Factors Influencing Science Achievements

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Abstract

The well-established science achievements serves the foundation of technological development and a key factor in economic growth. Currently, the factors influencing science achievements to Thai students are still developed. So this study aimed to examine the factors influencing science achievements. Predictor variables consisted of two latent variables: prior knowledge, working memory capacity (WMC); sixth observed variables. Data were collected from 212 students, grade 7^{th} - 12^{th}, using collecting score form to collect the science achievements and the prior knowledge consist of science, mathematics and Thai language, and using Computerized Battery Test2 (CBT2) to measure WMC. The data were analyzed with Structural Equation Modeling (SEM) using the M-Plus Statistical Modeling Program. The results showed that The causal model was fitted with the empirical data (χ^2= 0.384, RMSEA = 0.018, CFI = 0.999, TLI = 0.998, SRMR= 0.019). From this study, understanding the factors influencing science achievements can lead to the process of enhancing science achievement.

Keywords: working memory capacity, prior knowledge, science achievements, educational neuroscience

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Introduction

Science influences the daily lives of individuals throughout the world, our receipt of new and information, major factor in determining the economic health of country (TIMSS International Study Center, 1996). For more than a decade, educators have emphasized the importance of science (American Association for the Advancement of Science, 1989). A strong science background in high school is essential for future educational and occupational opportunities (NCTM, 2000). Considerable investments have been made to investigate student acquisition of knowledge and skills in science nationally and internationally, such as the National Assessment of Educational Progress (NAEP) and the Third International Mathematics and Science Study (TIMSS). In such a campaign, the attention of educators is often drawn to the various factors that affect academic achievement of students especially science (Fraser 1994; Greenfield 1996).

Recent findings suggest that prior knowledge are the knowledge that stems from previous experience. They derived from many sources, including earlier coursework, information from the media, folk theories, and the lessons of everyday experience. (Thompson, A.R. & Zamboang, L.B., 2004). A large body of findings shows that learning proceeds primarily from prior knowledge (Jeremy R., 2012). Prior knowledge is especially important for student's learning and can assist the new learning (Thompson, & Zamboang, 2004).

One of the recent finding suggest that working memory capacity (WMC) varies widely across individuals and reliably predicts higher-order cognitive abilities that influence academic achievements (Lawson, 2006). WMC refers to the capacity of working memory. Working memory is the ability to maintain, manipulate, and access mental representations as needed to support complex cognition. The capacity of working memory can be measured. Most researchers use reading ability, visual-spatial ability and operated ability to be the indicators of WMC (Alonso, 1998; Mary, & Maria, 1999; Nash, Richard, Josef, & Randall, 2005; Behzat, 2006; Frank, William, James, & RuSan, 2007; Helier, 2011; Srikoon, Bunterm, T, Wattanathorn, Wannatong, 2012a, 2012b). Reading ability is the ease in which text can be read and understood. Various factors to measure readability have been used, such as speed of perception, perceptibility at a distance, perceptibility in peripheral vision, visibility, the reflex blink technique, rate of work (e.g., speed of reading), eye movements, and fatigue in reading. (Frank, William, James, & RuSan, 2007; Srikoon, Bunterm, Wattanathorn, & Wannatong, 2012a). 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, 1998). Visual-spatial ability is used extensively in mathematics (Mary, & Maria, 1999; Behzat, 2006; Helier, 2011) including geometry problem-solving logical thinking, mathematics performance and kinesthetic graph, etc. (Behzat, 2006). The last, operated ability is ability to solve a series of math operations while trying to remember a set of unrelated words. The participants saw one math operation–word string at a time, centered on a computer monitor. (Nash, Richard, Josef & Randall, 2005). Many studies found that there are many factors affecting on WMC including attention, recognition memory and working memory (Alonso, 1998; Daryl, 2008).

Many educational neuroscience research in Thailand to promote science learning outcomes (Kaewkraisorn, et al., 2010; Ratthanawongsa, Bunterm, Wattanathon, & Muchimapura, 2011; Wangphomyai, Bunterm, Wattanathorn, & Muchimapura, 2011). However, Currently not possible to conclude on the factors influencing science achievements of Thai students. So this study aimed to examine the factors influencing science achievements.

Method/Experimental Design

1. Samples. 212 students, Thai, 50 men and 162 women (mean age 14.967 $\pm$ 1.382 years) were recruited to participate in the present study. Samples were also screened for physical health by a physician in order to assure healthy condition. Inclusion criteria were healthy, students in secondary school, Thai National children between the ages of 13 and 18 residing in one large school in the Northeast Thailand. From one large school, one class in the each 7^{th}-12^{th} grade were randomly to be samples. In this case study research, data were collected during 1^{st} December 2011 - 30^{th} May 2012.

2. Matherials and Measures. Computerized Battery Test2 (CBT2) is comprised of three tasks. They are Operated Ability Task (OAT), Reading Ability Task (RAT), Symmetry Ability Task (SAT) that is used via the computer to measure the quality of WMC. Collecting score form is used for collecting the science achievements and the prior knowledge (consist of science, mathematics and Thai language).

3. *Analizing 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)

Results

The factors influencing science achievements has been adopted to test the causal of constructs variables with the structural equation model (SEM). This research showed that there was a significantly effect from accuracy of WMC and prior knowledge on science achievements. In detailed, there was significantly effects both accuracy of WMC science achievements ($p<0.05$) and prior knowledge on science achievements ($p<0.01$).

