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The Relationship between Science Achievement and Self-concept among Gifted Students from the Third International Earth Science Olympiad

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ABSTRACT
This study investigated the relationship between gifted students' academic self-concept (ASC) and academic achievement (AC) in earth science with internationally representative high-school students from the third International Earth Science Olympiad (IESO) held in Taiwan in 2009. The results of regression analysis indicated that IESO students' ASC was significantly correlated with their AC (R^2=0.53, p<0.01) with large effect size, even when compared to other Asian countries such as Korea and Japan. It was found that Taiwan's students had the lowest ASC and exhibited poor interaction with other IESO students. The unique pattern of Taiwanese students exhibited through the 3rd IESO leads to the conclusion that: For the top notch gifted students, their social and psychological character such as their popularity and interaction skills, have much strongly effect on their ASC than cultural factors.
Keywords: science achievement, gifted, self-concept

INTRODUCTION

Do students with high academic test scores think highly of themselves? What makes successful students confident enough to think that they are truly "good enough" in the subject(s) that they are pursuing? Marsh (1995 & 2003) pointed out an interesting finding that students often exhibit lower academic self-concept when they are placed in academically selective schools or programs. This discovery begs the question: is there a positive correlation in gifted students, within a competitive setting? If so, is there a similar correlation between the self confidence level and academic performances? In other words: do students with excellent academic performance think they are "good enough" when they are competing with the other elites? In this article, we first discuss the importance of student's academic self-concept and academic achievement. Then we then focus on the uniqueness and research limitations within current gifted student studies. Finally, we step into the special gifted competitive context (The

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State of the literature

- The basic premise of "Big fish little pond"(BFLP) theory is that students need a reference frame when assessing their academic achievement; even the students with objective equal ability will have disparate academic self-concepts, depending on which frames of reference they chose to evaluate themselves. When approaching "other" extraordinary peers, those gifted students always feel less positive about their academic achievement (Marsh et al., 1995; Richardson & Benbow, 1990; Swiatek & Benbow, 1991).
- Traditionally, researches find that academic achievement and academic self-concept are positively correlated and have reciprocal effects on each other. Confident students tend to achieve more in academic studies (domain-specific measures), and vice versa.
- Since the ceiling effect is known to impede the investigation of gifted students' academic achievement and academic self-concept, the previous regular tests, developed for generally ability student, cannot effectively discern gifted students' achievement. Researchers also point out, in many special gifted student instructional contexts, much of the student's performance may not be readily measured and there also exists an absence of suitable sensitive self-concept research methods (Plucker & Stocking, 2001).

Contribution of this paper to the literature

- With the opportunity of the 3rd The International Earth Science Olympiad (IESO), the questionnaires and tests are specially designed for gifted students, in order to investigate gifted students' academic achievement and academic self-concepts appropriately.
- According to our results, it was found that 3rd IESO students' academic achievement was not significantly correlated with their academic self-concept. However, if more attention is paid to the details in Taiwan's students, it is found that the results of Taiwanese students have much larger deviation than other counties. The unique pattern of Taiwanese students exhibited through the 3rd IESO enables the conclusion that for the top notch gifted students, the social and psychological factors such as popularity and interaction skills are much stronger than the cultural factors on students' academic self-concept.
- Interactive processes in learning help students to establish an idea of their strengths and weaknesses. Through interaction with other students of their own level, these gifted students are allowed to improve themselves by asking themselves "can I do it?" instead of "am I better than others?"

International Earth Science Olympiad) to further investigate the relationship between gifted students' academic self-concept and academic achievement.

LITERATURE REVIEW

Academic Self-Concept and Academic Achievement

Academic self-concept, literally speaking, is a self- perception while people assess their academic ability by themselves. One of most influential authors in the academic self-concept field is Marsh. In his series research since 1983, Marsh defined academic self-concept in a

deliberate way and provided a novel theory -"Big fish little pond"-to discuss the relative influential factor and the function of academic self-concept.

