

A Study of Visualization Skills at Two Major Universities in Taiwan

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Abstract

A study of visualization skills at National Taiwan University and Feng Chia University was conducted in Spring 2016. At each university, approximately 40 students from a wide variety of academic majors enrolled in a short course titled “Development of Visualization Skills for Design”. The course consisted of lectures and exercises specifically developed to improve three-dimensional visualization skills. Pre-course and post course assessments were made using the PSVT-R and the Mental Cutting tests. The assessments showed a strong possibility of improvement in visualization ability as a result of the short course. The pre-course assessments showed visualization skills at the Taiwan universities to be approximately the same as at major US universities, and also that a gender gap in such abilities exists in Taiwan, as does in the US. Post-course assessments showed the possibility that this gap can be closed by visual skills training.

Introduction

The importance of strong spatial visualization skills for success in engineering programs has been well-documented, and summarized by Sorby (2009). Differences in the spatial visualization skill between US students and students in certain parts of Europe have been documented by Sorby (1999). In addition, many researchers, including Németh (2006) and Sorby (2001) have documented a gap in the spatial visualization skills between male and female students enrolled in engineering programs. The visualization skill gap between genders documented in US students also exists in Poland and Germany, as documented by Gorska (1998) and Sorby (1999), and in Brazil by Medina (1998). Interventions with the specific goal of improving visualization skills in students with weaker skills, to improve success in engineering and science programs, were done by Sorby (2000, 2001), with long term benefits documented by Sorby and Veurink (2010). As of yet, few such studies have been conducted in Asia.

The secondary and post-secondary education systems in Taiwan closely follow those used in the US. A study of the visualization skills at two major universities in Taiwan was conducted to

assess any differences that may exist due to the cultural environment in Taiwan as opposed to the US. A four-week workshop titled “Development of Visualization Skills for Design” was offered at National Taiwan University (NTU), which is considered the premier university in Taiwan. At NTU, the course was advertised mostly to the non-technical student population, and the final course enrollment was from a wide variety of academic majors and different undergraduate class levels. A total of 23 males and 17 females completed the course at NTU. A similar course was offered as an intensive two-day workshop at Feng Chia University (FCU), which is widely regarded in Taiwan as a mid-level university. A total of 28 males and 19 females completed the course at FCU. There was no restriction on advertising the workshop at FCU, and the majority of the participants there were from technical and science majors at all undergraduate levels. Both universities had recently launched a Design School, and the number of course participants was approximately 40 students at each university. Pre-course and post-course assessments of the students’ visualization abilities were made using the Purdue Spatial Visualization Test – Rotation (PSVT-R) by Guay (1977), and the Mental Cutting Test (MCT) by CEEB (1939).

It should be noted that visualization training courses, such as those developed by Sorby and Baartmans (2000), are typically administered over a time span of one academic semester. A fundamental assumption for the validity of the post-course assessment test is that any residual familiarity with the pre-course assessment test is negligible. Since the workshop at NTU was conducted over a time span of only four weeks, the effects of test familiarity are unknown. At FCU, with a two-day workshop format, the effects of pre-course test familiarity on the post-course assessment would certainly be of concern.

Course Content

The course at both universities was similar, including 18 hours of total meeting time organized into four 1.5-hour lecture and four 3-hour laboratory periods. For convenience, the lecture material and exercises were derived from Chapter 2 (Sketching) and Chapter 3 (Visualization) of Lieu and Sorby (2008). Lecture material included instruction on sketching techniques, sketching of three-dimensional pictorials, principles of orthogonal projection, and introductions to the rotation, reflection, cutting, and pictorial drawing exercises that would be done during the laboratory periods. Exercises during the laboratory periods were done entirely by freehand sketching, sometimes with the assistance of isometric grid paper. At NTU, unfinished exercises could be completed outside the laboratory period, whereas this was not possible at FCU due to the short duration format of the course there. Also, exercises were scored and returned to the students at NTU, whereas grading of the exercises was not possible at FCU.

Pre-course and Post-course Assessments

Pre-course and post course assessments were made using the PSVT-R and the MCT. Figure 1 shows the PSVT-R pre-course and post-course results at NTU, and indicates a significant improvement in scores as a result of the course. The PSVT-R at FCU, as well as the MCT at both NTU and FCU, showed similar trends.

