科技部補助專題研究計畫成果報告
期末報告

臺灣男女學生的家庭文化資本、科學興趣、科學自信、自我期望對科學成就之多層次模型分析

計 畫 類 別 ： 個別型計畫
計 畫 編 號 ： MOST 103-2511-S-152-012-
執 行 期 間 ： 103年08月01日至104年07月31日
執 行 單 位 ： 國立臺北教育大學教育經營與管理學系（所）

計畫主持人： 張芳全

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報 告 附 件 ： 出席國際會議研究心得報告及發表論文

處 理 方 式 ：
1.公開資訊：本計畫涉及專利或其他智慧財產權，2年後可公開查詢
2.「本研究」是否已有嚴重損及公共利益之發現：否
3.「本報告」是否建議提供政府單位施政參考：否

中 華 民 國 104 年 10 月 31 日

中 文 摘 要 ： 國際教育評量局(IEA)對於全球學生學業成就調查已有五十年之久，更有許多研究指出影響學生學習成就的因素。然而臺灣在這方面的研究很少將男女學生區分探究他們在影響科學表現的因素。本研究基於理論及相關研究，建立多層次模型，以男女八年級生的家庭文化資本、科學興趣、科學自信、自我期望等個人因素，並考量學校脈絡因素納入模型分析。本研究以臺灣參與2011年國際數學與科學成就調查(the Trend International Mathematics and Science Study, TIMSS 2011)資料做為分析依據。在研究設計上，以性別區分兩群，而在影響臺灣國二男、女生科學成就因素區分為兩層，其中階層一為學生因素(包括家庭文化資本、科學興趣、科學自信與自我期望) 及科學成就，而在階層二為學校環境因素(包括學校規模、教學資源、學校所在城鄉位置、學校脈絡因素)。本研究考量TIMSS資料結構具有巢套性，本研究將使用階層線性模式(Hierarchical Linear Models, HLM)，使得估計誤差減少，更能掌握影響男女生科學表現因素的差異性。本研究獲得結果如下：一、在臺灣的各校學生科學學習成就的差異有23.2%。二、在學生層次中，臺灣男女學生的家庭文化資本、科學學習興趣、科學自信、自我期望對於科學成就都是重要因素。三是在學校層次中，學校的學生組成-學生來自的經濟收入高低的家庭是影響學習成就的重要因素。本研究將執行結果，進行討論，提出建議，供相教育及未來研究參考。

中 文 關 鍵 詞 ： 國際數學與科學成就調查、科學成就、家庭文化資本、學習興趣、階層線性模式、性別

英 文 摘 要 ： The Evaluation of Educational Achievement (IEA) is a recognized pioneer of international assessments, having conducted comparative studies of students’ academic achievement for 50 years. There have been some research works that identified the impacted factors on student achievement. However, in past there were few studies together to explore the relationships among the cultural capital, learning interesting in science, self-confidence in science and self-expectancy impacted on student on male and female students’ science achievement. In this study will use the dataset of the Trend International Mathematics and Science Study (TIMSS) in 2011 which Taiwan’s participants (8-grades male and female students) to analyze. It investigated the impacted factors on male and female students’ science achievement in respectively, and it established the model that include on the school factors and student factors. That is, in the study discriminated impacted factors into two levels: the student-level variables (cultural capital, learning interesting in science, self-confidence in science, elf-expectancy and science achievement) and school-level variables. The school-level variables contain the location of school, the total student numbers, the teaching resources, and school contextual factors. Due to the character of TIMSS dataset is nested, the Hierarchical Linear Models (HLM) was performed. The results are as following: 1.there was 23.2% to explain the difference of students' achievement among Taiwan's school. 2. In student level, the cultural capital, learning interesting in science, self-confidence in science and self-expectancy were positively significant with male and female students' science achievement respectively. 3. In school level, the school composition was important factors on science achievement. According to our results can provide constructive suggestions for the government authority to make proper male and female science education policies.

英文關鍵詞： Science Achievement, learning interesting in science, cultural capital, Hierarchical Linear and Nonlinear Models (HLM), gender

By HLM to Exploring the Relationships among the Cultural Capital, Learning Interesting in Science, Self-Confidence in Science, and Self-Expectancy Impacted on Science Achievement: Evidence from Taiwan's Male and Female Students