In Mash's research (Marsh, 2008), academic self-concept is defined as students' self-perceptions of their academic accomplishment, academic competence and expectations of their academic success and failure; moreover, self-concept is also domain specific in each different academic subject: a student could have a high academic self-concept in Math but a low academic self-concept in English in the same time. In other words, if we want to investigate students' academic self-concept, it should be narrowed down to a specific academic subject.

"Big fish little pond"(BFLP) is the theory to predict that students with equal academic ability will have lower academic self-concept when attending a high average academic ability school than when attending a school with a lower academic school-average (Marsh, 1987). The basic premise of BFLP is that students need a reference frame when assessing their academic achievement; even the students with objective equal ability will have disparate academic self-concepts, depending on which frames of reference they chose to evaluate themselves. This academic self-concept is an influential implication for a student's future choice and behaviors and relevant to students' academic achievement (Marsh, 2007& 2008; Marsh& Craven 2006). Students' academic self-concept is relevant with their academic achievement and the interaction between academic achievement and academic self-concept will directly impact the students' future academic choices and goals.

The relationship between students' academic self-concept and academic achievement has become an issue of great interest for research in science education. Numerous studies (e.g., Hansford & Hattie, 1982; Marsh & Yeung, 1997; TIMSS, 2003; Chang& Cheng, 2008) have claimed that academic achievement and academic self-concept are positively correlated and have reciprocal effects on each other. Confident students tend to achieve more in academic studies (domain-specific measures), and vice versa.

The academic self-concept impression is first formed by related experiences and reinforced by environmental factors such as comments from peers or teachers (Kelly, 1973; Shavelson, 1976; Chang & Cheng, 2008). The (Spell out this before using the acronym) (TIMSS) 2003 and 2007 International Science Report also showed that extremely high academic achievement scoring students from Taiwan, Japan, and Korea also scored the lowest academic self-concept levels among all participating students worldwide. Researchers generally attributed this serious inconsistency between academic self-concept and academic performance to cultural factors of Asian countries, especially those countries under great influence of Confucianism (Chang & Cheng, 2008). Confucianism is often considered to be the cultural foundation of ethnic Chinese peoples in countries such as China, Japan, Korea, and Taiwan. Students from these countries tend to act less confident, in an attempt to be humble, as they do not want to be considered arrogant in the eyes of the others (Martin et al., 2004; Martin et al., 2007; Chang & Cheng, 2008; Hofstede & McCrae, 2004). The aforementioned

research, as well as the present one, also indicates that complicated social and psychological factors between academic self-concept and academic achievement also exist. Further focused investigation is needed if one wishes to delineate influencing factors on the academic self-concept of elite students.

The Uniqueness and Research Limitation of Gifted Students' Self-Concept and Academic Achievement

Since academic self-concept has been seen as an important factor to comprehend students' achievement and their educational and occupational aspirations, investigating the impact of academic self-concept on students has become an important issue for educators (Marsh, 1991; Hoge & Renzulli, 1993; Plucker & Stocking, 2001). According to Ross and Parkers' (1980) research, the result also emphasized the importance of academic self-concept to explain gifted students' underachievement. The previous research investigating the relationship of students' academic achievement and academic self-concept also points out the uniqueness of gifted students; researchers could successfully use an internal/external frame of reference model to predict the relationship between general ability students' academic self-concept and academic achievement but fail on predict gifted students' (Skaalvik and Rankin, 1992). Unfortunately, there is an absence of appropriate models to explain the relationship between gifted students' academic achievement and academic self-concept (Williams & Montgomery, 1995), and further investigating is needed to complete the picture of gifted students' unique distinction.

Generally speaking, gifted students are assumed to be highly confident with their academic performance. However, according to Plucker and Stocking's research (2001), the gifted students' academic self-concept is not generally high in all subjects but is domain specific; Students' math self-concept may be unrelated to their verbal self-concept, even though they have similar math and verbal achievement. Previous research also points out that the gifted students' subject-specific achievement had a strongly positive impact on corresponding self-concept domain but a weakly negative impact on other self-concept domains (Williams & Montgomery, 1995). Briefly, a complete understanding of the impact and interaction between gifted student's academic achievement and academic self-concept requires further research focus on subject-domain.

