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Students' Academic Performance in Engineering Drawing in Nigerian Polytechnics: A Case Study of the Federal Polytechnic Bida, Nigeria

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***Abstract*—The performance of students in Engineering Drawing across the Schools of Engineering Technology, Environmental Studies and Applied Arts and Sciences of the Federal Polytechnic, Bida has been investigated. The data gathered from 276 questionnaires distributed to the target audience were analysed using Statistical Package for Social Sciences (SPSS) and Microsoft Excel packages. Results showed that over 75% of the students who did not attend technical school during their post primary education performed better than those who did. It became obvious that having the required drawing tools in itself, does not guarantee good performance in Engineering Drawing. Students from the School of Engineering Technology performed far better than their counterparts in other schools in Engineering Drawing. It was also found that apart from having an enabling environment for teaching and learning, students' attitude towards Engineering Drawing play a vital role in their performance.**

Keywords—Engineering drawing, Students, Performance, the Federal Polytechnic, Bida.

I. INTRODUCTION

Engineering is a professional discipline that is fully committed to solving societal problems with the available resources and in the most economical ways. For any economy to stand the present challenges of development, the government must pay adequate attention to technological advancement in all aspect of its national life. Many stakeholders said that this can only be done by according engineering its rightful place in the scheme of things. Nearly all human daily endeavours are driven by engineering. The beds we sleep on, the water from the tap, the toilet, the car, elevator, photocopying machine, wrist watch are all products of engineering. Without engineering, little or no development could be attained. It is important for everyone to understand the important role of engineering for correct positioning of the profession through joint efforts (Adeola, 2010). For obvious reasons, modern nations show great concern for education, especially education in science, engineering and technology. This is because it enables rapid development of the social and economic infrastructure necessary for the growth of enterprise (Gemade, 2009) and reduces poverty; bridge the gap between nations in the knowledge emerging society (Ajimotokan *et al*., 2009) while Ajimotokan *et al* (2010) reported that the Nigerian government has made frantic efforts to encourage engineering education. From the mid-1980s, specialized universities with a mandate to increase scientific, technological and agricultural contribution to the transformation of the country were established (Ajimotokan *et al*., 2009; Ekeh, 2009).

There is a growing concern over the astronomical decline in students' academic achievements in engineering drawing courses in tertiary institutions in Nigeria. While some experts have blamed the spate of failure on the lack of commitment on the part of government at all levels, others feel it is a problem of implementation of government policies on education. Onyeachu (2008) asserted that no matter how well a curriculum of any subject is planned, designed and documented, implementation of the curriculum is important. All learners at the various levels of the nation's educational system are expected to be provided with appropriate learning experiences. A systematic integration of variety of resources in teaching – learning process and environment produce appropriate learning experiences, which in turn result in effective (active) or meaningful learning. The problem bedeviling the teaching and learning of this important course (Engineering drawing) is what this paper intends to investigate and proffer possible solutions.

Researchers generally agreed that a basic understanding of fundamental concepts of projection theory, orthographic projection, isometric drawing, hidden views, and sectional views was problematic to most learners due to poor spatial ability. In addition, the ability to grasp these topics is critical as it represents the fundamentals of Engineering drawing that deal with the construction of 2D and 3D geometry, and the creation of multi-view and pictorial representations (Bertoline and Wiebe, 2002; Olkun, 2003). A new educational reform implemented by the

Ministry of Education of Malaysia suggests more of a focus on critical-thinking processes, problem solving and student assessment deemed critical in academic curricula (Custer *et al*, 2001). One of the critical knowledge domains that received much attention is technical education. Several educational initiatives were drawn and implemented with special focus on the integration of computer technology in the curriculum of technical and vocational teaching and learning (Rafi and Samsudin, 2007). Engineering drawing for example became one of the critical subjects that drew the Ministry's attention at the secondary education level due to the fact that overall performance began to decline after 1994 as more non-technical students enrolled in public schools and began taking the same course (Nor Fadila & Widad, 1999). Experience over the years has shown that many Nigerian students studying engineering will prefer not to do any course in Engineering drawing. Majority of them see this cardinal course as a necessary evil that should just be passed, even at the lowest grade level. This is why the rate of failure over the years in both universities and polytechnics and even technical schools, have continued to snowball. The case is not different in the Federal Polytechnic, Bida. Reports from the department that teaches Engineering drawing show that students are not performing well in engineering drawing across the schools/faculties of the institution.