Model tested is displayed in Figure1. This model indicates an excellent fit with statistic of 11.732 (degrees of freedom = 11, p= 0.384), with the χ^2/df ratio having a value of 1.067 indicates a good fit. The comparative fit index (CFI) is 0.999, and Tucker-Lewis coefficient (TLI) is 0.998 which is more than 0.9 shows excellent fit. Root mean square error approximation (RMSEA) is 0.018 indicates a good fit. Standardized Root Mean Residual (SRMR) is 0.019 indicates a good fit, too. The highest variation percentage, R-squared value is 1.000.

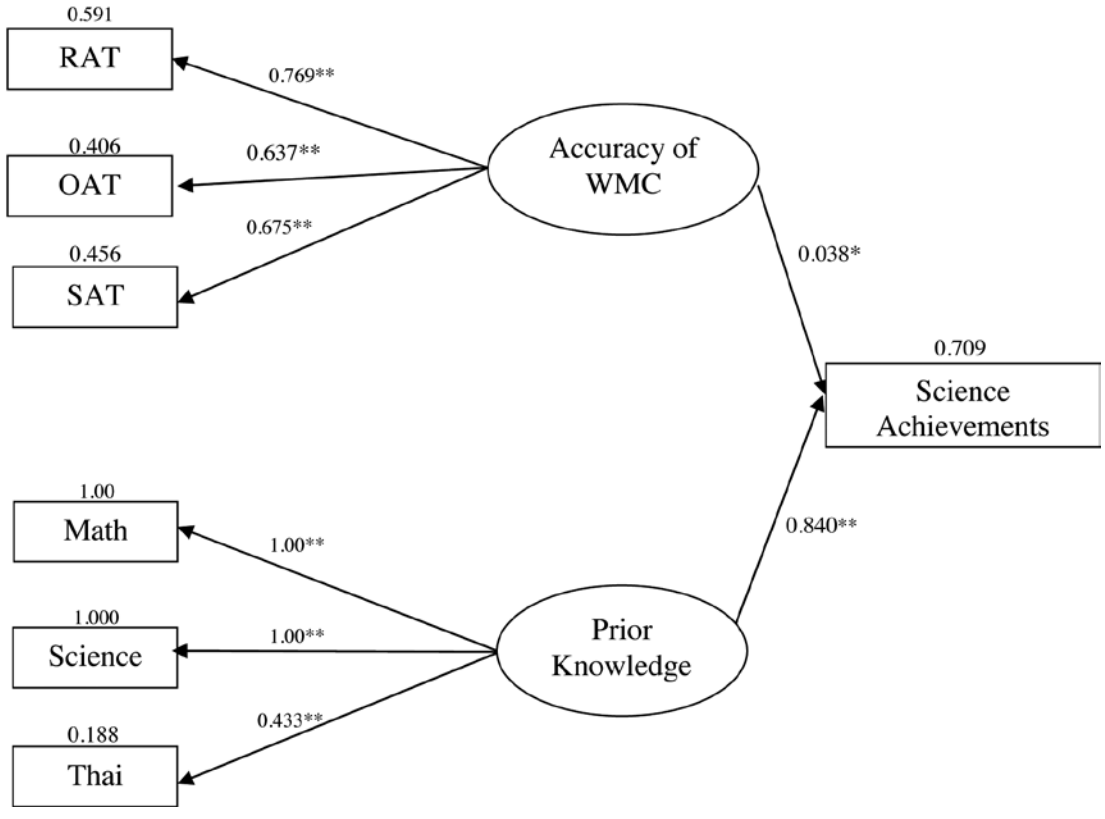

Figure 1 The factors influencing science achievements (*p<0.05, **p<0.01)

Discussion

The present study clearly demonstrates that WMC and prior knowledge influence science achievements.

From this study, we found that prior knowledge influences to science achievements, which comprised of science achievement, mathematics achievement and Thai achievement. Consistent with Thompson, & Zamboang, (2004) found that the prior knowledge is especially important for student's learning and can assist the new learning. Moreover, prior knowledge within specific domains influences achievement. So, if we can do increasing prior knowledge, then will do enhancing the science achievements.

One finding, we found that WMC influences to science achievements and Frank, R.V., William, James, & RuSan, (2007) found that WMC is the capacity of WM. Therefore,WMC may be relative with science learning outcomes. So, if we can do increasing WMC, then will do enhancing the science achievements, too. Consistent with many studies in Thailand have study about science learning outcomes (Kaewkraisorn, et al., 2010; Ratthanawongsa, et al., 2011; Wangphomyai, et al., 2011). They found that working memory relative with science learning outcomes.

Conclusion

The present study demonstrates that WMC and prior knowledge influence science achievements. Therefore, our data reveal that WMC should be focus for developing science achievements, which WMC is the capacity of WM. So, one approach for enhancing science achievements is developing WM, too. One factor influencing science achievements is prior knowledge, which comprised of science achievement, mathematics achievement and Thai achievement. So, one approach for enhancing science achievements is potentially training prior knowledge especially the science, mathematics. However, further study about the more two latent variables especially the attention and teaching models should be performed.

Abbreviations

CBT2 : Computerized Battery Test 2
WM : Working Memory
WMC : Working Memory Capacity
OAT : Operated Ability Task
RAT : Reading Ability Task
SAT : Symmetry Ability Task
Math : Mathematic Achievements
Science : Sciencetific Achievements
Thai : Thai Achievements

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