Since the ceiling effect is known to impede the investigation of gifted students' academic achievement and academic self-concept, the previous regular tests, developed for generally ability student, cannot effectively discern gifted students' achievement. Researchers also point out, in many special gifted student instructional contexts, much of the student's performance may not be readily measured and there also exists an absence of suitable sensitive self-concept research methods (Plucker & Stocking, 2001). Thus, out of level achievement tests, specially designed for gifted students, and appropriate academic self-concept questionnaires are necessary, to investigate further, gifted students' academic achievement and academic self-concept.

METHODS

The Setting: The International Earth Science Olympiad (IESO)

The question being researched is: Why some top-notched students feel bad about themselves after achieving excellent academic performances? To answer this question, we require a valid and representative sample within a researchable context. It is vital to take a closer look at the whole process of how students establish the relationship between their academic self-concept and academic achievement. In addition, previous research also points out the important impact for gifted students' academic self-concept in gifted programs; when approaching "other" extraordinary peers, those gifted students always feel less positive about their academic achievement (Marsh et al., 1995; Richardson & Benbow, 1990; Swiatek & Benbow, 1991). Those special programs provide gifted students not only the opportunities to interact with similarly talented peers, but a more amplitude frame of reference for their academic self-concept. Thus, while investigating the relationship between gifted students' academic achievement and academic self-concept, one cannot ignore the influence of such special programs and competitions which are specifically designed for gifted students. The representative samples of TIMSS are comprised of students from across each academic achievement level; this study, however, focuses on samples of highly gifted students. Accordingly, The International Earth Science Olympiad (IESO) was chosen as the sample for this research. Indeed, the IESO students, who are specially selected from each country, cannot fully encompass all the gifted students of their countries. These participants are, nevertheless, recognized by their countries as gifted representatives of their student bodies. While IESO has limitations in terms of sample size, it is nonetheless, an excellent opportunity to glimpse the relationship between gifted students' academic self-concept and academic achievement. Under this context, this research is focused on elite students in a specific field (in this case: earth science).

The International Earth Science Olympiad, founded by the International Geoscience Education Organization (IGEO), is an annual Earth Science competition held for secondary school students worldwide. The goals of IESO are to promote earth science education globally, to encourage students in the study of Earth Science, and to raise public awareness in environmental protection. The competition covers all major areas of earth science, including geology, geophysics, meteorology, oceanography and astronomy. The IESO competition consists of two parts: written and practical examinations. The written test, which covers all the major areas of Earth Science from geology, geophysics, meteorology, oceanography, and astronomy, aims to examine the participating students' understanding of the theoretical knowledge of Earth Science. The original language used for the written IESO test questions was English. Based on the original written test, the mentor of each country then translated the original written test into their own country's native language.

The practical examination includes experiments and field tasks designed to evaluate students' capacity to conduct experiments or to solving problems in the field of Earth Science.

The IESO 2009 Practical Test included equipment operation, data analysis, and field survey in the fields of astronomy, atmosphere, and geosphere. Before the practical tests, an orientation was given to the students to help them familiarize with the operation of several instruments. The orientation consisted of assembling a telescope, using the clinometers and GPS, online data analysis and handling the rod. For the astronomy practical test, the participating students were required to operate an astronomical telescope to observe and explain assigned astronomical phenomena. For the atmosphere practical test, the students were given related data charts for atmospheric interpretation and analysis using computers. For the geosphere practical test, a field test took place on the Northeast coast of Taiwan. Several stops were set up for the field test. Prior to the test, all mentors visited the field-test site to examine whether the stops of the field test corresponded to the test items. During their visit to the site, discussions were held regarding test details, safety issues, feasibility and etc. On the day of the field test the participating students were asked to conduct survey works such as sketching the topography, observing the sedimentary structures, classifying the rocks included in the strata, identifying the fossils observed, and measuring the strike and dip of the strata. In addition, by using a GPS receiver, the students were required to label their locations on the map, to sum up the interpretations, and to reconstruct the geological history of the field site surveyed.