Apart from the spatial issue, Rafi and Samsudin, (2007) reported in a similar study that gender and mathematics achievement was also found to be factors affecting students' performance in engineering drawing. Nor-Fadila and Widad (1999) found male students performed significantly better than their female counterparts based on a research report of engineering drawing courses (LPMK: LK-1998). The same study revealed better performance of students with greater previous Mathematics achievement over those with lower previous Mathematics achievement. A strong positive correlation between Mathematics achievement and spatial ability has been established in some other research (Pallrand and Seber, 1984; Siemankowski and MacKnight, 1971; Tartre, 1990). These gender differences pose potential threats to the success of female students in technical, scientific and Mathematics courses. A study by Scales (2000) indicated a slight relationship between gender and achievement in introductory engineering graphics, with females having lower final grades.

A. Statement of the Problem

Engineering drawing is one of the most important subjects in Engineering. It is not only necessary for academic achievement but also for everyday life. Addressing the worrisome trend of lower performance by students has been a crucial issue for the educators and teachers for years. Students' prospects for career pursuits in engineering, technical and vocational education (TVE) were being hampered by their poor performances in Technical and Engineering drawing as a core engineering subject (Diraso *et al*, 2013). Therefore, the dwindling state of students' academic achievements in tertiary institutions in Nigeria calls for immediate and urgent solutions. As a result, a thorough investigation is needed to identify the underlying factors that contribute to this problem and find the ways and means to address them.

The performance of students studying Technical/Engineering Drawing has over the year's generated concern both from the students and lecturers/instructors alike. Not much has been done in this area of research as there are scarce published reports on factors impacting on Engineering drawing learning in the FPB. This has therefore prompted the authors to embark on this all-important study as it will enhance policies and strategies that can be employed to improve students' performance in technology related courses and consequently improve the quality of students graduating from Nigerian tertiary institutions henceforth.

B. Research Hypotheses

1. Students who attended Technical College tend to perform better than their peers in engineering drawing.
2. There is a positive relationship between having the required drawing tools and doing well in Engineering drawing.
3. Engineering students perform better than their counterparts in other schools/faculties in engineering drawing.

C. Area of the Study

This study was conducted at the Federal Polytechnic, Bida, and (FPB) Niger State. A sample of 276 National Diploma students taking the course as at 2012/2013 academic session was selected from schools/faculties of Engineering Technology, Environmental and Applied Arts and Sciences at the FPB to participate in the study by filling the designed questionnaires.

II. METHODOLOGY

A total of two hundred and seventy six (276) students, representing more than 90% of the targeted students and comprising 43, 87 and 146 from the schools of Applied Arts and Sciences, Environmental Studies and Engineering Technology respectively, taking Engineering drawing courses at the National Diploma level that participated in the study. Majority of the respondents were between 20 to 24 years of age as shown in Table 1. Many of the respondents from the School of Applied Arts and Sciences (SAAS) are female with 76% of the entire SAAS population; 60 from the respondents are male from the School of Environmental Studies (SES), while only 10% of the respondents from the School of Engineering Technology (SET) are female.

Table 1: Respondents According to Age

		Freq.	%	Valid %	Cum. %
Valid	Less than 20yrs	30	10.8	11.8	11.8
	20 - 24 yrs	199	71.8	78	89.8
	25 - 29yrs	24	8.7	9.4	99.2
	30 yrs and above	2	0.7	0.8	100
	Total	255	92.1	100	
Missing	System	22	7.9		
Total		277	100		

Missing system represents the invalidated questionnaires because they were either filled wrongly or not filled at all

A well-structured questionnaire was designed to elicit information regarding students' personal details and general questions, including prior knowledge in Technical drawing at post primary level, class attendance by students, students' last scores in Engineering drawing, among others. Respondents were given an opportunity to leave a brief comment at the close of the questionnaire. The method adopted by the researchers left no room for any questionnaires to be lost in transit. The respondents were served with the questionnaires and given some time to fill it while the person(s) administering them waited to collect them. However, a few of the questionnaires were not filled correctly and hence rendered invalid for this study. Statistical Package for Social Sciences (SPSS) and Microsoft Excel software packages were used to analyze the data collected from the questionnaires.