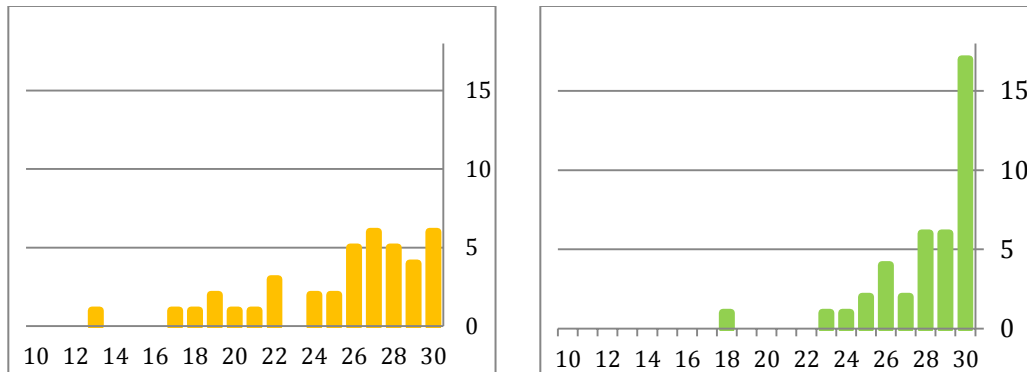


Figure 1. PSVT-R results at NTU. Pre-course assessment on left, post-course assessment on right. Raw score (maximum 30) on horizontal scale, number of students on vertical scale.

The students at FCU showed a significant improvement in scores even with the course compressed into a 2-day format. However, as compared the 4-week version of the course at NTU, the gains were not as high, especially for the female student. This result, as shown in Table 1 for the PSVT-R and in Table 2 for the MCT, suggests that extending the duration of the course exposure, which allowed for more contact and feedback to the students, may be a more effective implementation of the course.

Table 1. Raw PSVT-R (max 30) average assessment scores.

N, both genders	PSVT-R pre	SD-pre	PSVT-R post	SD-post
NTU (40)	25.5	4.17	28.1	2.53
FCU (47)	22.6	4.78	25.3	3.38

Table 2. Raw MCT (max 25) average assessment scores.

N, both genders	MCT pre	SD-pre	MCT post	SD-post
NTU (40)	18.1	3.89	21.6	2.73
FCU (47)	14.1	4.73	16.4	4.63

Gender Differences

The assessment tests at both NTU and FCU showed that male student typically scored higher than female students on the pre-course assessments. This trend is common in the US, and has been attributed to environmental and cultural difference between male and female students during their upbringing prior to attending college. A summary of the differences in gender scores is shown in Table 3 for the PSVT-R and in Table 4 for the MCT.

Table 3. Gender differences in PSVT-R average assessment scores.

N	PSVT-R pre	SD-pre	PSVT-R post	SD-post
NTU males (23)	27.2	3.26	28.9	1.73
NTU females (17)	23.1	4.18	27.1	3.07
FCU males (28)	23.6	3.84	25.9	3.06
FCU females (19)	22.2	4.49	24.9	3.46

Table 4. Gender differences in MCT average assessment scores.

N	MCT pre	SD-pre	MCT post	SD-post
NTU males (23)	19.0	3.89	22.0	2.91
NTU females (17)	16.8	3.61	21.1	2.44
FCU males (28)	15.0	4.92	17.4	5.10
FCU females (19)	12.6	4.32	15.0	3.77

The gender difference results suggest that although female students typically scored lower than male students at the beginning of the course, the visualization course may bring the female scores up to the same level as the male scores at the beginning of the course. Since the male students also took the course, their scores also rose, but the improvement was not as high as with the female students. It is interesting to note that there appeared to be a larger improvement at NTU, particularly with the female students, where the course was conducted over a 4-week period, as opposed to the 2-day compressed version of the course at FCU.

Conclusions

Since the workshops at both NTU and FCU were conducted over a time span that is much shorter than is normally done for a visualization training course, any final conclusions on the effectiveness of the current study must be confirmed by studies on the effects of shortened courses in this area. However, the results of the pre-course assessments at NTU and FCU are valid, and show similar trends as seen in the US, Poland, Germany, and Brazil. The pre-course assessments showed visualization scores at the Taiwan universities to be approximately the same as at major

US universities. The post-course assessments, with the cautions noted above, indicate the possibility of significant improvement in visualization scores at both NTU and FCU as a result of the short course. Male students in Taiwan typically scored higher on the pre-course assessments, which is a phenomenon seen also in the US. However, as with the US, post-course assessments showed that this gap may be closed by visualization training. Students at NTU scored higher than students at FCU on both the pre-course and post course assessments, despite the fact that the course participants at FCU were predominantly technical majors (who typically score higher on these tests than non-technical majors in the US) as opposed to the participants at NTU where the participants were a spectrum of technical and non-technical majors.

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