One of the related activities of IESO 2009 was the International Team Field Investigation (ITFI). In this activity, the participating students were regrouped into cross-country teams to conduct field investigations at the 921 Earthquake Memorial Tower and the Viticulture Research Center of the National Chung Hsing University in central Taiwan, where the terrains were deformed by the 921 Chichi Earthquake on September 21, 1999. While allowing cross-country teams to complete the assigned fieldwork together, the ITFI promoted cooperation of team members from different cultural backgrounds.

With specific equipment provided, the teams were expected to delineate the possible magnitudes of the past earthquake and the length of surface rupture for the earthquake hazard assessment. After survey-work in the field, the ITFI group presentations were held on the following day. The cross-country teams worked on computers to synthesize what they had observed, measured, and analyzed in the field into final group reports. Each team then presented their final reports in front of the ITFI judges and all the IESO participants. Students' performances on the ITFI were not accounted for in their final IESO competition outcomes.

In International Team Field Investigation (ITFI) participants were regrouped into cross-country teams. This activity encouraged the students to cooperate with people of different cultural backgrounds while conducting field investigations. As a result, students had to learn to understand one another in the process of discussions and during reaching group consensuses with information they observed, measured, and analyzed. At the end of the activity, the groups had to present final oral reports to ITFI judges and all the other IESO participants (IESO report, 2009). This served as a perfect opportunity to research the relationship between academic achievement and academic self-concept.

The 3rd IESO 2009 (IESO report, 2009) was held at National Taiwan Normal University in Taiwan, from September 14th to 22nd, 2009. It provided an excellent opportunity to observe gifted students from around the world, and take a close look at their social and psychological behaviors in relation to academic self-concept and academic achievement.

Participants

The research sample used data from the 32 IESO participants (participants were chosen as representatives through their own country's national selection process) from India (IDA, n = 2), Indonesia (IDN, n = 4), Italy (ITA, n = 4), Japan (JPN, n = 4), Korea (KOR, n = 4), Philippines (PLP, n = 2), Singapore (SGP, n = 4), Thailand (THA, n = 4) and Taiwan (TWN, n = 4). The participants' average age was 16.6; all of them are studying in high school in the IESO period. All of those students were regarded by their respective countries as the top students in the field of earth science. Someone might challenge that the sample of this study is small; however, it serves the purpose of this study in terms of representing gifted students in earth science around the world.

Measuring instruments

Participants' academic achievement was measured by their total score in IESO written, and practical examinations developed by international earth science experts with appropriate validity and reliability, while academic self-concept was measured with Inventory of Self-Confidence in Earth Science Learning (ISCESL), which was developed by Chang and Cheng (2008). The original instrument in Chang's paper is called "Inventory of Self-Confidence and Interest in Science (ISCIS)", with two subscales measuring Self-Confidence (SC) in the subject (seven items). Factor analysis and principal component analysis with varimax rotation was then used to clarify the structure of ISCIS scales, which can be characteristically grouped into two orthogonal factors, self-confidence in science and interest in science that accounted for 50.56% of total variance explained. Reliability was also established through internal consistency. The Cronbach reliability of ISCIS is 0.87. Their study results also point out a statistically significant correlation existed between students' science achievement and their self-confidence and interest in science with a moderate effect size.

Based on the idea of ISICIS, the instrument was revised for research purposes. A portion of self-confidence from ISICIS was selected. The items were modified to better align with our research goals and the characteristics of the sample participants. To show the distinction, the instrument used in this study to measure gifted students' academic self-concept (ASC) was called Inventory of Self-Confidence Earth Science Learning (ISCESL). The total reliability coefficient of ISCESL, by using the method of Cronbach's alpha, was estimated at 0.94, and Sub scale reliability coefficient of Traditional ASC (ASC), ASC not compared with others (ASC-NCO) and ASC in comparison with others (ASC-CO) were respectively 0.85, 0.87 and 0.92.

