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台灣地區大學科技領域女學生選讀影響因素暨學習滿意度與生涯規劃之研究

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台灣地區大學科技領域女學生科系選讀影響因素暨

學習滿意度與生涯規劃之研究

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中英文摘要

邁入 21 世紀，大專院校中有越來越多女學生選讀傳統被認為屬於男生領域的科技系所，唯女生在理工系所仍為少數。基於上述動機，本研究以大學科技領域女學生為對象，探討在求學過程中科技選讀的影響因素和學習滿意度，包括教師互動、課程學習、資源提供與同儕相處以及對於未來自己的生涯有何規劃等。本研究希望藉此瞭解我國高等教育機構所提供的學習環境是否有性別盲點的存在，影響大學女學生的學習，以及大學機構與教師是否可能為國內女性學生提供更好的學習環境與空間。量化研究顯示，自尊感和學習滿意度層面，男女生均無顯著差異。人格特質：僅在「經驗開放性」層面，男生高於女生，達到顯著差異；其餘層面則無。質性資料顯示，目前大學師生互動極為缺乏。學生最大成就感在於社團與和應對進退的學習，並認為這些對他們的生涯發展有極大幫助。在教學與學習方式上，科技領域的學習與訓練和人文社會科學領域有極大差異。在就業方面，相對於非科技領域，科技領域與就業密切結合。人文領域對於所學和就業結合，有較低期待。科學領域選擇升學的人數也高於非科技領域。科系選讀上，分數落點是多數學生選擇的主因。科技領域學生多半有考慮就業因素，男生比女生更知覺所學的經濟收益。在就業規劃方面，特定科技產業環境與條件，影響女性就業意願。可見在職涯輔導方面，科技領域女學生需要更多引導。

This research look at the learning experience of female students in science and technology faculties in universities and their aspiration for the future. By taking a closer look of their experience and the influencing factors, the research aim to provide guidance in the future so that these female students in science and technology faculties can be better supported in terms of their learning and career guidance. The interviews findings are: in terms of reasons for subject choices and career prospects, there are significant gender differences for students in S & T fields. In addition, there is significant differences about the way of learning and teaching for students from S & T and non- S & T fields. Interestingly, alienation with teachers and great appreciation of accumulation of experience related to extra-curriculum activities and student clubs.

關鍵詞: 性別、科技領域、大學生
Keywords: Gender, science and technology fields, undergraduates

壹、前言與研究目的

高等教育領域，近年來雖然多數院校均在課程中納入性別平等教育課程，但是男女生在系所的選擇上，仍有明顯性別區別。根據教育部統計處的調查顯示，95 學年度的大學女生在科學領域人數為 21,667 人，所佔比率為 3.38%，相較於 90 學年度 13,752 人，比例 2.33%（教育部統計處，無日期）略微上升，顯示出女生在選填大學科系時仍無法完全跳脫「男理工，女人文」的傳統刻板角色思維。

過去，讀理工的女生容易受到性別偏見所影響，被冠上太聰明、男性化等名詞。一般大眾普遍認同男女兩性在此方面的先天差異，而忽略了環境、後天教育與基因的交互影響也會改變此項差異。於此大學女生要在科技領域上嶄露頭角除了本身的興趣、學習動機、自信心高以外，還要有過人的能力來面對生活上的困擾、老師的互動、同儕的輿論與課業的壓力等。因此，探討科技領域系所大學女生在求學過程中所面臨的困境與壓力、學習滿意度、生涯規劃等，變得極為重要。

國內對於女性選擇科技領域就讀的相關研究仍不多見。除國內學者蔡麗玲(2003, 2004a, 2004b &2004c)有多篇著作探討相關議題，謝小芩、陳佩英、林大森（2007）也曾根據「台灣高等教育資料庫」，對於就讀非傳統性別系所的學生進行相關分析，整體而言，國內針對大學女性學生在科技系所求學經驗的相關研究並不多見。因此希望透過本研究提供大學科技領域女學生學習滿意度、生涯規劃與選讀科系影響因素等情形。

基於上述動機，本研究以大學科技領域女性學生為對象，探討在求學過程中科技選讀的影響因素和學習滿意度，包括教師互動、課程學習、資源提供與同儕相處以及對於未來自己的生涯有何規劃等。綜合上述，本研究擬達成以下幾點研究目的：

一、瞭解大學科技領域女學生選擇該學系就讀的原因與動機。

二、分析大學科技領域學系不同背景變項女學生的學習滿意度，藉以瞭解求學過程中在教師互動、課程學習、資源提供與同儕相處等方面滿意的情形及所遭遇的問題。

三、探討大學科技領域女學生對自己未來的生涯規劃情形。

貳、文獻探討

科學與性別

有關科學與性別方面的關係，過去傳統典型看法是是科學是客觀的知識，而女孩因為抽象思考能力不足，自信不夠或因教師態度影響，因此數理學科表現不理想，當然也就沒有勇氣選讀相關學科。許多比較男女學生學業成就表現的報告，更顯示女生在此一方面表現不若男生表現優異，因為此種思維，各國政府往往試圖推動一些措施，鼓勵女學生選修科技學科，也改寫教材，試圖改進女學生的在數理領域的成就表現。但是國內學者蔡麗玲(2004a)指出，這樣的思考往往是將女學生「問題化」，以「主流」認知和反應為主，視達不到標準者為待改善的群體。也就是說並沒有去質疑知識的內容結構和社會文化，而認為問題在於女學生，認為女學生自信不足，甚至是抽象思考能力不如男生。

台灣地區大學系所男女生分配情形

國內外的研究發現男學生多數集中於科技與科學學系而女學生多數偏向就讀人文科系(Stromquist, 1991；Xie & Shauman, 2003；林玉萍，2001；蔡麗玲，2004a)。根據教育部統計處(無日期)，按科系9大領域及性別調查歷年大專校院學生人數的統計，也呈現同樣的狀況。從87學年度到95學年度的數據顯示，大學女學生歷年修習科系人數最多為社會科學、商業及法律領域，其他依序為醫藥衛生及社福領域，人文及藝術領域，工程、製造及營造領域，服務領域，教育領域，科學領域，修習人數最少的是農學及其他領域。大學男學生歷年修習科系人數最多為工程、製造及營造領域，社會科學、商業及法律領域次之，科學領域位居第四，教育、農學領域及其他領域最少。

影響女性選讀學系之因素

許多的研究中發現男學生大多集中於科技與科學類組而女學生則以就讀人文科系佔多數（Stromquist, 1991；Xie & Shauman, 2003；林玉萍，2001；蔡麗玲，2004a）。以我國歷年來大專院校在9大領域的比例來看，女生就讀比例以社會科學、商業及法律為最高，男生偏重就讀工程、製造及營造領域，與上述的研究發現相同，細究此現象的原因，謝小芩、陳佩英、林大森（2007）指出學生從高中職進升到大學過程中，科系的選擇是來自於傳統社會性別框架、重要他人的影響力、學校體制的科系性質與職場就業機會等多種因素交互作用下的結果。