III. RESULTS AND DISCUSSION

Data from questionnaires was compiled, sorted, edited, classified and coded and analysed using Statistical Package for Social Sciences. The results obtained are presented in Tables 1 to 6 and Figures 1 to 3.

A. Hypothesis 1: Students Who Attended Technical College Tend to Perform Better than Their Peers in Engineering Drawing.

Of the 260 valid counts of the respondents who either did or did not attend technical school for their post primary education, it was found that performance in Engineering Drawing was not necessarily affected by prior knowledge of the course. Sentamu (2003) as cited in Considine and Zappala (2002) argued that the type of school a student attends influences academic achievement; not in Technical/Engineering Drawing. According to Martha (2005), depending on the environment, a school can either open or close the doors that lead to academic achievement. All these arguments, though valid, did not apply to performance in Drawing as seen in this work.

Table 2: Respondents According to School/Faculty

		Freq.	%	Valid %	Cumulative %
Valid	SET	146	52.7	52.9	52.9
	SES	87	31.4	31.5	84.4
	SAAS	43	15.5	15.6	100
	Total	277	99.6	100	
Missing	System	1	0.4		
Total		277	100		

Table 4 show that only 4.5% of the entire 30.8% of the respondents who scored above 70% in engineering drawing did attend technical school. The remaining 26.3% never or partially attended technical school. Summarily, about 26.1% of the respondents with prior knowledge of Technical Drawing scored "A" and 64.5% passed the course generally. In all, over 75% of the total performance was for the respondents who never attended technical school in their post primary education while 14.2% of the performance was for the respondents who attended technical school. From the Chi Square Tests in Table 3, we find that there is no significant difference between performances in terms of which schools the students attend (Chi Square = 24.549, p = .138).

Table 3: Chi-Square Test for Hypothesis One

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	24.549[a]	18	0.138
Likelihood Ratio	19.111	18	0.385
Linear-by-Linear Association	1.342	1	0.247
No of Valid Cases	260		

a. 20 cells (71.4%) have expected count less than 5. The minimum expected count is .10.

B. Hypothesis 2: There is a Positive Relationship between Having the Required Drawing Tools and Doing Well in Engineering Drawing.

One would expect that 56.4% is enough evidence to infer that possessing the required drawing tools should guarantee good academic performance in Engineering Drawing. But a careful study of performances distribution in Table 6 shows that less than 40% of the respondents scored above 60%. Even though about 65% of the respondents claimed they have all the required tools, only 51 respondents representing 19% scored above 70%. Therefore it would be rather misleading to think that possessing the required drawing tools is enough to guarantee good performance in Engineering Drawing. 33.6% of the students who did not have all the necessary tools to work with scored above 50%. This is in partial disagreement to the position held by some of the experienced Lecturers/Instructors in the School of Engineering Technology. Therefore other factors might be responsible for good academic performance

in drawing courses other than possessing the required drawing tools. Again there is no significant difference between performances in terms of possessing the required drawing tools as depicted in Table 5 (Chi Square = 20.091, p = .328).

Table 4: Effect of Technical School Attendance on the Performance in Technical/Engineering Drawing

