A cross-cultural comparison of the relationship between motivation and performance in math and science

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Abstract

Prior research suggests that motivation, including intrinsic and extrinsic motivation, is key to effective math and science learning. In this study, international assessment data, including 2015 Trends in International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA) data, were utilized to examine the relationship between motivation-related variables and performance in math and science. Asian countries/regions (Taiwan, Hong Kong, Singapore, Japan, and South Korea) and USA were selected for cross-cultural comparison. Because the sample size of these international assessments is very large, data visualization and data mining, which are based on pattern recognition, instead of hypothesis testing, were employed as the primary tools for this study. The data reveal that intrinsic motivation does not necessarily predict performance, especially in USA. According to 2011 TIMSS, whether US Grade 8 students agreed that math can help in their daily life, whether they need math to learn other subjects, and whether they need math to get the job they want have no impact on their math performance. Similarly, 2015 PISA does not show a significant association between instrumental motivation and math/science test scores among US students. Rather, interest in broad science topics and enjoyment of science are powerful predictors of PISA math and science test performance. Cultural differences between Asians and Americans in motivation for math and science are discussed in this presentation.

Introduction

Traditionally, motivation is classified into two major categories, namely, intrinsic motivation and extrinsic motivation (Sansone & Harackiewicz, 2000). Intrinsic motivation is said to be the drive for action arising from internal factors, whereas extrinsic motivation is believed to be driven by external factors, such as utility value. Specifically, in the former students might be enthusiastic to learn math and science because they are interested in the subject matter that they like. In the latter group, interest and making things fun turns out to be an extrinsic motivator. As mentioned before, many US researchers believe that extrinsic factors, such as interest in broad science topics (intrinsic), interest in broad science topics (intrinsic), and instrumental variable using observations of USA and East Asian students (r = .54, 978). It is apparent that the data cloud shows no pattern between instrumental motivation and the two variables related to intrinsic motivation.

Results

2011 TIMSS data (Table 1-3) reveal that Asian students who agree a lot to the statements regarding the utility value of math tend to have much better performance than those who agree only a little. However, this difference is not observed among American students. No matter whether they agree a lot or a little, the average scores remain flat. In other words, US students seem to be immune to extrinsic motivation.

Intrinsic motivation is often tied to interest (Eccles, Wigfield, & Schiefele, 1998; Pintrich & Schunk, 2002). Hence, triggering and maintaining interest is said to be the key to effective science and math education (Reninger, Nieswandt, & Hidi, 2015). However, prior research on the motivation mode of Asian students does not appear to be straightforward. Utilizing TIMSS data, Leung (2002) found that while Hong Kong, Singapore, South Korean, and Japanese students outperformed their Western peers in math performance, they held a negative attitude towards the subject. Another study shows that while Whites invest more efforts into the subject matter that they like, Chinese student spent equal efforts on all task, no matter whether they are interested in the subject matter or not (Dally, 2004). More importantly, among Chinese students intrinsic and extrinsic motivation tend to co-exist rather than being in opposition (Sallij, Chiu, & Lai, 2001).

International assessment data, such as TIMSS and PISA, were utilized. Because the sample size is extremely large, conventional statistical procedures are inappropriate. I.e. given a large sample size, any trivial effect would be mis-identified as significant. Hence, in this study data visualization tools will be utilized to unveil the data patterns.

Table 1 shows the descriptive statistics of test performance and intrinsic motivation. Interestingly, the mean scores of enjoyment of science and interest in science of Hong Kong students are both higher than that of US students.

Conclusion

In summary, large-scale international assessment data, including TIMSS and PISA, suggest that Hong Kong and other Asian students are motivated by so-called extrinsic factors while US students. To some extent, are immune to this type of motivation. Further, PISA data show that there is no seesaw relationship between intrinsic and extrinsic motivation. Specifically, Hong Kong students who are extrinsically motivated also show a higher mean score in "interest in broad science topic" and "enjoyment of science" than their American peers.

What is the implication for education reform in the US? In the US it is very common for teachers, professors, and parents to give this type of advice to children and youths: “Follow your heart. Don’t do something that you don’t have a passion for.” In this sense intrinsic motivation seems to be the prime motivator. As mentioned before, many US researchers believe that triggering and keeping interest is crucial to successful math and science education in order to make the content interesting, education becomes “edutainment” and usually technology is employed to make learning fun and exciting (Svein, 2012). However, according to So & Sansone (2010), interest and making things fun turns out to be an extrinsic motivator. Specifically, students will not be motivated to learn math and science, which are inherently difficult and dry and inevitably cause confusion and frustration. By contrast, Hong Kong educators do not tell students to follow their passion or do something that they enjoy. The implicit assumption is that students who are extrinsically motivated are not doing what they like to do in the future. Nonetheless, as Hau and Ho (2010) pointed out, students might start from extrinsic motivation and become both intrinsically and extrinsically motivated. They will continue to do something that they enjoy and, as a result, become both intrinsically and extrinsically motivated.

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