學習滿意度之相關研究

綜合學者對學習滿意度的看法，可以發現對於學習滿意度的界定，大都強調個人內在層面的感受，本研究所指「學習滿意度」的含義是指大學科技領域女學生對學習歷程和經驗中的一種感覺或態度，在學習歷程和經驗中大學科技領域女學生的需求或期望，能知覺獲得或滿足的程度。瞭解大學科技領域女學生學習歷程和經驗中的各項因素，有助於瞭解女性在科技領域中感到困頓的部分與滿意的部分。

參、研究方法

研究程序

本研究在確立研究主題之後，即開始著手蒐集大學科系男女生比例、學習滿意度、生涯規劃理論等相關文獻及廣泛參閱相關研究問卷，由研究者者自編「大學科技領域學生學習滿意度與生涯規劃調查問卷」，以作為本研究蒐集資料之工具。同時著手進行研究的準備工作，並準備訪談工作相關聯絡事宜。本研究以各大學科技領域涵蓋生命科學學門、自然科學學門、數學及統計學門、電算機學門與工程學門等五個學門學系的學生為研究對象，實施問卷調查，以所得有效問卷作為研究樣本。

研究工具

本研究所使用之研究工具分為二種，第一種是大學科技領域學生學習滿意度與生涯規劃調查問卷；第二種是訪談。在問卷部分，採問卷調查法來蒐集資料，並根據研究目的，編訂問卷，問卷內容計分為四大部份，第一部份為自尊與人格特質；第二部份學習歷程或學習經驗中的學習滿意度；第三部份為生涯規劃；第四部份為個人背景變項。

（一）自尊與人格特質

自尊量表係依據 Rosenberg(1965)所設計之自尊量表；人格特質量表修改自 Costa and McCrea(1987)所提出的「親和性」、「外向性」、「神經質」、「開放學習性」、「勤勉正直性」五大類人格特質構面。

（二）學習滿意度

學習滿意度量表係參考施台珠（2006）學生學習滿意度問卷調查，修改編制而成，分為「學習成果」、「學習環境」、「人際關係」、「師資與教學」四個構面。

在訪談部分，針對本研究所定義科技領域五學門中 30 位女性學生，15 位男學生以及非科技領域 15 位女學生為訪談對象。訪談的內容包括選讀領域學系的動機、學習經驗、師長家人與同儕之影響、學習過程中所獲得的資源協助、及未來的人生規劃方向等方面。

肆、研究結果與討論

本章研究結果主要分為二節，第一節為量化研究：一、運用敘述性統計法針對回收之有效問卷進行樣本特性分析，以瞭解回收資料之樣本結構；二、生涯規劃分析；三、說明自尊感、人格特質、學習滿意度性別上的 t 檢定考驗；四、探討自尊感、人格特質及學習滿意度之差異性分析；五、探討人格特質各層面與學習滿意度各層面之差異性分析；六、透過典型相關分析，以求出人格特質與學習滿意度的相關聯程度。第二節為質性訪談的結果。茲分別敘述如下：

一、量化研究

本研究以科技領域的學生為研究對象，總計發放 1,300 份問卷，扣除無效及未回收問卷，實際回收之有效問卷計有 891 份，有效回收率為 68.5%。

一、學生基本資料分析：

1. 個人基本資料分析：包括性別、年級、父親教育程度、母親教育程度、家庭月入等五項，以人數分配及百分比說明。(見完整報告)
2. 選讀目前科系之因素分析：此部分共有父母的期望，自己的興趣，經濟考量（學雜費、獎學金、住宿費)，師長的建議，就業的考量，朋友、同學、學長（姐）的影響或建議，科系的聲望，考試分數落點，其他等 9 項因素，依重要性選填。(見完整報告)

二、生涯規劃之分析

1. 未來發展各題項次數分配（見完整報告）
2. 工作取向調查 （見完整報告）

三、自尊感、人格特質、學習滿意度在性別上的 t 檢定

以 t 檢定考驗性別在自尊感的二個層面、人格特質的四個層面與學習滿意度的四個層面是否有顯著差異，並以.05 為差異考驗水準。

（1） 自尊感：男女生均無顯著差異。

（2） 人格特質：僅在「經驗開放性」層面，男生（14.56）高於女生（14.14），經 t 考驗檢定，達到顯著差異（t 值 2.38*，p<.05）；其餘層面則無顯著差異。

（3） 學習滿意度層面：四個層面男女生均無顯著差異。

四、自尊感、人格特質及學習滿意度之差異性分析。

為了瞭解科技領域不同的年級、家長教育程度、家庭月收入學生，其自尊感與人格特質

及學習滿意度是否有差異。逐進行單因子變異數分析，並以.05為差異考驗水準。若其F值達顯著水準，則以薛費法進行事後比較，茲分別比較如下：

1.年級：不同年級科技領域的學生在自尊感 F 值未達顯著（F=1.01；p>.05)；在人格特質 F 值未達顯著（F=0.46；p>.05)，僅在學習滿意度 F 值達顯著（F=3.03；p<.05)，進一步以薛費法事後比較，不同年級間則無差異。

2.家長教育程度：(1)不同父親教育程度科技領域的學生僅在自尊感 F 值達顯著(F=2.30；p<.05)，進一步以薛費法事後比較，不同父親教育程度間則無差異；在人格特質 F 值未達顯著（F=1.915；p>.05)，在學習滿意度 F 值未達顯著（F=1.78；p>.05)。(2) 不同母親教育程度科技領域的學生僅在自尊感 F 值達顯著（F=2.17；p<.05)，進一步以薛費法事後比較，不同母親教育程度間則無差異；在人格特質 F 值未達顯著（F=1.35；p>.05)，在學習滿意度 F 值未達顯著（F=1.29；p>.05)。

3.家庭月收入：不同家庭月收入科技領域的學生在自尊感 F 值達顯著（F=3.00；p<.05)，進一步以薛費法事後比較，不同家庭月收入間則無差異；在人格特質 F 值未達顯著（F=1.25；p>.05)，在學習滿意度 F 值達顯著（F=3.57；p<.01)。進一步以薛費法事後比較，不同家庭月收入間則無差異。

五、不同自尊感與人格特質的學生在學習滿意度之差異性分析

為了瞭解科技領域不同自尊感與人格特質的學生在學習滿意度四個層面是否有差異。逐進行單因子多變量變異分析，並以.05為差異考驗水準。若其Λ值達顯著水準，則以薛費法進行事後比較，茲分別比較如下：1.不同人格親和性的學生在學習滿意度四個層面的差異分析，如表4-3所示；2.不同人格外向性的學生在學習滿意度四個層面的差異分析，如表4-4所示；3.不同人格經驗開放性的學生在學習滿意度四個層面的差異分析，如表4-5所示；4.不同人格勤勉正直性的學生在學習滿意度四個層面的差異分析，如表4-6所示。

1.不同人格親和性的學生在學習滿意度四個層面的差異分析：由表4-3可以得知，不同人格親和性組在學習滿意度四個層面方面有顯著差異(Wilks' Λ =.881***)，從單變量變異數考驗結果來看，四個層面的事後比較均顯示；「高分組」學生的學習滿意度均顯著的優於「中分組」、「低分組」的學生；而「中分組」學生的學習滿意度又顯著的優於「低分組」學生。可見人格特質越親和的學生，其學習滿意度越高。