			Your score in the last Drawing/Drafting Examination							Total
			70+	60+	50+	40+	30+	20+	10+	
Did you attend Technical School?	Yes	Count	12	13	7	2	3	0	0	37
		Expected Count	11.4	11.1	8.8	3.8	1.1	.3	.4	37.0
		% within Did you attend Technical School?	32.4%	35.1%	18.9%	5.4%	8.1%	.0%	.0%	100.0%
		% within Your score in the last Drawing/Drafting exam	15.0%	16.7%	11.3%	7.4%	37.5%	.0%	.0%	14.2%
		% of Total	**4.6%**	**5.0%**	**2.7%**	**.8%**	**1.2%**	**.0%**	**.0%**	**14.2%**
	No	Count	59	61	47	21	4	1	2	195
		Expected Count	60.0	58.5	46.5	20.2	6.0	1.5	2.2	195.0
		% within Did you attend Technical School?	30.3%	31.3%	24.1%	10.8%	2.1%	.5%	1.0%	100.0%
		% within Your score in the last Drawing/Drafting exam	73.8%	78.2%	75.8%	77.8%	50.0%	50.0%	66.7%	75.0%
		% of Total	**22.7%**	**23.5%**	**18.1%**	**8.1%**	**1.5%**	**.4%**	**.8%**	**75.0%**
	At all	Count	4	1	5	3	1	1	0	15
		Expected Count	4.6	4.5	3.6	1.6	.5	.1	.2	15.0
		% within Did you attend Technical School?	26.7%	6.7%	33.3%	20.0%	6.7%	6.7%	.0%	100.0%
		% within Your score in the last Drawing/Drafting exam	5.0%	1.3%	8.1%	11.1%	12.5%	50.0%	.0%	5.8%
		% of Total	**1.5%**	**.4%**	**1.9%**	**1.2%**	**.4%**	**.4%**	**.0%**	**5.8%**
	Not really	Count	5	3	3	1	0	0	1	13
		Expected Count	4.0	3.9	3.1	1.4	.4	.1	.2	13.0
		% within Did you attend Technical School?	38.5%	23.1%	23.1%	7.7%	.0%	.0%	7.7%	100.0%
		% within Your score in the last Drawing/Drafting exam	6.2%	3.8%	4.8%	3.7%	.0%	.0%	33.3%	5.0%
		% of Total	**1.9%**	**1.2%**	**1.2%**	**.4%**	**.0%**	**.0%**	**.4%**	**5.0%**
Total		Count	80	78	62	27	8	2	3	260
		Expected Count	80.0	78.0	62.0	27.0	8.0	2.0	3.0	260.0
		% within Did you attend Technical School?	30.8%	30.0%	23.8%	10.4%	3.1%	.8%	1.2%	100.0%
		% within Your score in the last Drawing/Drafting exam	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	**30.8%**	**30.0%**	**23.8%**	**10.4%**	**3.1%**	**.8%**	**1.2%**	**100.0%**

Table 5: Chi-Square Test for Hypothesis Two

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	20.091[a]	18	0.328
Likelihood Ratio	20.904	18	0.284
Linear-by-Linear Association	1.939	1	0.164
No of Valid Cases	264		

a. 16 cells (57.1%) have expected count less than 5. The minimum expected count is .02.

Table 6: Effect of Having the Entire Drawing Tools on the Performance in Engineering/Technical Drawing

			Your score in the last Drawing/Drafting Examination							Total
			70+	60+	50+	40+	30+	20+	10+	
Do you have your entire Drawing tools?	Yes	Count	51	51	31	11	4	0	1	149
		Expected Count	45.7	44.6	35.0	16.4	4.5	1.1	1.7	149.0
		% within Do you have your entire Drawing tools?	34.2%	34.2%	20.8%	7.4%	2.7%	.0%	.7%	100.0%
		% within Your score in the last Drawing/Drafting examination	63.0%	64.6%	50.0%	37.9%	50.0%	.0%	33.3%	56.4%
		% of Total	**19.3%**	**19.3%**	**11.7%**	**4.2%**	**1.5%**	**.0%**	**.4%**	**56.4%**
	No	Count	11	13	20	12	2	1	1	60
		Expected Count	18.4	18.0	14.1	6.6	1.8	.5	.7	60.0
		% within Do you have all your Drawing tool?	18.3%	21.7%	33.3%	20.0%	3.3%	1.7%	1.7%	100.0%
		% within Your score in the last Drawing/Drafting examination	13.6%	16.5%	32.3%	41.4%	25.0%	50.0%	33.3%	22.7%
		% of Total	**4.2%**	**4.9%**	**7.6%**	**4.5%**	**.8%**	**.4%**	**.4%**	**22.7%**
	At all	Count	1	1	1	0	0	0	0	3
		Expected Count	.9	.9	.7	.3	.1	.0	.0	3.0
		% within Do you have all your Drawing tool?	33.3%	33.3%	33.3%	.0%	.0%	.0%	.0%	100.0%
		% within Your score in the last Drawing/Drafting examination	1.2%	1.3%	1.6%	.0%	.0%	.0%	.0%	1.1%
		% of Total	**.4%**	**.4%**	**.4%**	**.0%**	**.0%**	**.0%**	**.0%**	**1.1%**
	Not really	Count	18	14	10	6	2	1	1	52
		Expected Count	16.0	15.6	12.2	5.7	1.6	.4	.6	52.0
		% within Do you have all your Drawing tool?	34.6%	26.9%	19.2%	11.5%	3.8%	1.9%	1.9%	100.0%
		% within Your score in the last Drawing/Drafting examination	22.2%	17.7%	16.1%	20.7%	25.0%	50.0%	33.3%	19.7%
		% of Total	**6.8%**	**5.3%**	**3.8%**	**2.3%**	**.8%**	**.4%**	**.4%**	**19.7%**
Total		Count	81	79	62	29	8	2	3	264
		Expected Count	81.0	79.0	62.0	29.0	8.0	2.0	3.0	264.0
		% within Do you have all your Drawing tool?	30.7%	29.9%	23.5%	11.0%	3.0%	.8%	1.1%	100.0%
		% within Your score in the last Drawing/Drafting exam	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	**30.7%**	**29.9%**	**23.5%**	**11.0%**	**3.0%**	**.8%**	**1.1%**	**100.0%**

