Chapter 9
Impact of Spatial Ability Training in Desktop Virtual Environment

Ahmad Rafi
Multimedia University Cyberjaya, Malaysia

Khairulanuar Samsudin
Sultan Idris University of Education, Malaysia

ABSTRACT

This case study reports an experimental research based on pretest-post test design that was carried out to investigate the extent of Spatial Visualization (SV) and Mental Rotation (MR) training improvement, differential impact attributed to gender and training method, and training transfer to engineering drawing task. The participants of the study were 101 eight graders comprising 42 girls and 59 boys (mean age = 15 years) and were randomly assigned into two experimental groups and one control group. The first experimental group employed interaction-based training in a desktop virtual environment trainer, the second group used animation-based training, and the control group trained using printed materials and all the three groups were trained for 8 weeks. Data were collected through spatial ability tests and a survey and were analyzed using SPSS version 14. Analysis of data reveals that there were substantial performance gains in SV and MR accuracy, but not in MR speed. Main effects of training in SV and MR accuracy were found where those trained by novel methods especially the interaction-enabled method outperforming the control group. Interaction effects were observed where differential improvement gain in SV and MR accuracy only involved male participants but not their female counterparts. Transfer of training to performance in solving engineering drawing task was observed by differential performances of groups, where those with higher spatial ability managed to perform the task better than those with lower spatial ability after spatial training. This transfer was qualified by the multiple linear regression procedure revealing that spatial visualization was a significant factor in predicting performance in basic engineering drawing task.

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INTRODUCTION

Technology has impacted and continues to transform almost every sphere of human endeavors in social, political and economic fields. The use and diffusion of technology has taken place very rapidly in line with the current thinking of learning emphasizing the role of pupils as active participants in the teaching and learning process. Training to improve one's performance involves a complex web of issues entailing careful analysis of factors that can result in either success or failure. The tools and resources for training are aplenty and more are becoming integrated and embedded in IT technology particularly Web technology. Choosing the right and effective tools will be quite a challenge as to create training environment that is not only conducive but also efficient. One of the human intelligence that has fascinated researchers and scientists is spatial ability or spatial intelligence. Notwithstanding the differences of opinions, all agreed that this cognitive ability is importance for humans to function effectively in everyday chores and it becomes more pronounced in performing tasks in specialized domains such as engineering and science. Spatial ability is multi-facet rather than unitary being conceptualized as a cognitive construct built upon several independent sub-abilities or sub-skills. Linn & Petersen (1985) categorized this ability into three components namely spatial visualization, mental rotation and spatial perception. Earlier on, this ability was regarded as innate not amendable to training. However, evidence from experimental studies suggests that improving spatial ability is possible through proper and specific training (Khairulanuar & Azniah, 2004; Olkun, 2003; Rafi, Khairulanuar, & Said, 2008; Turos & Ervin, 2000). One of the important discoveries emerging from studies involving psychometric testing of spatial ability was the revelation of gender differences favoring boys. Generally, boys were consistently found to perform better than girls on these tests suggesting that the former possess greater spatial skills than the latter. Male advantages in spatial ability have been established in reviews by Maccoby & Jacklin (1974), Linn & Petersen (1985), and Voyer, Voyer, & Bryden (1995). Age was also found to mediate gender differences where spatial ability was relatively higher among girls at young age, but began to favor boys as individuals approached adolescence (Maccoby & Jacklin, 1974). Given the diverging orientations or preferences in engaging spatial activities such as games, sports and types of educational enrolment, it can be inferred that environmental or experiential factors may influence the development of this ability. The more spatial experience one has the higher his/her spatial ability which reinforces the notion that this ability can be trained. Various training methods have been employed in spatial training to improve spatial ability namely spatial visualization and mental rotation focusing on the use of current technology and gender (Moyer, Bolyard & Spikell, 2001; Rafi et al,,2008; Rafi & Khairulanuar, 2009; Turos & Ervin, 2000). These studies indicate that the improvement of spatial ability was achievable but the level of performance gain was mediated by training specificity, gender, practice duration and condition.

Spatial ability has been established to be a strong predictor of success in engineering and science disciplines or majors (Olkun, 2003; Rafi & Khairulanuar, 2007; Sorby & Baartmans, 2000; Strong & Smith, 2001). One such course for these engineering majors is the engineering drawing or engineering graphics where strong positive correlation was found between engineering drawing performance and spatial ability particularly spatial visualization. Engineering drawing is a prominent component in technology education curriculum in major countries such as United States, Europe and in Asia, notably Japan and Korea. In general, students need to utilize two perceptual processing when learning the subject matter which falls into two categories utilizing these two processes. In the

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