表4-3不同人格親和性的學生在學習滿意度的差異分析

變異來源	層面名稱	SS	Df	MS	F	事後比較
親和性	學習成果	1161.774	2	580.887	26.564***	1>2；1>3；2>3
	學習環境	1794.288	2	897.144	31.750***	1>2；1>3；2>3
	人際關係	2371.040	2	1185.520	47.522***	1>2；1>3；2>3

	師資與教學	1689.979	2	844.990	25.703***	1>2；1>3；2>3
誤差	學習成果	19418.370	888	21.868		
	學習環境	25091.398	888	28.256		
	人際關係	22152.794	888	24.947		
	師資與教學	29193.374	888	32.875		
單因子多變量整體考驗Wilks’ Λ =.881，p<.001						

備註：1:高分組；2:中分組；3:低分組；***p<.001

2.不同人格外向性的學生在學習滿意度四個層面的差異分析：由表4-4可以得知，不同人格外向性組在學習滿意度四個層面方面有顯著差異(Wilks’ Λ =.852***)，再從單變量變異數考驗結果來看，四個層面的事後比較均顯示；「高分組」學生的學習滿意度均顯著的優於「中分組」、「低分組」的學生；而「中分組」學生的學習滿意度又顯著的優於「低分組」學生。可見人格特質越外向性的學生，其學習滿意度越高。

表4-4不同人格外向性的學生在學習滿意度的差異分析

變異來源	層面名稱	SS	Df	MS	F	事後比較
外向性	學習成果	1801.172	2	900.586	42.586***	1>2；1>3；2>3
	學習環境	1025.534	2	512.767	17.608***	1>2；1>3；2>3
	人際關係	2972.357	2	1486.178	61.236***	1>2；1>3；2>3
	師資與教學	1601.790	2	800.895	24.288***	1>2；1>3；2>3
誤差	學習成果	18778.972	888	21.147		
	學習環境	25860.152	888	29.122		
	人際關係	21551.477	888	24.270		
	師資與教學	29281.564	888	32.975		
單因子多變量整體考驗Wilks’ Λ =.852，p<.001						

3.不同人格經驗開放性的學生在學習滿意度四個層面的差異分析：由表4-5可以得知，不同外向性組在學習滿意度四個層面方面有顯著差異(Wilks’ Λ =.903***)。再從單變量變異數考驗結果來看，學習成果與人際關係二個層面的事後比較均顯示；「高分組」學生的學習滿意度均顯著的優於「中分組」、「低分組」的學生；而「中分組」學生的學習滿意度又顯著的優於「低分組」學生。在學習環境、師資與教學二個層面的事後比較均顯示，「高分組」、「中分組」學生的學習滿意度顯著的優於「低分組」，但高分組與中分組則無顯著差異，可見人格特質越屬經驗開放的學生，其學習滿意度越高。

表4-5不同人格經驗開放性的學生在學習滿意度的差異分析

變異來源	層面名稱	SS	Df	MS	F	事後比較
經驗開放性	學習成果	1255.517	2	627.759	28.847***	1>2；1>3；2>3
	學習環境	615.923	2	307.961	10.410***	1>3；2>3
	人際關係	1797.077	2	898.539	35.108***	1>2；1>3；2>3

	師資與教學	953.704	2	476.852	14.148***	1>3；2>3
誤差	學習成果	19324.626	888	21.762		
	學習環境	26269.763	888	29.583		
	人際關係	22726.757	888	25.593		
	師資與教學	29929.650	888	33.705		
單因子多變量整體考驗Wilks' Λ =.903，p<.001						

備註：1:高分組；2:中分組；3:低分組；***p<.001

4.不同人格勤勉正直性的學生在學習滿意度四個層面的差異分析：由表4-6可以得知，不同勤勉正直性組在學習滿意度四個層面方面有顯著差異(Wilks' Λ =.848***)，此種差異係由學習成果、學習環境、人際關係、師資與教學四個依變數所造成。再從單變量變異數考驗結果來看，四個層面的事後比較均顯示；「高分組」學生的學習滿意度均顯著的優於「中分組」、「低分組」的學生；而「中分組」學生的學習滿意度又顯著的優於「低分組」學生。可見人格特質越是勤勉正直性的學生，其學習滿意度越高。

表4-6不同人格勤勉正直性的學生在學習滿意度的差異分析

變異來源	層面名稱	SS	Df	MS	F	事後比較
勤勉正直性	學習成果	2746.526	2	1373.263	68.380***	1>2；1>3；2>3
	學習環境	731.368	2	365.684	12.416***	1>2；1>3；2>3
	人際關係	1873.977	2	936.989	36.735***	1>2；1>3；2>3
	師資與教學	1814.914	2	907.457	27.722***	1>2；1>3；2>3
誤差	學習成果	17833.618	888	20.083		
	學習環境	26154.318	888	29.453		
	人際關係	22649.857	888	25.507		
	師資與教學	29068.439	888	32.735		
單因子多變量整體考驗Wilks' Λ =.848，p<.001						

備註：1:高分組；2:中分組；3:低分組；***p<.001

六、人格特質與學習滿意度之相關性分析

人格特質與學習滿意度之典型相關分析與相關徑路情形，其分析結果如表4-7所示，典型相關分析徑路圖，如圖4-1所示。表4-7為典型函數的顯著性檢定結果，人格特質各分量表與學習滿意度各分量表之線性組合分數之間的相關是存在的。三組典型相關係數均達到.05以上的顯著水準，第一個典型相關係數為$\rho 1$=.456（p<.001）屬於中度相關；第二個典型相關係數為$\rho 2$=.237（p<.001）屬於低度相關；第三個典型相關係數為$\rho 3$=.122（p<.01）屬於低度相關。典型相關結構組型分別說明如下：

第一個典型相關結構：由表4-7典型相關中，控制變項（X 變項）的$\chi 1$可以解釋Y變項的典型因素$\eta 1$的總變異量為20.8%；而$\chi 1$自X 變項（人格）的四個變項中所抽出的變異數佔四

個變項總變異量67.04%。因此，χ1所解釋的20.8%的η1之變異量，其中由四個X變項所解釋的η1之變異量佔13.96%；同樣地，η1自Y的四個變項中所抽出的變異數佔四個變項總變異量10.82%，即 η1可以解釋Y變項（學習滿意度）總變異量的10.82，因此，由四個Y變項所解釋的χ1之變異數佔51.93%。

由表4-7可得知人格特質變項中，包括「親和性」與「外向性」以及「外向性」、「開放性」、「勤勉正直性」與學習滿意度相關係數均呈現正相關，且為多數係數為中高度相關。即科技領域學生人格各項特質之負荷愈高時，則在學習成果、學習環境、人際關係、師資與教學的學習滿意度相對也越滿意。