C. Hypothesis 3: Engineering Students Perform Better than Their Counterparts in Other Schools/ Faculties in Engineering Drawing.

Although all the respondents were subjected to the same conditions, the results in Table 8 represent better performance for respondents from the school of Engineering Technology. While 20.5% of the school of engineering respondents recorded above 70% scores in Engineering Drawing, the schools of Environmental Studies and Applied Arts and Sciences had 8.7% and 1.5% respectively. This result is clear evidence that students from SET do better in Engineering Drawing courses. There is therefore a significant difference between performances in terms of respondents' schools as shown in Table 7 (Chi Square=37.188, p=.000)

Table 7: Chi-Square Test For Hypothesis Three

	Value	df	Asymp. Sig.(2-sided)
Pearson Chi-Square	37.188[a]	12	0.000
Likelihood Ratio	34.739	12	0.001
Linear-by-Linear Association	16.020	1	0.000
No of Valid Cases	264		

a. 10 cells (47.6%) have expected count less than 5. The minimum expected count is .30.

Going by the results presented in Figure 2, students are unlikely going to perform well since majority of them lack access to relevant materials to aid their study. Considine and Zappala (2002) reported that students from high social economic backgrounds are well exposed to scholastic materials, which aid their intelligence. But with only 34% of the respondents having drawing textbooks, one could conclude that majority of them are from low income earning class of the society and so could not afford good books which are a key to good performance.

Contrary to general opinion that class attendance always impacts positively on good performance in Engineering Drawing. With over 88% of the valid counts of respondents having more than 70% class attendance, one would expect better performance from the respondents. But obviously the factors that affect students' performance in Engineering Drawing transcends being physically present in the class. Figure 1 is a graphical representation of this finding.

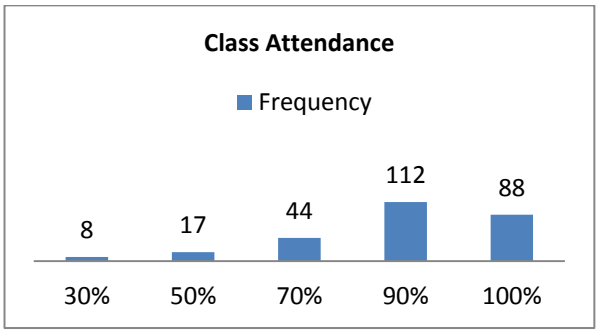

Figure 1: Class Attendance Percent

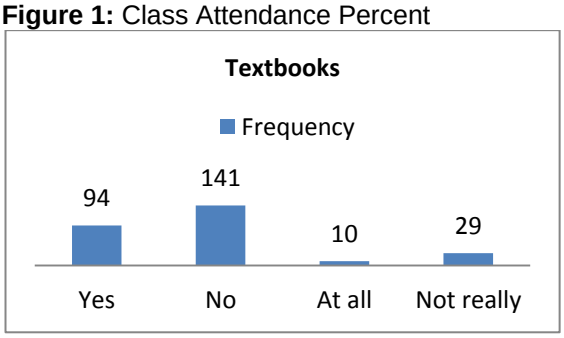

Figure 2: Possession of drawing textbooks

Table 8 : Performance in Engineering/Technical Drawing Across Faculties/Schools in the FPB