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Abstract

The Evaluation of Educational Achievement (IEA) is a recognized pioneer of international assessments, having conducted comparative studies of students' academic achievement for 50 years. There have been some research works that identified the impacted factors on student achievement. However, in past there were few studies together to explore the relationships among the cultural capital, learning interesting in science, self-confidence in science and self-expectancy impacted on student on male and female students' science achievement. In this study will use the dataset of the Trend International Mathematics and Science Study (TIMSS) in 2011 which Taiwan's participants (8-grades male and female students) to analyze. It investigated the impacted factors on male and female students' science achievement in respectively, and it established the model that include on the school factors and student factors. That is, in the study discriminated impacted factors into two levels: the student-level variables (cultural capital, learning interesting in science, self-confidence in science, elf-expectancy and science achievement) and school-level variables. The school-level variables contain the location of school, the total student numbers, the teaching resources, and school contextual factors. Due to the character of TIMSS dataset is nested, the Hierarchical Linear Models (HLM) was performed. The results are as following: 1.there was 23.2% to explain the difference of students' achievement among Taiwan's school. 2. In student level, the cultural capital, learning interesting in science, self-confidence in science and self-expectancy were positively significant with male and female students' science achievement respectively. 3. In school level, the school composition was important factors on science achievement. According to our results can provide constructive suggestions for the government authority to make proper male and female science education policies.

Key words: Science Achievement, learning interesting in science, cultural capital, Hierarchical Linear and Nonlinear Models (HLM), gender

Introduction

Today, researchers increasingly focus on improving the quality of education as the differences in quality between schools. Student achievement is affected by many factors from different sources such as personal, home, community and school factors. Different researchers conduct studies considering different factors which explain the cause of achievement gaps, and which also develop different models to explain the factors affecting academic achievement. Coleman et al.(1966) pointed out that school has little role in explaining student achievement compared with student demographics and home environment. Edmonds (1979) put emphasis on school-related factors, explaining effective school characteristics such as strong principal leadership, high expectations for student achievement, emphasis on basic skills, an orderly environment, and frequent and systematic evaluation of students. Walberg (1986) put emphasis on the relationship of school-based factors and socio-environmental factors with academic achievement. Koutsoulis and Campbell (2001) added factors related to family background, parental support, and student motivation such as self-concept and attitude toward school to Walberg's model. The literature shows that all these factors have direct and indirect factors on the science achievement of students.

The purpose of this study is to research the effects of individual student and school factors related to environmental and affective characteristics on the science achievement of eighth-grade students in Taiwan. The student-level factors were determined as socioeconomic status (SES) of families, gender, like learning science, self-confidence in science, engaged science learning and parent education level. The school-level factors were school emphasis on achievement, school resources, and school composition by students' economic background. These multilevel effects were examined through Hierarchical Linear Modelling (HLM) using the TIMSS 2011 8-grade database. The key objectives of the TIMSS (Mullis, Martin, Foy & Arora, 2012) describe the context in which the teaching and learning process of mathematics and science take place, and assess the changes in the mathematics and science achievement of students over time. The TIMSS 2011 data for Taiwan was examined through HLM to answer the following research questions:

1. How much do schools vary in their mean science achievement in Taiwan?
2. Which student- and school-level factors are significantly related to the science achievement of eighth-grade students in Taiwan?

Literature Review

Previous studies have shown that socioeconomic status (SES) is strongly associated with student outcomes (Şirin, 2005). There is a positive relationship between affective characteristics and mathematics achievement. Although affective characteristics about mathematics achievement is a broad domain and measured by several dimensions in mathematics attitude scales (Fennama & Sherman, 1976), especially two of the dimensions, namely self-confidence and like learning mathematics, are mostly related to mathematics achievement. Self-confidence is the perceived ease, or difficulty, of learning mathematics, and like learning mathematics means the affective, emotional and behavioral reactions of students concerning their interest in learning mathematics.

The students' persistence, effort, motivation, positive learning values, enthusiasm, and interest (Gibbs & Poskitt, 2010). It is expected that engaging students during the learning process leads to success and more learning, both inside and outside school.

Academic emphasis of school is another key variable in explaining student achievement. Setting achievable high academic goals for students lead to an orderly and serious learning environment; motivated students working hard; and higher academic achievement (Hoy, Tarter & Kottkamp, 1991).

The *Expectancy Theory of Motivation* (Porter & Lawler, 1968) is one of the process theories. I see this theory as a model of behavioral choice, that is, as an explanation of why individuals choose one behavioral option over others. In doing so, it explains the behavioral direction process. It does not attempt to explain *what motivates* individuals, but rather how they make decisions to achieve the end they value.

There are inconsistent results about the relationship of school resources and academic achievement. While there are studies which concluded that there is no strong and continuous link between school resources and the academic performance of students.