第二個典型相關結構：控制變項（X 變項）的χ2可以解釋Y變項的典型因素η2的總變異量為5.6%；而χ2自X 變項（人格）的四個變項中所抽出的變異數佔四個變項總變異量10.42%。因此，χ2所解釋的5.6%的η2之變異量，其中由四個X變項所解釋的η2之變異量佔0.585%；同樣地，η2自Y的四個變項中所抽出的變異數佔四個變項總變異量10.03%，即 η2可以解釋Y變項（學習滿意度）總變異量的17.87%，因此，由四個Y變項所解釋的χ2之變異數佔17.87%。

進一步由典型負荷量(canonical loading)來看，考慮典型負荷量大於.30的變項。第二個典型相關主要由控制變項（X變項）中的「親和性」(r=.488)、「勤勉正直性」(r=.416透過第二個典型因素(χ2)影響效標變項（Y變項）中的「學習環境」(r=.546)、「人際關係」（r=.424)、「學習成果」(r=.461）三項滿意度產生關連。即科技領域學生越是親和性與勤勉正直性的學生，則在學習環境、人際關係的學習滿意度相對較高，在學習成果的滿意度較低。

第三個典型相關結構：控制變項（X 變項）的χ3可以解釋Y變項的典型因素η3的總變異量為1.5%；而χ3自X 變項（人格）的四個變項中所抽出的變異數佔二個變項總變異量14.43%。因此，χ3所解釋的1.5%的η3之變異量，其中由四個X變項所解釋的η3之變異量佔0.215%；同樣地，η3自Y的四個變項中所抽出的變異數佔四個變項總變異量2.85%，即 η3可以解釋Y變項（學習滿意度）總變異量的19.15%，因此，由四個Y變項所解釋的χ3之變異數佔19.15%。

進一步由典型負荷量(canonical loading)來看，考慮典型負荷量大於.30的變項。第二個典型相關主要由控制變項（X變項）中的「親和性」(r=.359)、「外向性」(r=.446)、「開放學習性」透過第三個典型因素(χ3)影響效標變項(Y變項）中的「師資與教學」(r=.632)、「學習環境」(r=.467)、「學習成果」(r=.342）三項滿意度產生關連。即科技領域學生人格越是親和性與外向性、開放學習性的學生，則在學習成果、學習環境、師資與教學的學習滿意度相對較高。

表 4-7 人格特質層面與學習滿意度層面的典型相關分析摘要表

控制變項	典型因素			效標變項	典型因素		
(X 變項)	χ1	χ2	χ3	(Y 變項)	η1	η2	η3
親和性	.791	.488	.359	學習成果	.816	-.461	.342

外向性	.867	.058	-.446	學習環境	.508	.546	.467
開放學習性	.731	-.048	-.449	人際關係	.876	.424	-.177
勤勉正直性	.877	-.416	.219	師資與教學	.622	.158	.632
抽出變異數百分比	.67035	.10418	.14431	抽出變異數百分比	.10816	.01003	.00285
重疊	.13963	.00585	.00215	重疊	.51929	.17867	.19148
				ρ^2	.208	.056	.015
				ρ	.456***	.237***	.122**

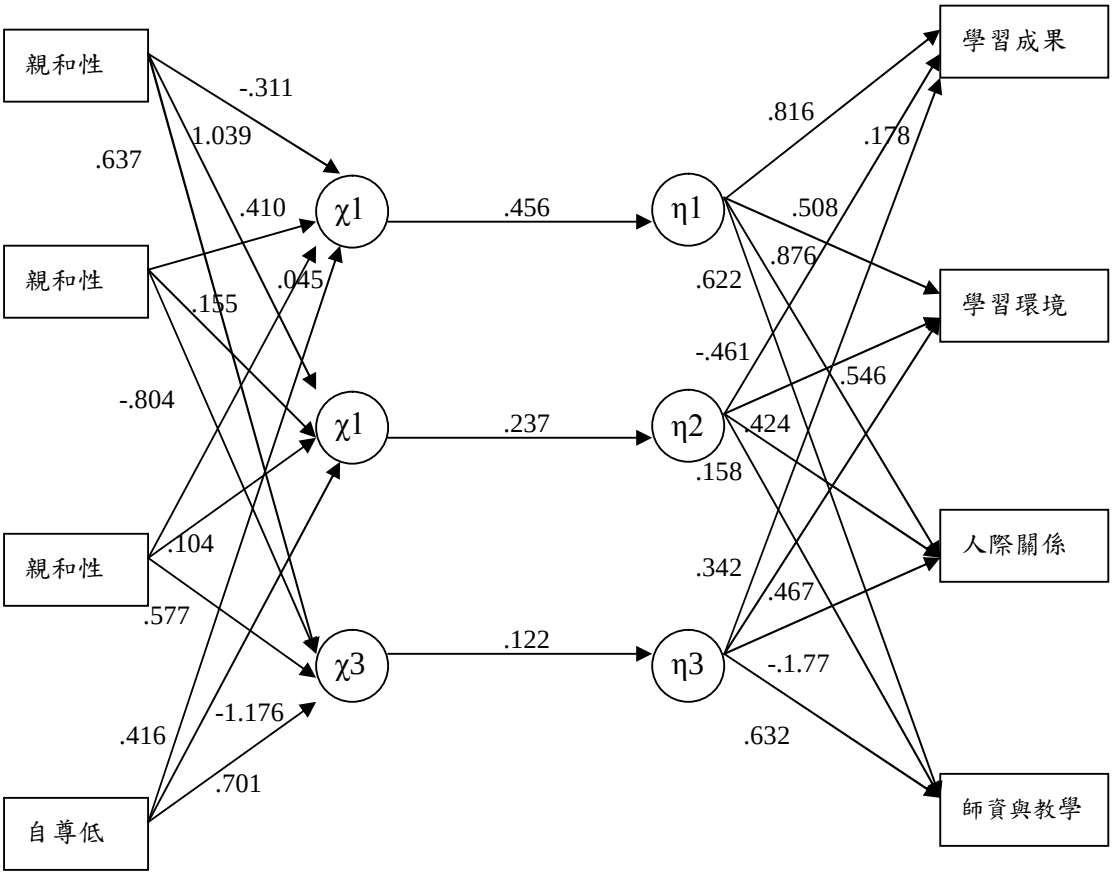

圖 4-1 人格特質層面層面與學習滿意度層面的典型相關分析徑路

二、質性訪談結果初步呈現

(一)、訪談對象

理工科系女性（訪談人數）		理工科系男性（訪談人數）		非理工科系女性（訪談人數）	
30		15		15	
科系	人數	科系	人數	科系	人數
土木	9	土木	6	歷史	4

物理、通訊、地科	各1	電機	4	公行	5
資館	5	機械	2	中文	4
應化	5	應化	3	外文	2
電機	3				

本次訪談對象主要來自台灣地區五所公私立大學，訪談學生的學習滿意度多半不錯，可能因為對學業成績較滿意的同學較願意接受訪談，分享學習經驗。學習上，大一大二較不積極，通常在大三之後有所轉變。訪談對象普遍對於名次不太重視。

(二)、科系選讀

學生最普遍的選讀科系原因是分數適合。以土木系來說，土木幾乎都不是女性的第一選擇。以電機而言，男性較女性更知覺選讀科系的就業優勢。訪談結果中呈現，科技領域女學生家長多半為高學歷，或從事科技相關工作，國內陳建州(2009)的研究也有同樣發現，但是男生部分則不明顯。