			Your score in the last Drawing/Drafting exam							Total
			70+	60+	50+	40+	30+	20+	10+	
School /Faculty	Engineering	Count	54	39	28	12	5	1	1	140
		Expected Count	43.0	41.9	32.9	15.4	4.2	1.1	1.6	140.0
		% within School/Faculty	38.6%	27.9%	20.0%	8.6%	3.6%	.7%	.7%	100.0%
		% within Your score in the last Drawing/Drafting examination	66.7%	49.4%	45.2%	41.4%	62.5%	50.0%	33.3%	53.0%
		% of Total	**20.5%**	**14.8%**	**10.6%**	**4.5%**	**1.9%**	**.4%**	**.4%**	**53.0%**
	Environmental	Count	23	33	20	6	2	0	0	84
		Expected Count	25.8	25.1	19.7	9.2	2.5	.6	1.0	84.0
		% within School/Faculty	27.4%	39.3%	23.8%	7.1%	2.4%	.0%	.0%	100.0%
		% within Your score in the last Drawing/Drafting examination	28.4%	41.8%	32.3%	20.7%	25.0%	.0%	.0%	31.8%
		% of Total	**8.7%**	**12.5%**	**7.6%**	**2.3%**	**.8%**	**.0%**	**.0%**	**31.8%**
	Sciences	Count	4	7	14	11	1	1	2	40
		Expected Count	12.3	12.0	9.4	4.4	1.2	.3	.5	40.0
		% within School/Faculty	10.0%	17.5%	35.0%	27.5%	2.5%	2.5%	5.0%	100.0%
		% within Your score in the last Drawing/Drafting examination	4.9%	8.9%	22.6%	37.9%	12.5%	50.0%	66.7%	15.2%
		% of Total	**1.5%**	**2.7%**	**5.3%**	**4.2%**	**.4%**	**.4%**	**.8%**	**15.2%**
Total		Count	81	79	62	29	8	2	3	264
		Expected Count	81.0	79.0	62.0	29.0	8.0	2.0	3.0	264.0
		% within School/Faculty	30.7%	29.9%	23.5%	11.0%	3.0%	.8%	1.1%	100.0%
		% within Your score in the last Drawing/Drafting examination	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	**30.7%**	**29.9%**	**23.5%**	**11.0%**	**3.0%**	**.8%**	**1.1%**	**100.0%**

IV. CONCLUSION

A survey was conducted to investigate the academic performance of students in Engineering drawing in three Schools of the Federal Polytechnic, Bida. It was discovered that academic performance in Engineering Drawing is not necessarily affected by attendance of technical school. This is corroborated by the performance variation in this study. Only 4.6% of the 14.2% of the respondents who attended technical school scored A's in Engineering Drawing courses. It is also concluded that mere possession of drawing tools is not enough to guarantee good academic performance in Engineering Drawing. Other factors including the real usage of the tools must come into play to achieve success. Even though more of the respondents who scored A's had the necessary tools, 19.3% is a far cry from the expected outcome. The study also discovered a generally below-average academic performance in Engineering Drawing in FPB. But SET recorded the highest A's overall.

V. RECOMMENDATION

Based on the findings of the study, the following recommendations were made as instruments for enhancing students' performance in Engineering Drawing in Nigerian Polytechnics.

1. The school and departmental libraries should be equipped with current textbooks to encourage good reading culture in Engineering Drawing students.
2. More should be done to help students in the schools of Environmental Studies and Applied Arts and Sciences in the area of tutorials and extra lectures to help improve their understanding of the courses.
3. Students should endeavour to match their high class-attendance with good performance in Engineering Drawing by cultivating the right attitude towards the course.
4. Students should acquire drawing tools and put them to good use at all times.
5. Students in the schools of Environmental Studies and Applied Arts and Sciences should spend more time on their drawing courses in order to measure up to expectation.

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