To probe participants' multidimensional attitudes toward the academic self-concept (ASC), three sub-dimensions of the survey were assessed and identified: (1) traditional ASC

Table 1. Examples of the Items

Type	Subject
Traditional ASC	I am confident that I do well in the subject of earth science.
ASC not compared with others	When I do not compare myself with others, I think that I do well in earth science.
ASC in compares with others.	I do better work in earth science when I have the chance to compare myself with others.

Table 2. Principal Components Analysis of ISCESL Items with Varimax Rotation

Item	Sub-dimensions	Factors			
		1	2	3	4
6	ASC –CO[a]	.874	.329	.013	.087
9	ASC -CO	.818	.320	.316	.168
15	ASC -CO	.788	.014	.259	.339
12	ASC -CO	.681	.115	.477	.390
3	ASC -CO	.647	.157	.566	-.005
5	ASC –NCO[b]	.185	.885	.182	.102
8	ASC -NCO	.425	.761	-.024	.274
2	ASC -NCO	.160	.737	.385	.323
7	ASC-T[c]	.062	.689	.389	.241
13	ASC-T	.219	.267	.708	.416
4	ASC-T	.291	.442	.684	.117
10	ASC-T	.104	-.009	.674	.614
1	ASC-T	.366	.347	.623	.003
14	ASC -NCO	.270	.285	.115	.811
11	ASC -NCO	.152	.319	.144	.767
Eigenvalue		8.1	1.6	1.3	1.0
Percentage of variance		53.94	10.47	8.87	6.79

(ASC) (2) ASC not compared with others (ASC-NCO) (3) ASC in comparison with others (ASC-CO). (**Table 1**) The questionnaire given to the students adopted the five point Likert-type scoring methods. For each question item, there were five response options extending numerically from 5 (strongly agree) to 1 (strongly disagree). The reliability coefficient by using the method of Cronbach's alpha is estimated at 0.94, and all items were found to be highly correlated (**Table 3**). The evidence suggests that the ISCESL be treated as constituting an internally consistent measuring instrument. In **Table 2**, all five items 3, 6, 9, 12, 15 from ASC -CO are loaded heavily on the first factor. The three items of ASC -NCO are loaded heavily on the second factor, but items 11 and 14 from the fourth factor also cross-loaded heavily on this factor. The four items from ASC-T are loaded heavily on the third factor, but item 7 from the second factor also crossed –loaded heavily on this factor. The evidence from this analysis shows that the first factor includes all the ASC-CO items, the second factor includes three items from ASC –NCO, and the third factor include four items from ASC-T. According to the above, the evidence suggests the presence of three dominant factors.

Table 3. Corrected Item-Total Correlations for ISCESL Item

Please answer the following questions based on your own experiences.		$r_{i\text{-}t}$
1.	I am confident **that I** do well in the subject of earth science.	.71
2.	When I do not compare myself with others, I think that I do well in earth science.	.77
3.	I do better work in earth science when I have the chance to compare myself with others.	.75
4.	I am confident in my understanding of difficult earth science concepts.	.78
5.	When I do not compare myself with others, I think that I can understand difficult earth science concepts.	.67
6.	I know that I can understand difficult earth science concepts more quickly when I have the chance to compare myself with others.	.71
7.	I am confident that I can complete earth science assignments even if they seem hard.	.67
8.	When not comparing myself with others, I think that I can complete earth science assignments, even if they seem hard.	.70
9.	I know that I can complete difficult earth science assignments faster if I get the chance to compare myself with others.	.86
10.	I am confident that I am good at working in earth science labs and hands-on activities.	.65
11.	When not comparing myself with others, I think that I am good at working in earth science labs and hands-on activities.	.63
12.	When comparing myself with others, I know that I become better at working in earth science labs and hands-on activities.	.86
13.	I am confident that I can always get earth science assignments done.	.78
14.	When not comparing myself with others, I think that I can always get the earth science assignment done.	.68
15.	I know that I can complete earth science assignments more quickly if I have a chance to compare myself with others,	.74

All the questionnaires and tests were written in English and completed in the period of the 3rd IESO, from September 14th to 22nd, 2009.