- **科技系所特性：就業和所學較密切關連**

男生對於科技選擇與就業之間的關連，極為重視。

我那時候聽親戚朋友說土木系以後比較賺錢，以經濟現實生活面的考量才選擇了土木系（土木，M1）

傳統比較強的系，就是它基礎比較穩固、歷史比較久啊。電機……對就是它的資源比較多，它的……就是未來可以選讀的組別也很廣，比起其他的理工科的系就是還要廣。然後就是……而且加上師長啊、家長啊就是覺得這種系未來的出路也比較好，對啊出來就是電子新貴啦或是工程師啊，對啊就是類似這樣子。(電機，M2)

其實最早的選擇（IC）還是因為那的薪水（笑）因為其實我們電機方面是…IC 設計算是最難的吧，而且薪水是最高的，啊覺得說很難，如果我學會的話，我在這方面有（咋舌）能夠獨當一面的這樣，自己其實是蠻厲害的啊。(電機，M3)

- **人文社會領域學生較不考慮就業**

當初在高中的時候因為用各科成績來看，就覺得讀歷史分數比較高，然後就是說覺得自己可能在這方面比較強，算強項 ，於是就報考歷史系這樣。【】其實沒有想到過(出路)(笑)。就是每一個階段就是..想說先就去讀阿 然後之後可能再想之類的，對。（歷史，F4)

(三)、上課與學習方式

成績好壞與學習滿意度有密切關連。科技領域學生所學科目較容易被當，也較感受不及格的壓力。科技領域女性和男性在學習表現上差異不大。

- **科技領域學生問問題：不知從何問起**

科技領域學生上課很少問問題，部分提到因為聽不懂，所以也無法發問，要思考如何組織自己的問題，就需要相當時間，而人文社科領域，較無這種問題。

沒有，我本來就沒有問問題的習慣，對對對…所以那個不是我…可是我會覺得就是現在問題好像很重要，就變成說…我很不會問問題，對！就是…有時候老師麥克風舉到我面前了，可是…我知道我不會這個東西，可是我不知道從哪裡開始問，就真的…就…就要學啊…學問問題…【】我知道我…我可能知道我自己是哪個地方要說，但是我講不出來……要怎麼說，而且因為會有點怕怕的，就是覺得…因為有些老師很跩，讓你覺得你問這個好像別人都會，你自己不會，很差勁什麼的啊…會很怕老師印象不好。【】嗯…他每次都會說，我搞不懂我講那麼久，全班卻沒幾個人聽懂，對啊…(資館，F1)

- **科技領域學生：習慣有讀書會，一起讀書。**

科技領域的知識，學生若自己讀書，往往遇到問題時無法求助，所以多數科系都有讀書會文化，相對之下，人文設柯學生的討論往往是為了分享不同的觀點和看法。

呃……四樓都是電機的啦，然後一樓就可能一半是電機，一半就不知道是哪裡的。…我是覺得我們的課程應該是…我個人覺得比較難一點，我們會比較就是討論，有時候大家甚至我們要小考要討論，就是怕吵到別人還會借會議室這樣子，討論是這樣子。(電機，M2)

- **非科技領域女性學習經驗：分組報告多，重批判能力訓練**

人文社科領域的上課方式，就是以讓學生討論和上台報告為主，這樣一來，學生的參與感以及師生互動，似乎是相對於理工科系來得多。

大學一般比較注重團體報告，就是大家可能...老師一開始會說這學期要做哪些報告，然後要分組，大家去討論，然後就一直重複的討論討論，一直討論到報告做出來為止，算還蠻有趣的，然後時間比較自由。(中文，F1)

就是寫報告的時候老師會先叫你寫題目還有大綱，可是你題目跟大綱，你怎麼想都想不出來，然後你列的很好，可是大家會一直評你，你就會覺得好像沒有辦法承受 然後必須去找老師。【】就是看那時候修課 如果要交大報告的話就會比較因為像那種選修課老師都是期中發表你的大綱，然後期末發表整篇論文，這樣子那那個就會遇到比較大的困擾。(歷史一，F1)

- **非科技領域女性學習經驗：重視個人想法與意見發表**

嗯…成績比較高的會是文學類，對。因為是文學類的話，自己的口語會發揮的比較大，對老師給的空間很大。所以，我覺得讀起來..講出自己的看法，很有成就感，對。【】

但是像文學，我分析起來會覺得我這個概念我以前沒想過，然後對事情的看法會有不一樣的觀點，讓我覺得還不錯，還蠻有趣的這樣，對！（外文，F2）

可是那堂課(婦女史)還蠻辛苦的。就是因為每個禮拜可能都有兩篇論文， 然後又要打又要看，然後上課要一起討論，【】因為那時候我是大一剛上去，那時候我還就是，還蠻害怕就是自己發表意見，所以我就很恐懼上那一堂課， 就是每次上課都要發表意見，然後老師就問你，就不太敢說話這樣子，然後，所以就是上完那堂課之後，我會覺得，好像就是，就是自己要開始要有那種意識說，就是說你要發表你自己的意見。(歷史，F4)

(四)、就業

科技領域女性學生在就業部分面臨最大挑戰，這也是為何西方文獻在這方面的著墨極多(Fox, Johnson & Rosser 2006; Phipps, 2008; Scott, 2004)。

(笑)，我最近還蠻...蠻複雜的，【】因為化學系一開始去工作，很容易被那個...外派，就是你一定...就是外派，你企圖心一定要很重，才會有升遷的工作。(外派？）就是有人去大陸啊，什麼之類的，然後...然後我就覺得，我的企圖心沒有很重這樣子，對，這樣就覺得...好像有點...就是沒辦法好好...好好過一個很平凡的生活這樣，對，就是...因為它...就是...因為感覺女生就是做那些工作，其實還蠻辛苦的啦。【】...比如說工作時數很長啊，或者是...嗯...比如說因為其實園區...待在實驗室，對身體也不好，就是...就是有一些化學藥品之類的。【】...之前就會想說..就是...就是研究所去修個...看可不可以去修個教程，或什麼之類的，就是到時候...真的不喜歡去那個...比如說會讓我比較緊張的科技業場合，就可以考慮去考公職。【】...反正我們上課的時候，老師都會稍微跟我們講，這很重要啊，我們的（工作）選擇...要類似分析啊，什麼之類的，但因為在化學工廠裡面，研發部門的薪水比較高，做分析啊、結果的，都比較低。（化，F4）

科技領域男性較少會「亂想」。電機等系幾乎是全班升學。而土木系所不管男女生，解有考公職意願。

我不會想把未來限定在哪，其實我最想當的是一個……民宿的老闆吧（笑）就想說自己有自己的錢之後，想去……想去休閒一下。【】(笑）可能像我們班想得比較少，女生比較多啦，但男生像我這樣……亂想得比較少啦 （電機，M1）