Method

I framework

In the study, it discriminated impacted factors into two levels: the student-level variables (Students' gender, cultural capital, learning interesting in science, self-confidence in science, elf-expectancy, engaged science learning and science achievement) and school-level variables. The school-level variables contain the school composition and school resources. School composition by students' economic background is an important variable in the study. School resources included instructional materials (e.g., textbooks); supplies (e.g., papers, pencils); school buildings and grounds; heating/cooling and lighting systems; instructional space (e.g., classrooms); technologically competent staff; computers for instruction.

II Data

The data were collected in Taiwan as part of TIMSS 2011. In addition to collecting student achievement data based on mathematics and science tests, information was collected from students, their teachers and schools by way of background questionnaires. Only 8th grade level and science achievement are considered in this study. A complete list of variables in the analyses is given in Appendix A. In this study, the data was gathered through the student questionnaire, the school questionnaire and the mathematics test in the international database (http://timssandpirls.bc.edu/timss2011/international-database). The international sample design for TIMSS is generally referred to as a two-stage random sample design with a sample of schools drawn as a first stage, and one or more intact classes of students selected from each of the sampled schools as a second stage (Martin & Mullis, 2012).

III Variables

Dependent variable. The dependent variable in this study was the science achievement scores of students. In multilevel modelling, the parameter estimates were based on the average parameter estimates from separate HLM analyses of the plausible values (Raudenbush & Bryk, 2002).

Independent variable. The independent variable in this study included as follows:

Students' gender. 1 stands for the male student, and 0 is stands for female.

Parent education level. Parents' highest education level: The index was created by TIMSS and based on students' responses related to the highest education level of mother or father. [1=some primary or no school, 2=lower secondary, 3=upper secondary, 4=postsecondary but not university, 5=university or higher].

Home educational resources. It also can be seen as cultural capital. This index is based on 8th-grade students' responses to the following variables: number of books in the home; educational aids in the home (computer, study desk/table for own use, dictionary); and parents' education (mother's and father's) [1=few resources, 2=some resources, 3=many resources].

Like learning science. Students like learning science: The index was created by TIMSS and based on students' responses to the following five statements: a) I enjoy learning science; b) I wish I did not have to study science; c) science is boring; d) I learn many interesting things in science; e) I like science [1=don't like learning science, 2=somewhat like learning science, 3=like learning science].

Self-confidence in science. Students' confidence in science: The index was created by TIMSS and based on students' responses to the following seven statements: a) I usually do well in science; b) science is harder for me than for many of my classmates; c) I am just not good at science; d) I learn things quickly in science; e) I am good at working out difficult science problems; f) My teacher tells me I am good at science; g) science is harder for me than any other subject [1=not confident, 2=somewhat confident, 3=confident].

Engaged science learning. Engaged science learning: The index was created by TIMSS and based on students' responses to the following five statements: a) I know what my teacher expects me to do; b) I think of things not related to the lesson (reverse coded); c) My teacher is easy to understand; d) I am interested in what my teacher says; and e) My teacher gives me interesting things to do [low=1, medium=2, high=3].

Self-Expectancy. Self-Expectancy is a person's belief about his or her ability to perform a particular behavior successfully. In this study, student will expect to gain the education degree for future.

School composition. School composition by students' economic background: The index was created by TIMSS 2011 and based on students' responses to the following two statements replied by school principals. Approximately what percentage of students in your school have the following backgrounds? a) Come from economically disadvantaged homes; b) Come from economically affluent homes [1= more disadvantaged, 2= neither more affluent nor more disadvantaged, 3= more affluent].

School resources. School resources: The index was created by TIMSS and based on principals' responses related to how much capacity is available to provide instruction affected by a shortage or inadequacy of the following statements: Instructional materials (e.g., textbooks); Supplies (e.g., papers, pencils); School buildings and grounds; Heating/cooling and lighting systems; Instructional space (e.g., classrooms); Technologically competent staff; computers for instruction; Teachers with a specialization in science; Computer software for science instruction; Library materials relevant to science instruction; Audio-visual resources for science instruction; Calculators for science instruction [1= affected a lot, 2=somewhat affected, 3=not affected].

V Analyses

In order to address the above research questions, hierarchical linear modeling analysis (HLM)(Raudenbush & Bryk, 2002) was employed to overcome the limitations of traditional single level multiple regression analyses. The multiple regression analyses can examine relationships between variables at only one level at a time. This means that either only student or only school variables may be related to each other and achievement. Alternatively, student variables need to be aggregated to the school level need to be disaggregated to the student level in order to be analyzed in one multiple regression model.

The analysis does not reflect the nested structure of formal education. Analyses were undertaken using the HLM software (HLM-6) firstly to examine the relationship between school level variables and science performance once the socio-economic status of schools and students.

