



Impact of Working Memory on Visual-Spatialability

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Abstract

Working memory is a system for temporarily storing and managing the information required to carry out complex cognitive tasks. Visual-spatial ability is the ability to mentally manipulate 2-dimensional and 3-dimensional figures. This study aimed to examine the effect of working memory on visual-spatial ability. Data collected from 212 students, grade 7th - 12th, using Computerized Battery Test 1 (CBT1) and Visual-Spatial Ability Test (VSAT) to measure working memory and visual-spatial ability respectively. The data was analyzed by the M-Plus Statistical Modeling Program. The results showed that there was a significant effect from working memory on visual-spatial ability ($\chi^2 = 0.096$, RMSEA = 0.029, CFI = 0.975, TLI = 0.969, SRMR = 0.049). So developing students' working memory can enhance visual-spatial ability.

Introduction

Mathematics is the language of science. The student's achievements in science require mathematical ability. (Margaret, W. and Alexandre C., 1999) Beyond calculation skills, one of mathematical ability is the visual-spatial ability. Thus, one process for increasing the level of scientific achievements may be from increasing the visual-spatial ability. (Mary, H., Maria, K., 1999)

Visual-spatial ability is one aspect of the cognitive functions. It is ability to mentally manipulate 2-dimensional (geometric model of the planar projection of the physical universe; length and width) and 3-dimensional (a geometric 3-parameters model of the physical universe; length,

width, and depth (or height)) figures. (Alonso, D.L., 1998). Visual-spatial ability is used extensively in mathematics (Mary, H., Maria, K., 1999, Behzat, B., 2006, Helier J. R., 2011) including geometry problem-solving logical thinking, mathematics performance and kinesthetic graphetc. (Behzat, B., 2006).

Working memory originated from earlier models of short-term memory, one of the most influential frameworks for working memory in cognitive science. The updated model (Baddeley, A.D., 2007) assumes an attentional control system, the central executive, and three storage subsystems, the phonological loop, the visuospatial sketchpad, and the episodic buffer. The phonological loop holds verbal and acoustic information. The sketchpad

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holds visual and spatial information. The episodic buffer forms an interface between long-term memory, the other storage systems, and the central executive. It is assumed to provide a common coding mechanism (i.e., a common “language”) for the exchange and manipulation of information from different modalities. It thus may serve as a basis for a temporary and flexible work-space in which diverse information can be combined into meaningful chunks under the attentional control of the central executive. The episodic buffer, like the phonological loop and the visuospatial sketchpad, is limited by the number of chunks of information it can maintain (Baddeley, A.D., 2007).

Working memory is the cognitive functions for the complexity cognitive functions. (O'Connor, B., Spencer, F., Patton, W., 2003). Many studies found that working memory is an important factor in making cognitive processes but still not be concluded about how much Working memory can affect visual spatial ability. This study aimed to examine the effect of working memory on visual-spatial ability.

Material and Method

1) Samples

The large schools of the Northeast in Thailand, one class in the each 7th-12th grade were random selected to be samples. In this survey research, data were collected during 1st-30th December 2011.

2) Materials and Measures

(1) Computerized Battery Test 1 (CBT1) is comprised of eight tasks. They are word recognition task (WR), picture recognition task (PR), choice reaction task 1 (CR1), choice reaction task 2 (CR2), stoop task (ST), spatial working memory task (SWM), numeric working memory task 1 (NWM1), and rapid visual information processing task (RVIP). All tasks are used to measure the accuracy and speed of working.

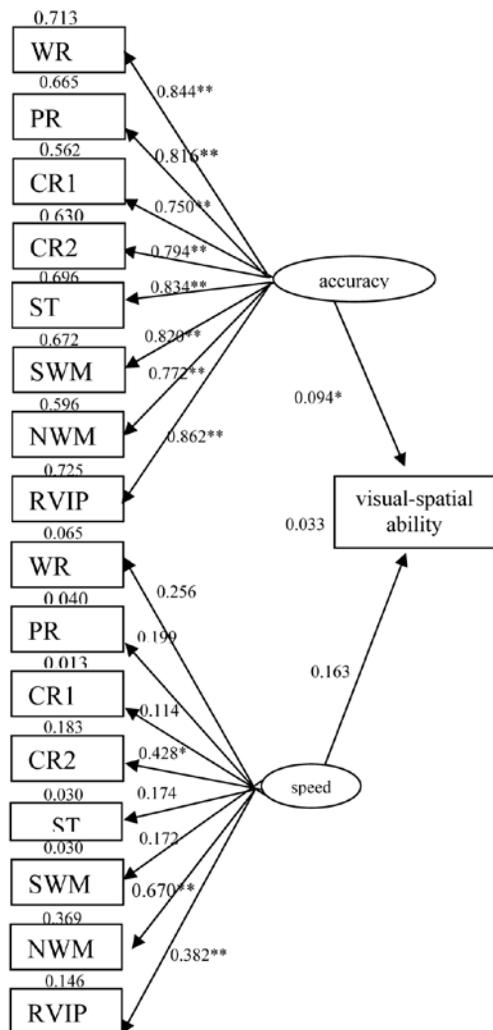
(2) Visual-Spatial Ability Test (VSAT) is used via the computer to measure the quality of Visual-spatial ability.

3) Analyzing Data

Structural equation modeling (SEM) is a technique used for specifying and estimating this model of linear relationships among variables. This technique is a family of statistical techniques permitting researchers to test such models and as a hybrid of factor analysis and path analysis that researchers can test hypothesized relationships between constructs. (Judea P., 2011)

Result

Impact of working memory on visual-spatial ability models have been adopted to test the causal of constructs variables with the structural equation model (SEM).



Figs. 1 Impact of working memory on reading ability (* $p < 0.05$, ** $p < 0.01$)

Model tested are displayed in **Figs.1**. This model indicates an excellent fit with χ^2 statistic of 129.760 (degrees of freedom = 110, $p = 0.096$), with the χ^2/df ratio having a value of 1.179 indicates a good fit. The comparative fit index (CFI) is 0.975, and Tucker-Lewis coefficient (TLI) is 0.969 which is more than 0.9 shows excellent fit. Root mean square error approximation (RMSEA) is 0.029 indicates a good fit. Standardized Root Mean

Residual (SRMR) is 0.029 indicates a good fit, too. The highest variation percentage, R-squared value is 0.725.

Discussion

This research showed that there was a significantly effect from working memory on visual-spatial ability. In detailed, there was significantly effect from accuracy of working memory on visual-spatial ability, but could not prove the significantly effect from speed of working memory on visual-spatial ability. Thus, If you can do working tasks correctly, then will do the visual-spatial ability test but the times spent in the activities of the working memory tasks more less did not cause a change in visual-spatial ability.

Many studies in Thailand found that the appropriate teaching method can promote working memory and can promote science learning outcomes (Wattanathorn J., et al., 2008; Kaewkraisorn, N., et al., 2010; Ratthanawongsa J., et al., 2011; Wangphomyai P, et al., 2011). There may be some variables between working memory and science learning outcomes and one of these variable may be visual-spatial ability. From this study, one approach to improve visual-spatial ability is increasing working memory, and the result, improve mathematics and science achievements too.

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