我們研究所老師是偏實務，就有去工地出差過。就要爬鷹架，可能隨時就有大型的機具在你頭上。上次出差的時候就有個東西從鷹架掉下來就差點砸到人。就要戴安全頭盔、穿長袖、長褲還有雨鞋。【】我們老師就都出差的時候都會找男生，真的人數不夠才會找女生，所以我也只被找過兩三次而已。因為之前颱風天就要去橋上裝東西，就很危險，我們那時候老師就說都不要找女生。【】我們家就都說不要去當工頭，然後說公職比較

好。像工頭那種就比較適合男生，叫我去坐辦公室會比較好。（土，F7）

- **非科技領域：不期待和所學結合**

對，然後就想說往那個比較有興趣的去，就是餐飲業，對。【】…我是覺得說…歷史這樣讀下去，其實他是…雖然沒有找到自己什麼讀歷史系那種有用的那種學術上的東西。可是就是在學習過程中學到的東西，我覺得比較重要這樣子。然後你就找到自己想要做的事情。然後就是，學習上的過程就是有學到東西這樣，就是拿去用這樣子，我就很能了。(歷史，F4)

- **非科技領域：就業焦慮**

非科技系所女性有較多就業焦慮，也有較多選擇輔系。

我大二的時候其實還不知道自己要修什麼，就是那時候大家會覺得說以後要幹嘛 就是比較惶恐(大家班上都這樣?)對阿。然後老師也說我們現在就開始想說要幹嘛。可是大家都會想說可是就是不知道要幹嘛。可是就是一定要去想，然後自己可能突然有一天，哦想通了這樣子，就是要，嘖，每個人其實都是這樣子拉。(歷史，F4)

(五)、期待不高的師生互動

- **放年吃草的老師以及怕老師的學生**

大學生與多與教師及學長姐接觸不多，學業問題主要向助教以及同學請教。對大學老師疏離，認為老師都很忙，但期待大學老師給予人生方向指引。科技領域學生經由作專題研究，才能和和老師有較密切聯繫。

你沒有辦法想像說真的是這樣子。因為其實你進來之前你長輩或是老師其實都講說教授大部分都是放你…放牛吃草這樣子，對啊…（電機，M4）

（笑)對啦!就是有只有課堂上的時間。然後….我不知道耶!可能我比較會從小養成習慣會比較害怕這樣【】對對對!會有一種權威性的感覺。【…】我有一些朋友可能也是這樣，都跟我一樣。比較少跟老師接觸，然後跟老師講話都會很害怕，對!恩…我那的一群朋友還蠻多人是這樣。【】不..不會不會，老師人很好 可是就是有時候就是..會有一種距離感吧!（外文，F2）

其實我之前有想過就是 因為那時候還沒有找到方向 然後就想找班導師，就是討論一下未來怎麼樣怎麼樣，可是後來就是不敢去(笑)，一直不敢去跨越那一道藩籬，【】其實我很怕老師，我就是..不知道，我從小到大都很怕老師。【】沒有!我們老師其實人很好，可是就是有些就是很可愛那種的，可是就是…(笑)對阿就是自己的問題。（歷史，F4）

像我曾經有想說就是送教師卡,可是就會變成說可能找不到老師,然後或者是…那種在路上跟老師打招呼,就是因為我們是他的學生認得他,可是他就只是笑笑的，還是不認得

我是誰。(資館，F1)

- **期望老師人生經驗分享**

像跟系上教授導生聚的時候會聊到他們的求學過程或背景，有時候聊起來還滿感興趣的，對每個教授他們怎麼一路讀上來的方式就還滿感興趣的。(化，M3)

- **男教師 vs. 女學生**

理工科系多半以男老師居多。就部分學生的知覺而言，男老師對待男女學生的態度是有差異的。但也可能是因為部分科系性質(土木系)的所學性質，讓老師更關注女學生的人身安全。

嗯，有的老師看起來就兇兇的，感覺問問題的話有點危險。【】…感覺女生比較喜歡問問題，男生好像就不太敢問問題。【】不知道(笑)我覺得問老師問題很奇怪，不知道不知道(笑)。【】嗯…就(沉默)應該是隔閡吧，我就覺得除非真的跟老師熟了就敢，如果不熟的話就不敢問他問題。【】我覺得女生，那種兇兇的男老師女生比較敢去問他。(土木，M4)

我覺得在我們系裡面女生好像比較佔優勢，老師會比較疼女生呀！然後覺得女生比較乖呀，也會給女生的分數比較高。【】對，男女（老師）都有，都是對女學生比較好。【】因為女生都比較努力，譬如說上課會比較認真，男生可能就比較常翹課。【】(笑)，可能因為女生比較認真吧！所以老師也特別會疼女生。(土木，F1)

師生性別不同，也可能會影響師生互動內容。

因為我有修專題嘛，有修專題多少會跟老師互動，因為老師都是男生比較多，或許不會是一般生活上的聊天，他們不會去虧探生活上的隱私。(土木，F5)

(六)、最有成就感，認為對生涯發展最有幫助的課程或參與活動的經驗?

學生對專業學習著墨不多，反而強調的是社團經驗對人際關係和活動組織能力的訓練，以及獨立生活所帶來的成就感。這是否意味學生在中學階段，這些經驗非常缺乏，所以進入大學之後，突然發現他們這一部份能力的欠缺，以及這一部份和日後生涯發展的重要關連。而他們大量時間精力的投入，也往往意味極高成就感。

- **對社團經驗有極高成就感，男女不拘。**

我覺得最滿意的部份是進入社團，九二一那年剛好是我大二那一年，九二一之後其實我跟著社團到過很多災區，去做志工服務。…XX 社，我是 XX 社第一任社長(笑)他背後是屬於人道關懷，所以我們九二一之後，我們 XX 社和人道關懷的志工，我們固定每個禮拜一天或兩天，或是一些節慶日我們都會到災區去辦活動。…在我人生是起了很大的價值意義的里程碑。(土木，M1)

- **獨立生活的成就感**

我覺得大學喔...可能就是因為你讀大學，像我這種外地，就一定要到外地，一個人嘗試生活，我覺得一個人就你自己出去，就不要說讀書，你一個人自己去嘗試找房子，辦理自身所需的一些證件之類的，還蠻有用的。【】對對對，就是你可以自己一個人在社會生活的能力，你如果因為你住在家裡，其實就你爸媽都幫你安排好了，你也不用說什麼，自己生病自己去看醫生之類的。(中文，F1)

質性訪談初步結論：

（一）科系選讀上，分數落點是多數學生選擇的主因，顯示學校科系排名仍有相當影響力。科技領域學生多數有考慮就業因素，男生比女生更知覺所學在經濟的收益。非科技領域對於所學和就業結合，有較低期待，特別是歷史系等，學生往往因為興趣就讀。

（二）男女學生學習經驗相差不多，學習成效相差不大。可能也因為多數選擇科技系所女性來自高學歷家庭。在教學與學習方式上，科技領域的學習與訓練和人文社會科學領域有極大差異。科學領域選擇升學的人數也高於非科技領域。

（三）在就業規劃方面，科技領域男女生有不同考量，特定產業環境與條件，影響女性就業意願。女生需要更多職業引導。學校老師與職場，多以「老老的」男老師居多，在求學和人生經驗上，可見女學生缺乏適切的就業典範。