Results

According to the unconditional HLM results (saw the table1), within-school variance in Taiwan was larger than between-school variance. The intraclass correlation coefficient was .232 [$\rho = .210/(.210+ .696) = .232$]. That is, the difference of school science achievement mean is large in Taiwan. So if we want to understand the impacted factors on science achieve, we do not ignore the difference of school.

Table1 null model

fixed effect	Coefficient	std error	*t-value*
level 2 science achievement mean r_{00}	.0958	.044	2.10^{*}
randomized effect	variance	*df*	χ^2
level 2 Between-school variance u_{0j}	.210	135	883.93^{***}
level 1 Within-school variance ε_{ij} (σ^2)	.696		

$^{*}p<.05$, $^{***}p<.001$

Coefficients and their standard errors obtained in the multilevel analysis are presented in Table 2. The explained amount of variances at level 1 and level 2 were also calculated after all student- and school-level factors were included in the full model. Table 2 shows that at student level, self-confidence in science and home educational resources positively affected the TIMSS 2011 8-grade science scores in all countries. On average, the increases in the science scores, which were associated with one point increase in science self-confidence, were .239 points in Taiwan. The increases in the science scores which were associated with .21 point increase in home educational resources. Parent education level was also a significant positive factor associated with science achievement. Like learning science and engaged science learning activities were also positive with science achievement. Like learning science was a positive factor affecting science achievement. We can see male science achievement better than female. In addition, school composition was positive with science achievement, however, the school resources was not.

Table2 the impacted factors on science achievement by HLM

	Coefficient	std error	*t-value*
Intercept	1.190	.192	6.20**
Student level			
gender (1= male, 0=female)	.125	.096	2.30*
Parent education level	.168	.100	2.68**
Home educational resources	.203	.075	2.72**
Like learning science	.234	.077	3.04**
Self-confidence in science	.239	.050	3.77**
Engaged science learning	.217	.093	3.25**
Self-Expectancy	.214	.134	3.10**
School level			
School composition	.321	.027	4.48**
School resources	.029	.018	1.65
Explained variance at Level 1	65		
Explained variance at Level 2	15		

*p<.05, **p<.01

Discussion and Conclusion

The objectives of the study were to examine the effects of gender, like learning mathematics, self-confidence in mathematics, parent education level and student engagement in learning activities which may have nested influences under school emphasis on achievement, school resources, and school composition by students' economic background.

Similar to the previous studies on TIMSS data, it was found that there were some similarities and differences in the factors effecting student achievement (Papanastasiou & Zembylas, 2004; Shen & Pedulla, 2000). The reason might be the difference between social and cultural backgrounds.

The results showed that SES and school composition by students' socioeconomic background at school level positively contribute to the science achievement of students similar to the previous studies (Olatunde, 2010). Parent education level was an effective factor in Taiwan. Students from families with more resources, namely higher parental education level, had higher science scores, attended more previleged schools with superior schoolmates, better physical resources, better teachers, and higher academic expectations (Chiu, 2010). Affluent people live in more affluent neighborhoods, send their children to more affluent schools, and support their children more at home. As this is the case, there are differences among the schools in the achievement levels based on the socioeconomic level of students.

Self-confidence was another factor which has a great influence on mathematics achievement in all countries. Kadijevich (2006) concluded with the same results in his study including the TIMSS 2003 data of 33 countries. Since self-confidence in learning science was mostly related to science achievement, science teachers may help their students develop and maintain positive beliefs about their scientific competency. Engaging students in the learning process through learning tasks helps students build their self-confidence in learning science. These activities can be easy enough to be solved by students so that they feel the pleasure of success, and can require them to use knowledge and skills. These tasks can respect students' knowledge and skills more, and give an opportunity for the further development of students. Although teachers were not included in this study, they have the responsibility to design the activities that increase self- confidence in science (Eisenberg, 1991). Therefore, the pedagogical knowledge of teachers is important to improve the affective characteristics related to science in positive direction.

School composition also found to be having a great effect on student achievement. There were many students lived in affluent area, and they have more resources for their learning. The role of the school principal and his/her instructional leadership should understand the students' background, and develop some activities to improve learning for the low SES students.

The variable of school resources had no significant effect in Taiwan. This was inconsistent conclusions in the literature related to this variable (Hanushek, 1997). Namely home educational resources, parent education level and school composition, may lead to this conclusion. More studies should be conducted to investigate the effect of school resources on achievement.

In conclusion, the study revealed that home educational resources and student self-confidence were the most influential at student level, and school composition by students' economic background was more effective at school level. The study explains some of the factors that are expected to have practical implications. However, the variables included in this study were not enough to explain all the variance. Further studies should also be carried out with different student- and school-level variables to reveal the causal relationships among them.

