefore, the admissions decision of the faculty would directly affect educational outcomes of its own.

Female students have chosen a wider variety of academic specialities in these last few decades. As women's universities have competed with co-educational universities for enrolments, they have tried to differentiate themselves from coeducational universities by emphasising tradition as women's higher education institutes and, instead, focusing academic disciplines and constraining targets to appeal their educational status (Hashimoto, Kobaru & Kato, 2017; Yukawa, Yamamoto & Sugiyama, 2018). Women's universities, therefore, tend to be small in size and offer their similar curricula to students being alike. Although Miyake (2010) reported that women's universities were superior in the effectiveness on female educations to coeducational universities in the aspects of expectations from university faculty members, confidence of achievement and self-efficacy, it remains inconclusive whether this effectiveness could be ascribed to educational practices at women's universities, to student characteristics enrolling at women's universities, or to the interaction of both factors. Moreover, as Azman et al (2014) suggested and Onozuka (2020) implied, students admitted through different admissions processes would be different in personal characteristics influencing academic achievement, and the difference could depend on the selectivity of their university. For further exploring the effectiveness of women's universities on female educations, research needs to be done regarding personality traits of students deliberately choosing a women's university instead of doing a coeducational university.

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