Data analysis

It has been widely recognized that using only statistical significance testing (i.e., *p*-value) is insufficient for interpreting quantitative data in education (Daniel, 1998; McLean & Ernest, 1998; Rennie, 1998; Thompson, 1996). As a matter of fact, the computation of statistical significance is highly dependent on the sample size involved in the analysis; a small sample size is inherently more difficult to achieve statistical significance than a large one. Daniel (1998) even indicated that an "SST (statistical significance testing) is largely a test of whether or not the sample is large." (p26). It is quite common to observe a statistical significance with a large sample size, even if there is little practical effect.

Since the sample size involved in this study is rather small, the coefficient of effect size may offer more informative implications of the data in this case. Because the coefficient of effect size is the standardized statistical score, it can give a practical estimate of the noteworthiness of the results and help following studies to conduct meta-analysis between different studies (McLean & Ernest, 1998). Consequently, this study reports effect sizes along with the results of statistical significance testing. Therefore, how much of the variability in the

dependent variable is associated with the variation in the independent variable are used for examining proportion of variance such as R^2 in the regression analysis. According to Cohen's rough characterization (Cohen, 1988), R^2 = 0.196 is deemed as a small effect size, R^2 = 0.130 a medium effect size, and R^2= 0.260 as the large effect size, in light of the nature and characteristics of behavioral or social sciences (p. 78-83).

RESULTS

According to the results of regression analysis, it was found that IESO students' academic achievement was not significantly correlated with their academic self-concept (R^2=0.07, p>0.01, see (**Figure 1** Chart A)). However, if more attention is paid to the details in **Figure 1** Chart A, it is found that the results of Taiwanese students have much larger deviation than other counties. It appears that Taiwanese students' academic achievement scores are much higher than other students, yet their academic self-concept scores are exceedingly low. Therefore, If we excluded samples of Taiwanese students from the data sets, a significantly positive correlation (as **Figure 1**, Chart B) between students' academic achievement, and academic self-concept can be observed (R^2=0.53, p<0.01, large effect size). As McLean and Ernest (1998, p17) stated that, "the effect size gives an estimate of the noteworthiness of the results." The effect size (R^2) found between academic self-concept and academic achievement in the current study was quite large; Taiwan, however, was a notable exception to this finding see (**Figure 1** Chart A).

As the TIMSS 2003 and 2007 reports pointed out: Taiwan, Korea, and Japan had the least confident students due to cultural factors; this study found similar results in Taiwanese gifted students from the 3rd IESO. To determine if the same phenomenon existed for Korea and Japan, data from these countries were removed. When further regression analysis was conducted (excluding Japan's sample, see (**Figure 1**, Chart C), R^2=0.06, p>0.01 and excluding Korea's sample, see (**Figure 1**, Chart D) R^2=0.001, p>0.01); no significant change was noted. Thus, the relationship between academic performance and self-concept of students from Japan and Korea are not significantly different from those of other countries.

The host of International Team Field Investigation (ITFI), a professor of Geology in National Taiwan Normal University, was interviewed. This professor was the main speaker of the ITFI orientation. She helped students to familiarize themselves with the operation of several instruments and operations that consisted of: assembling a telescope, using the clinometers and GPS, online data analysis and handling the rod. She also full participated in the ITFI activity, and judged the final ITFI report. She had first-hand experience and comprehensive observation time with the students involved in the ITFI activities. According to her observations of students' interaction through the ITFI, she noted that Taiwan's students, in comparison to other students, had very little interaction with their team members.

To provide additional quantitative evidence to support the above statement, data were compiled from the vote for "Mr. and Ms. Congeniality," in which all of the students could vote for their favorite fellow student. Students were selected and votes calculated by country from