科技部補助專題研究計畫出席國際學術會議心得報告

日期： 2015 年 7 月 29-31 日

計畫編號	MOST103-2511-S-152-012		
計畫名稱	臺灣男女學生的家庭文化資本、科學興趣、科學自信、自我期望對科學成就之多層次模型分析		
出國人員姓名	張芳全	服務機構及職稱	國立臺北教育大學 教育經營與管理學系
會議時間	104 年 7 月 29 日 至 104 年 7 月 31 日	會議地點	日本沖繩
會議名稱	(中文)2015 年教育、心理與社會的國際研討會 (英文)International Conference on Education, Psychology and Society-ISCEAS 2015		
發表論文題目	(中文)臺灣男女學生的家庭文化資本、科學興趣、科學自信、自我期望對科學成就之多層次模型分析 (英文) By HLM to Exploring the Relationships among the Cultural Capital, Learning Interesting in Science, Self-Confidence in Science, and Self-Expectancy Impacted on Science Achievement: Evidence from Taiwan’s Male and Female Students		

壹、 與會照片

報到會場(右邊第三位為研究案主持人)

貳、心得報告內容，如下：

一、參加會議經過

2015 年教育、心理與社會的國際研討會(International Conference on Education, Psychology and Society-ISCEAS 2015)於 2015 年 7 月在日本沖繩舉行。其宗旨是為教育、心理及社會專業研究提供學術交流的理論研究和實踐結合。2015 年該學會徵稿主題之一是教育與學習（Education & Learning)，與本研究案主題之臺灣男女學生的家庭文化資本、科學興趣、科學自信、自我期望對科學成就之多層次模型分析，因此本研究案參與此國際學術研討會。

二、與會心得

此次研討會與會學者，除主辦日本之外，還有韓國、香港、馬來西亞、中國大陸、澳州、印尼及菲律賓；臺灣研究的專家學者也不少。在論文發表過程中，與專家學者討論本研究發表成果之外，也可以參考各國專家學者成果，做為本研究論文思考與延續探討題材。參與此次學術研討會收穫良多。

三、考察參觀活動(無是項活動者略)

無

四、建議

本研究案榮獲科技部補助出席國外學術會議，讓主持人出席此國際學術盛會在研究觀念及與會專家學者討論研究議題受益良多。若沒有此項補助經費，單憑藉個人，恐無法成行。希冀未來科技部的研究案，可以繼續補助國外差旅費，增加研究案深度與廣度，豐富學術研究的體驗及增加國際視野。

五、攜回資料名稱及內容

2015 年教育、心理與社會的國際研討會的發表論文資料、該學會出版學術期刊、發表證書、註冊費收據等。

六、其他：檢附本研究發表論文，如後所附。

By HLM to Exploring the Relationships among the Cultural Capital, Learning Interesting in Science, Self-Confidence in Science, and Self-Expectancy Impacted on Science Achievement: Evidence from Taiwan's Male and Female Students

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The authors would like to thank Ministry of Science and Technology for the grant support under the contract MOST103-2511-S-152-012

Abstract

The Evaluation of Educational Achievement (IEA) is a recognized pioneer of international assessments, having conducted comparative studies of students' academic achievement for 50 years. There have been some research works that identified the impacted factors on student achievement. However, in past there were few studies together to explore the relationships among the cultural capital, learning interesting in science, self-confidence in science and self-expectancy impacted on student on male and female students' science achievement. In this study will use the dataset of the Trend International Mathematics and Science Study (TIMSS) in 2011 which Taiwan's participants (8-grades male and female students) to analyze. It investigated the impacted factors on male and female students' science achievement in respectively, and it established the model that include on the school factors and student factors. That is, in the study discriminated impacted factors into two levels: the student-level variables (cultural capital, learning interesting in science, self-confidence in science, elf-expectancy and science achievement) and school-level variables. The school-level variables contain the location of school, the total student numbers, the teaching resources, and school contextual factors. Due to the character of TIMSS dataset is nested, the Hierarchical Linear Models (HLM) was performed. The results are as following: 1.there was 23.2% to explain the difference of students' achievement among Taiwan's school. 2. In student level, the cultural capital, learning interesting in science, self-confidence in science and self-expectancy were positively significant with male and female students' science achievement respectively. 3. In school level, the school composition was important factors on science achievement. According to our results can provide constructive suggestions for the government authority to make proper male and female science education policies.