（四）目前大學師生互動極為缺乏，學生期待和教師有更多互動，特別是人生方面的指引。學生最大成就感在於社團與和應對進退的學習，並認為這些對他們的生涯發展有極大幫助。顯示此一學習在中小學階段極為缺乏，也影響學生人格的成熟。

計畫成果自評：

本研究問卷發放與回收不甚理想，之後希望與台灣高等教育整合資料庫 97 學年度對針對大三學生的學習經驗問卷來進行比對，彌補問卷部分的不足。目前已開始撰寫相關論文，預計於 2010 年投稿在相關學術期刊發表。

■ 本年度性別與科技相關主題研討會論文發表以及投稿情形

Chen, D. I-ru & Yan-ru Liu (2009) How socioeconomic backgrounds affect boys and girls' science achievement and their attitudes towards science? : Examining Taiwan, Korea, Japan and Finland in PISA 2006. ISER – 5th International Symposium on Educational Reform at the University of JYVÄSKYLÄ, Finland (2009, June 4-5) （獲國科會補助出國發表）

Chen, D. I-ru **(under review)**. Higher education reform in Taiwan and its implications on equality. Chinese Education and Society. (SSCI)

出席國際學術研討會心得

本人於今年六月一起至芬蘭 University of Jyvaskyla 參加六月初所舉辦之 International Symposium of Educational Reform 並和該校教育學院討論合作事宜。此一研討會明年將在南非 Pretoria 大學主辦，該大學教授 Johan Beckmann 也積極邀請我們參與明年的活動，由於本次暨南大學多位教師(4 人)與博士生(六人)參與發表，因此後續系上有意積極爭取此一跨國教育研討會來年的主辦權。

原先計畫在抵達芬蘭之前，先拜訪挪威奧斯陸大學資深教授 Suzanne Lie，Prof. Lie 專研性別與高等教育多年，為感謝她也曾寄所有相關著作供本人研究之用。但因聯繫不及，後改為拜訪 Faculty of Education and Internationalisation，Høgskolen i Oslo/Oslo University College(奧斯路大學學院)的教授 Unni Hagen，她負責該學院之研究與國際化事宜，個人專長研究領域為性別與學校領導，同時也拜訪當地小學老師 Elisabeth Tompson，分享挪威學校中的性別文化。本人於 2009 年五月 28 日抵達挪威奧斯陸，拜訪過奧斯路大學學院之後，再於六月一號啟程至芬蘭 Jyvaskyla，研討會於六月五號結束後，搭乘六月七號的飛機由芬蘭回台。感謝國科會給予經費補助參加此一研討會。

How socioeconomic backgrounds affect boys and girls' science achievement and their attitudes towards science? : Examining Taiwan, Korea, Japan and Finland in PISA 2006

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Abstract.
In recent years, more attention has been given to boys and girls' attitudes and performance in science. The study is based on the analysis of the PISA 2006 data between Taiwan, Korea, Japan and Finland. The study tries to look at how socioeconomic backgrounds affects boys and girls' science achievement as well as their attitudes towards science. Base on the statistic analysis of science performance and the Student Questionnaire for PISA 2006, the result has shown that among 4 countries, Taiwan is the only country which socioeconomic backgrounds play an important role for boys and girls' science achievement. Gender differences exist for students from middle and low socioeconomic backgrounds. But it is not significant for Taiwanese boys and girls from high socioeconomic background.

In terms of the *views on science, the expectation of a science-related career, the frequency in engaging in scientific activities and their experience in learning science*, it is found that there are significant gender differences for students in different socioeconomic groups in Taiwan, Korea and Japan. However, Finland's case has presented a very different picture. Among the high socioeconomic group, only *the experiences in learning science* shows significant gender difference. Among the middle and low socioeconomic groups, there are significant gender differences in terms of the *views on science, the expectation of a science-related career and the frequency in engaging in scientific activities*. Moreover, it is actually the Finnish girls who have more positive responses towards the above three items rather than the boys.

Keywords.: Science achievement, Gender, PISA 2006

Section One: Introduction

1-1 PISA 2006

The OECD Programme for International Student Assessment (PISA) measures how well students, at age 15, are prepared to meet the challenges they may encounter in the future. Age 15 is chosen because in most OECD countries, students are approaching the end of compulsory schooling at this age. Thus, some measure of the knowledge, skills and attitudes accumulated over approximately ten years of education is gained from an assessment at this time. (OECD, 2006a)

The PISA measures every three years young people's knowledge and skills in reading, mathematics and science. The main focus of the first (PISA 2000) was reading and in the second (PISA 2003) mathematics, while this latest, PISA 2006, focused on science. The PISA assessment takes a broad approach to assessing knowledge, skills and attitudes that reflect current changes in curricula, moving beyond the school based approach towards the use of knowledge in everyday tasks and challenges. (OECD, 2006a)

Scandinavian countries such as Finland and East Asian countries with Confucian heritage such as Taiwan, Japan and Korea all show outstanding performance in PISA 2006. In particular, countries such as Finland ranks top for all three assessments.

Table 1: PISA 2006 Science Result

	Science		Math		Reading	
	Mean	Rank	Mean	Rank	Mean	Rank
Finland	563	1	548	2	547	2
Taiwan	532	4	549	1	496	16
Japan	531	6	523	10	498	15
Korea	522	11	547	4	556	1

For this reason, the paper intends to examine countries such as Finland, Taiwan, Japan, Taiwan and South Korea, the gender impact on students' performance and students' attitudes and experiences towards the subject. As the main focus of PISA 2006 is science, the authors look at the cross relationship between: 1. gender, socio-economic backgrounds and science achievement; 2. gender, socio-economic backgrounds and attitudes and experiences towards science.

1-2 Gender, social class, science achievement and attitudes and experiences towards science

There have been a serious concern about the underachieving boys in the West (Jones

and Myhill, 2004; Francis, 2000; Francis & Skelton, 2005). However, when it comes to science, boys are still perceived as having better performance. Nevertheless. compared with reading and mathematic literacy, the finding of PISA 2006 suggest that in OECD countries, the gender differences in science performance tend to be small in absolute term and when compared with the large gender gap in reading performance. Gender differences were much larger within schools than they were in the country over all. (OECD, 2006b)

Nevertheless, females and males do show strength in different areas of science. Across countries females are stronger in identifying scientific issues, while males are stronger at explaining phenomena scientifically. Conversely, in the science content areas, males generally outperform female in 'Physical systems'. These reveal an emphasis on different educational experiences with science that policymakers can remedy. (OECD, 2006b: 114-115)

There have been various of way to look at gender differences in achievement, such as boys and girls are born with different interests, motivations and abilities, they have different learning styles, assessment procedures and teaching practices are biased or pupils' construction of gender produce different behaviors which impact on education. (Francis and Skelton, 2005) While these remain important, this paper will closely examine the impacts of socioeconomic factors.

Research often look at the issue of gender and socioeconomic factors separately (Jenkins etc, 2007, Hamilton, 1998). Very often, it is suggested that socioeconomic background factor out-weight gender factors when it comes to the study of students' achievement. However, some researchers do suggest that the concern with negligible gender differences in achievement actually hide far more substantial differences in educational achievement according to race and social class in particular. (Francis, 2000)

Thus, this research would like to combine gender and socio-economic factors. The authors try to examine whether gender has made significant difference in science achievement for students from different socioeconomic background.