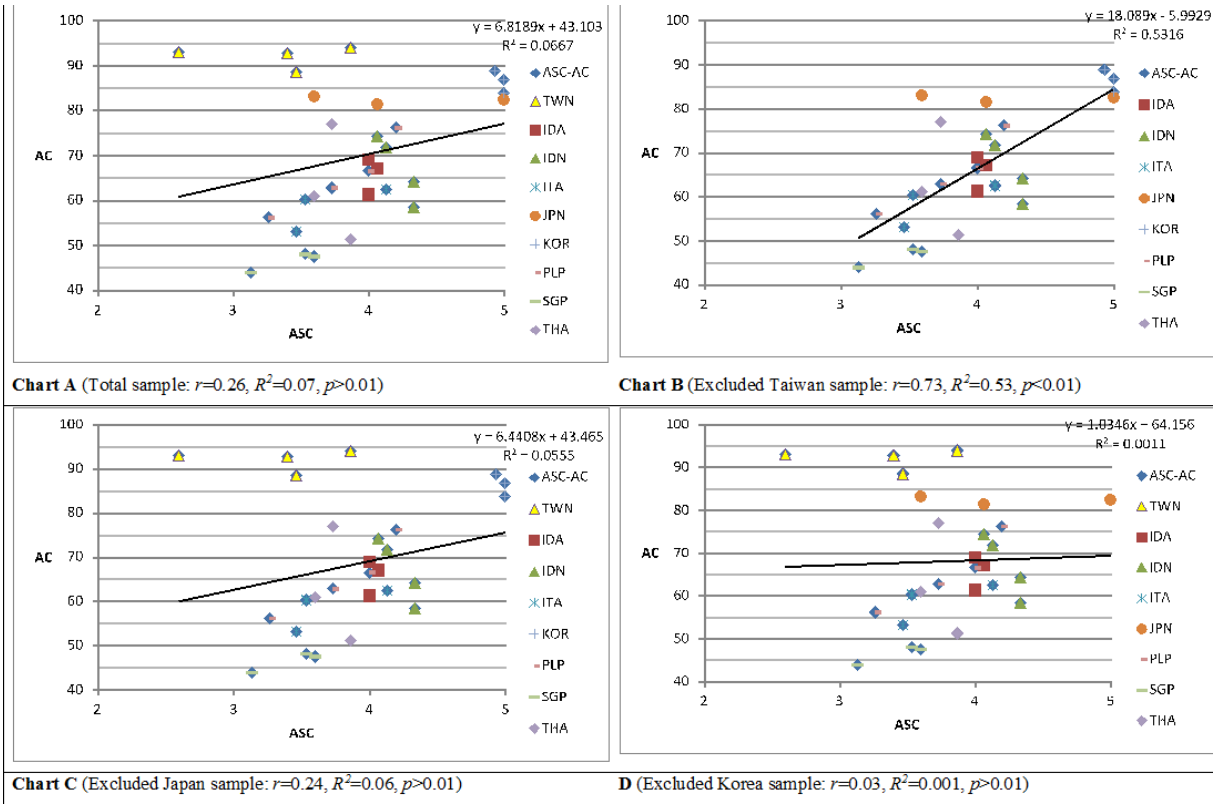

Chart A (Total sample: r=0.26, R^2=0.07, p>0.01) **Chart B** (Excluded Taiwan sample: r=0.73, R^2=0.53, p<0.01)

Chart C (Excluded Japan sample: r=0.24, R^2=0.06, p>0.01) **D** (Excluded Korea sample: r=0.03, R^2=0.001, p>0.01)

Figure 1. Regression models from IESO data: (Chart A) IESO Students' academic achievement was not significantly correlated with their academic self-concept. Taiwanese students' academic achievement seems to be much higher than students from other countries, yet their academic self-concept is, exceptionally low. (Chart B) Student's academic achievement and academic self-concept are significantly positively correlated if samples of Taiwanese students are excluded. The same analysis from (Chart B) applied to the samples of Japanese and Korean students (see (Chart C) and (Chart D), IESO Students' academic achievement was not significantly correlated with their academic self-concept, mainly because the low academic self-concept observed in Taiwanese students.

India (IDA, n = 2), Indonesia (IDN, n = 4), Italy (ITA, n = 4), Japan (JPN, n = 4), Korea (KOR, n = 4), Philippines (PLP, n = 2), Singapore (SGP, n = 4), Thailand (THA, n = 4) and Taiwan (TWN, n = 4). According to the average voting for "Mr. and Ms. Congeniality," Japanese students were ranked the second and Korea were ranked forth favorite, but Taiwanese students got the least number of votes and were ranked last among the nine sample countries. The results for "Mr. and Ms. Congeniality," including the nine countries involved, are shown in **Table 4**.