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8-grade database. The key objectives of the TIMSS (Mullis, Martin, Foy & Arora, 2012) describe the context in which the teaching and learning process of mathematics and science take place, and assess the changes in the mathematics and science achievement of students over time. The TIMSS 2011 data for Taiwan was examined through HLM to answer the following research questions:

1. How much do schools vary in their mean science achievement in Taiwan?
2. Which student- and school-level factors are significantly related to the science achievement of eighth-grade students in Taiwan?

Literature Review

Previous studies have shown that socioeconomic status (SES) is strongly associated with student outcomes (Şirin, 2005). There is a positive relationship between affective characteristics and mathematics achievement. Although affective characteristics about mathematics achievement is a broad domain and measured by several dimensions in mathematics attitude scales (Fennama & Sherman, 1976), especially two of the dimensions, namely self-confidence and like learning mathematics, are mostly related to mathematics achievement. Self-confidence is the perceived ease, or difficulty, of learning mathematics, and like learning mathematics means the affective, emotional and behavioral reactions of students concerning their interest in learning mathematics.

The students' persistence, effort, motivation, positive learning values, enthusiasm, and interest (Gibbs & Poskitt, 2010). It is expected that engaging students during the learning process leads to success and more learning, both inside and outside school.

Academic emphasis of school is another key variable in explaining student achievement. Setting achievable high academic goals for students lead to an orderly and serious learning environment; motivated students working hard; and higher academic achievement (Hoy, Tarter & Kottkamp, 1991).

The *Expectancy Theory of Motivation* (Porter & Lawler, 1968) is one of the process theories. I see this theory as a model of behavioral choice, that is, as an explanation of why individuals choose one behavioral option over others. In doing so, it explains the behavioral direction process. It does not attempt to explain *what motivates* individuals, but rather how they make decisions to achieve the end they value.

There are inconsistent results about the relationship of school resources and academic achievement. While there are studies which concluded that there is no strong and continuous link between school resources and the academic performance of students.

Method

I framework

In the study, it discriminated impacted factors into two levels: the student-level variables (Students' gender, cultural capital, learning interesting in science, self-confidence in science, elf-expectancy, engaged science learning and science achievement) and school-level variables. The school-level variables contain the school composition and school resources. School composition by students' economic background is an important variable in the study. School resources included instructional materials (e.g., textbooks); supplies (e.g., papers, pencils); school buildings and grounds; heating/cooling and lighting systems; instructional space (e.g., classrooms); technologically competent staff; computers for instruction.

II Data

The data were collected in Taiwan as part of TIMSS 2011. In addition to collecting student achievement data based on mathematics and science tests, information was collected from students, their teachers and schools by way of background questionnaires. Only 8th grade level and science achievement are considered in this study. A complete list of variables in the analyses is given in Appendix A. In this study, the data was gathered through the student questionnaire, the school questionnaire and the mathematics test in the international database (http://timssandpirls.bc.edu/timss2011/international-database). The international sample design for TIMSS is generally referred to as a two-stage random sample design with a sample of schools drawn as a first stage, and one or more intact classes of students selected from each of the sampled schools as a second stage (Martin & Mullis, 2012).

III Variables

Dependent variable. The dependent variable in this study was the science achievement scores of students. In multilevel modelling, the parameter estimates were based on the average parameter estimates from separate HLM analyses of the plausible values (Raudenbush & Bryk, 2002).

Independent variable. The independent variable in this study included as follows:

Students' gender. 1 stands for the male student, and 0 is stands for female.

Parent education level. Parents' highest education level: The index was created by TIMSS and based on students' responses related to the highest education level of mother or father. [1=some primary or no school, 2=lower secondary, 3=upper secondary, 4=postsecondary but not university, 5=university or higher].

Home educational resources. It also can be seen as cultural capital. This index is based on 8th-grade students' responses to the following variables: number of books in the home; educational aids in the home (computer, study desk/table for own use, dictionary); and parents' education (mother's and father's) [1=few resources, 2=some resources, 3=many resources].

Like learning science. Students like learning science: The index was created by TIMSS and based on students' responses to the following five statements: a) I enjoy learning science; b) I wish I did not have to study science; c) science is boring; d) I learn many interesting things in science; e) I like science [1=don't like learning science, 2=somewhat like learning science, 3=like learning science].

Self-confidence in science. Students' confidence in science: The index was created by TIMSS and based on students' responses to the following seven statements: a) I usually do well in science; b) science is harder for me than for many of my classmates; c) I am just not good at science; d) I learn things quickly in science; e) I am good at working out difficult science problems; f) My teacher tells me I am good at science; g) science is harder for me than any other subject [1=not confident, 2=somewhat confident, 3=confident].

Engaged science learning. Engaged science learning: The index was created by TIMSS and based on students' responses to the following five statements: a) I know what my teacher expects me to do; b) I think of things not related to the lesson (reverse coded); c) My teacher is easy to understand; d) I am interested in what my teacher says; and e) My teacher gives me interesting things to do [low=1, medium=2, high=3].

Self-Expectancy. Self-Expectancy is a person's belief about his or her ability to perform a particular behavior successfully. In this study, student will expect to gain the education degree for future.

School composition. School composition by students’ economic background: The index was created by TIMSS 2011 and based on students’ responses to the following two statements replied by school principals. Approximately what percentage of students in your school have the following backgrounds? a) Come from economically disadvantaged homes; b) Come from economically affluent homes [1= more disadvantaged, 2= neither more affluent nor more disadvantaged, 3= more affluent].

School resources. School resources: The index was created by TIMSS and based on principals’ responses related to how much capacity is available to provide instruction affected by a shortage or inadequacy of the following statements: Instructional materials (e.g., textbooks); Supplies (e.g., papers, pencils); School buildings and grounds; Heating/cooling and lighting systems; Instructional space (e.g., classrooms); Technologically competent staff; computers for instruction; Teachers with a specialization in science; Computer software for science instruction; Library materials relevant to science instruction; Audio-visual resources for science instruction; Calculators for science instruction [1= affected a lot, 2=somewhat affected, 3=not affected].

V Analyses

In order to address the above research questions, hierarchical linear modeling analysis (HLM)(Raudenbush & Bryk, 2002) was employed to overcome the limitations of traditional single level multiple regression analyses. The multiple regression analyses can examine relationships between variables at only one level at a time. This means that either only student or only school variables may be related to each other and achievement. Alternatively, student variables need to be aggregated to the school level need to be disaggregated to the student level in order to be analyzed in one multiple regression model.

The analysis does not reflect the nested structure of formal education. Analyses were undertaken using the HLM software (HLM-6) firstly to examine the relationship between school level variables and science performance once the socio-economic status of schools and students.

Results

According to the unconditional HLM results (saw the table1), within-school variance in Taiwan was larger than between-school variance. The intraclass correlation coefficient was .232

[/ That is, the difference of school science achievement mean is large in Taiwan. So if we want to understand the impacted factors on science achieve, we do not ignore the difference of school.

Table1 null model

fixed effect	Coefficient	std error	*t-value*
level 2 science achievement mean r_{00}	.0958	.044	2.10*
randomized effect	variance	*df*	χ^2
level 2 Between-school varianceu_{0j}	.210	135	883.93***
level 1 Within-school varianceε_{ij} (σ^2)	.696		

*p<.05, ***p<.001

Coefficients and their standard errors obtained in the multilevel analysis are presented in Table 2. The explained amount of variances at level 1 and level 2 were also calculated after all student- and school-level factors were included in the full model. Table 2 shows that at student level, self-confidence in science and home educational resources positively affected the TIMSS 2011 8-grade science scores in all countries. On average, the increases in the science scores, which were associated with one point increase in science self-confidence, were .239 points in Taiwan. The increases in the science scores which were associated with .21 point increase in home educational resources. Parent education level was also a significant positive factor associated with science achievement. Like learning science and engaged science learning activities were also positive with science achievement. Like learning science was a positive factor affecting science achievement. We can see male science achievement better than female. In addition, school composition was positive with science achievement, however, the school resources was not.

Table2 the impacted factors on science achievement by HLM

	Coefficient	std error	*t-value*
Intercept	1.190	.192	6.20**
Student level			
gender (1= male, 0=female)	.125	.096	2.30*
Parent education level	.168	.100	2.68**
Home educational resources	.203	.075	2.72**
Like learning science	.234	.077	3.04**
Self-confidence in science	.239	.050	3.77**
Engaged science learning	.217	.093	3.25**
Self-Expectancy	.214	.134	3.10**
School level			
School composition	.321	.027	4.48**
School resources	.029	.018	1.65
Explained variance at Level 1	65		
Explained variance at Level 2	15		

*p<.05, **p<.01

Discussion and Conclusion

The objectives of the study were to examine the effects of gender, like learning mathematics, self-confidence in mathematics, parent education level and student engagement in learning activities which may have nested influences under school emphasis on achievement, school resources, and school composition by students' economic background.

Similar to the previous studies on TIMSS data, it was found that there were some similarities and differences in the factors effecting student achievement (Papanastasiou & Zembylas, 2004; Shen & Pedulla, 2000). The reason might be the difference between social and cultural backgrounds.