The sample size is quite small, so making inference from the results of including or excluding four students' data (representing a country) is risky. It should be noted that there still exists an interfering limitation in our analysis process and these results may be case sensitive. However, the statistical technique of regression may help us to determine the trend of the relationship between IESO student's academic performance and academic self-concept;

Table 4. The descriptions of "Mr. and Ms. Congeniality"

	Total score	Average voting	Rank
SGP	34	8.5	1
JPN	22	5.5	2
IDA	12	3	3
KOR	9	2.25	4
PLP	9	2.25	5
IND	7	1.75	6
THA	7	1.75	7
ITA	5	1.25	8
TWN	4	1	9

In the future, we will endeavor to take these results as the basis of a larger sample size investigation of gifted students in a specific science domain.

DISCUSSION AND CONCLUSION

The results of the current study suggest that IESO students' academic self-concept was significantly correlated with their academic achievement (R^2=0.53, p<0.01) with large effect size, when Taiwanese students were excluded from data analysis. It was found that only Taiwan's students had the lowest academic self-concept and poor interaction with other IESO students, even when compared to other Asian countries such as Korea and Japan. Consequently, Asian cultural factors cannot be used to explain why Taiwanese students' inconsistency between academic self-concept and academic performance.

One of the complicating, social and psychological influencing factors between academic self-concept and academic achievement is the interaction ability among students. Bianchini (1997) claimed students will have different statuses determined by their perceived academic ability and perceived popularity, and that will definitely affect their self-confidence. Cooley (1968) and Mead (1934) also emphasized that interaction with other people is the main factor in establishing one's self-concept. With these supportive findings as well as the collective data from IESO (and ITFI), it appears that for Taiwanese students, even with high academic achievement but with low popularity, academic ability is not the only thing that determines academic self-concept, popularity also served as a powerful influential factor. Popularity indicated how well a student could interact with other students in the process of scientific learning, which affected students' status and their self-confidence. The unique pattern of Taiwanese students exhibited through the 3rd IESO enables the conclusion that for the top-notch gifted students, the social and psychological factors such as popularity and interaction skills are much stronger than the cultural factors on students' academic self-concept. Interactive processes in learning help students to establish an idea of their strengths and weaknesses. Through interaction with other students of their own level, these gifted

students are allowed to improve themselves by asking themselves "can I do it?" instead of "am I better than others?"

In addition, since Constructivism becomes the main pedagogy of science education, the concern of learning has been extended from individual experiences to the interaction with environment and others people (e.g. teachers, classmates or peers) (Solomon, 1987). Since group work and cooperation have become important ways of learning science, how students are assisted in developing interaction skills should be an issue of emphasis for science education.

Chang (1999; 2003) showed most Taiwan students are quiet and passive learners who are accustomed to listening to their teachers and generally do not perform well in nor do they enjoy cooperative learning activities. Therefore, country-based, rather than culture-based, characteristics of gifted students' learning preferences appear to have brought about these different results among Japanese, Korean, and Taiwanese gifted students. Further research is needed to corroborate the hypothesis - student's country-based character, not whole Asian culture impact, might be the main factor for their academic self-concept development.

From the results of this research, it appears that interaction skills in students with high academic achievement scores are an influential factor in developing the important influences of interaction skills for the gifted students with excellent academic performances on their own academic self-concepts. It suggests that cooperative learning should be more broadly applied not only in Taiwan but also in countries similar to the Taiwanese situation. Since teamwork and cooperation have become important parts of learning science, how students are assisted in developing interaction skills and are encouraged not to be afraid of adventures involving interacting with others, should be emphasized in gifted science education. These results from IESO, suggest not simply focusing on the problem of Taiwan gifted students, but on improving the development of positive academic self-concept among students. Finally, future research investigating Asian student interaction skills are needed as a result of current study.

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