The results showed that SES and school composition by students' socioeconomic background at school level positively contribute to the science achievement of students similar to the previous studies (Olatunde, 2010). Parent education level was an effective factor in Taiwan. Students from families with more resources, namely higher parental education level, had higher science scores, attended more previleged schools with superior schoolmates, better physical resources, better teachers, and higher academic expectations (Chiu, 2010). Affluent people live in more affluent neighborhoods, send their children to more affluent schools, and support their children more at home. As this is the case, there are differences among the schools in the achievement levels based on the socioeconomic level of students.

Self-confidence was another factor which has a great influence on mathematics achievement in all countries. Kadijevich (2006) concluded with the same results in his study including the TIMSS 2003 data of 33 countries. Since self-confidence in learning science was mostly related to science achievement, science teachers may help their students develop and maintain positive beliefs about their scientific competency. Engaging students in the learning process through learning tasks helps students build their self-confidence in learning science. These activities can be easy enough to be solved by students so that they feel the pleasure of success, and can require them to use knowledge and skills. These tasks can respect students' knowledge and skills more, and give an opportunity for the further development of students. Although teachers were not included in this study, they have the responsibility to design the activities that increase self- confidence in science (Eisenberg, 1991). Therefore, the pedagogical knowledge of teachers is important to improve the affective characteristics related to science in positive direction.

School composition also found to be having a great effect on student achievement. There were many students lived in affluent area, and they have more resources for their learning. The role of the school principal and his/her instructional leadership should understand the students' background, and develop some activities to improve learning for the low SES students.

The variable of school resources had no significant effect in Taiwan. This was inconsistent conclusions in the literature related to this variable (Hanushek, 1997). Namely home educational resources, parent education level and school composition, may lead to this conclusion. More studies should be conducted to investigate the effect of school resources on achievement.

In conclusion, the study revealed that home educational resources and student self-confidence were the most influential at student level, and school composition by students' economic background was more effective at school level. The study explains some of the factors that are expected to have practical implications. However, the variables included in this study were not enough to explain all the variance. Further studies should also be carried out with different student- and school-level variables to reveal the causal relationships among them.

科技部補助計畫衍生研發成果推廣資料表

日期:2015/10/31

<table>
<tr><td rowspan="3">科技部補助計畫</td><td>計畫名稱: 臺灣男女學生的家庭文化資本、科學興趣、科學自信、自我期望對科學成就之多層次模型分析</td></tr>
<tr><td>計畫主持人: 張芳全</td></tr>
<tr><td>計畫編號: 103-2511-S-152-012- 學門領域: 性別與科技研究</td></tr>
<tr><td colspan="2">無研發成果推廣資料</td></tr>
</table>

103年度專題研究計畫研究成果彙整表

計畫主持人：張芳全	**計畫編號：**103-2511-S-152-012-	
計畫名稱：臺灣男女學生的家庭文化資本、科學興趣、科學自信、自我期望對科學成就之多層次模型分析		

成果項目			量化：實際已達成數（被接受或已發表）	量化：預期總達成數（含實際已達成數）	量化：本計畫實際貢獻百分比	單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
國內	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	1	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		

其他成果（無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文	無

字敘述填列。）			
	成果項目	**量化**	**名稱或內容性質簡述**
科教處計畫加填項目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	0	

科技部補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估
■達成目標
□未達成目標（請說明，以100字為限）
　　□實驗失敗
　　□因故實驗中斷
　　□其他原因
說明：

2. 研究成果在學術期刊發表或申請專利等情形：
論文：□已發表 ■未發表之文稿 □撰寫中 □無
專利：□已獲得 □申請中 ■無
技轉：□已技轉 □洽談中 ■無
其他：（以100字為限）
本研究已發表於2015年教育 心理與社會的國際學術研討會　以臺灣男女學生的家庭文化資本、科學興趣、科學自信、自我期望對科學成就之多層次模型分析為題進行發表 英文的論文初稿已完成

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以500字為限）
本研究以臺灣參與2011年國際數學與科學成就調查(the Trend International Mathematics and Science Study, TIMSS 2011)資料做為分析依據。在研究設計上，以性別區分兩群，而在影響臺灣國二男、女生科學成就因素區分為兩層，其中階層一為學生因素(包括家庭文化資本、科學興趣、科學自信與自我期望）及科學成就，而在階層二為學校環境因素(包括學校規模、教學資源、學校所在城鄉位置、學校脈絡因素)。本研究考量TIMSS資料結構具有巢套性，本研究將使用階層線性模式(Hierarchical Linear Models, HLM) ，使得估計誤差減少，更能掌握影響男女生科學表現因素的差異性。本研究將執行結果，進行討論，並擬發表學術期刊論文，提出建議，供相關單位在科學教育及未來研究參考。