1-3 Countries Profile Studied: Finland, Taiwan, Japan and Korea

This study choose Finland, Taiwan Japan and Korea to study. Before looking at students' academic performance, the authors found that it is necessary to look at the

countries' profiles. Home background, social and cultural status, remains one of the most powerful factors influencing performance. As to the performance in science and the impact of socio-economic background, PISA 2006 divided the countries into three types: Type One: Strength of the relationship between performance and socio-economic background **above** the OECD average impact; Type Two: Strength of the relationship between performance and socio-economic background **not statistically significantly different** from the OECD average impact and Type 3: Strength of the relationship between performance and socio-economic background **below** the OECD average impact. Among 4 countries, Taiwan is the only country classified as Type Two while three other countries are classified as Type Three (OECD, 2007: 33). With the above information in mind, the paper further reviews related countries' socio-economic backgrounds such as GDP (PPP) per capital, gini coefficient, GEM, GDI and HDI.

In terms of GDP (PPP) per capital, according to the IMF data, the four countries are quite similar with Finland slightly ahead and South Korea slightly lagging behind. In terms of Gini coefficient of the four countries, according to the data from OECD and Directorate General of Budget Accounting and Statistics in Taiwan, Finland rank 1st among the four countries while Taiwan is at the bottom.

Table 2: 2008 GDP (PPP) per capita

Rank	Country	Geary-Khamis dollar
20	Finland	36,217
24	Japan	34,100
25	Taiwan	30,881
32	South Korea	27,647

Source: International Monetary Fund (2008) http://www.imf.org/external/data.htm

NB: The Geary-Khamis dollar, also known as the international dollar, is a hypothetical unit of currency that has the same purchasing power that the U.S. dollar had in the United States at a given point in time.

Table 3: Levels of income inequality based on different summary measures in mid-2000s: Gini coefficient

	Level	Rank
Finland	0.27	7
Japan	0.32	20
Korea	0.31	17
Taiwan (2006)	0.339	

Source: OECD (2008) Growing Unequal? Income Distribution and Poverty in OECD Countries (p. 51) & Liberty Times (Sep. 25, 2007) Retrieved April 30, from http://www.libertytimes.com.tw/2007/new/sep/25/today-e3-3.htm

The Gender Empowerment Measure (GEM) is a measure of inequalities between men's and women's opportunities in a country. It combines inequalities in three areas: political participation and decision making, economic participation and decision making, and power over economic resources. It is one of the five indicators used by the United Nations Development Program in its annual Human Development Report. In this aspect, Finland and Taiwan show much better values and ranks than Japan and S. Korea.

Table 4: GEM value and rank of Finland, Taiwan, Japan and S. Korea

Countries	GEM		Seats in parliament held by women		Female legislators, senior officials and managers		Female professional and technical workers		Ratio of estimates female to male earned income	
	Value	Rank	%	Rank	%	Rank	%	Rank	%	Rank
Finland	0.887	3	42.0	3	30	49	55	24	71	13
Taiwan	0.707	19	21.4	52	17	81	45	69	67	26
Japan	0.557	55	11.1	113	10	89	46	65	45	119
Korea	0.510	65	13.4	100	8	92	40	76	40	132

Source: Directorate General of Budget, Accounting and Statistics (2007). Retrieved April 28, 2009, from http://www.dgbas.gov.tw/public/Data/7121916233271.pdf & UNDP (2007-8) Human Development Report

The Gender-related Development Index (GDI) is an indication of the standard of living in a country, developed by the United Nations. It is one of the five indicators used by the United Nations Development Programme in its annual Human Development Report. It aims to show the inequalities between men and women in the following areas: long and healthy life, knowledge, and a decent standard of living. The Human Development Index (HDI) is an index used to rank countries by level of "human development", which usually also implies whether a country is a developed, developing, or underdeveloped country. In these two Indexes, both Finland and Japan are slightly ahead of Taiwan and S. Korea.

Table 5: 2005 GDI and HDI in Finland, Taiwan, Japan and S. Korea

Country	GDI		HDI	
		Rank		Rank
Finland	0.947	8	0.952	11
Japan	0.942	13	0.953	8
Taiwan	0.931	20	0.932	23
South Korea	0.910	26	0.921	26

Source: UNDP (2007) Human Development Report & Directorate General of Budget, Accounting and Statistics (2005) http://www.dgbas.gov.tw/public/Data/

Compared the overall performance of GDP (PPP) per capital, gini coefficient, GEM, GDI and HDI in these four countries, we found that Finland always rank first, while South Korea ranked bottoms for the Indexes of GDP (PPP) per capital, GEM, GDI and HDI.

Section Two: The methodology

2.1 2006 PISA: Analysis of science literacy and students questionnaires

Similar to the previous cycles, the 2006 assessment covers the domains of *reading*, *mathematical* and *scientific literacy*, with the major focus on *scientific literacy*. Both students and principals also respond to background questionnaires, and additional supporting information is gathered from the school authorities. Thus, the PISA assessment can provide contextual indicators that show how such skills relate to important demographic, social, economic and educational variables.

Fifty-six countries and regions took part in the PISA 2006 assessment. In PISA the science "literacy" means young people's ability to use scientific knowledge and skills in different areas and in different life situations.

The data analysis is based on the result of science achievement in PISA 2006 and analysis of findings from seven questions which are derived from Student Questionnaire for PISA 2006. The seven questions are divided into 4 items: the views on science, the expectation of a science-related career, the frequency in engaging in scientific activities and their experience in learning science.

The total number of students took part in Science assessment in PISA 2006 are: 4192 females and 4620 males from Taiwan; 2949 females and 3003 males from Japan; 2563 females and 2613 males from S. Korea and 2385 females and 2329 males from Finland. These students' socio-economic backgrounds are divided into three categories: high, middle and low socio-economic backgrounds.

The research method adopts in this paper is t-test as the t-test is the most commonly used method to evaluate the differences in means between two groups.

2.2 Research Aims:

The purposes of the study are to find out whether:

1. significant gender differences in science achievement exist for students from different socio-economic background in Taiwan, Japan, Korea and Finland.
2. significant gender differences exist in students' views on science, the expectation of a science-related career, the frequency in engaging in scientific activities and their experience in learning science for students from different socio-economic background in Taiwan, Japan, Korea and Finland.

Section Three: Gender and Science performance

3-1 Does gender make significant difference to students' science performance

Table 6 has showed that among four countries, the only country which shows significant gender difference in science performance is Taiwan. Also, male students perform better than female students.

Table 6: The gender significance in students' science achievement

Taiwan					
	Gender	N	Mean	T value	Sig.
Science Achievement	Female	4192	540.4229	-3.310**	.001
	Male	4620	546.6513		
Japan					
	Gender	N	Mean	T value	Sig.
Science Achievement	Female	2949	533.5848	-.106	.915
	Male	3003	533.8499		
Korea					
	Gender	N	Mean	T value	Sig.
Science Achievement	Female	2563	523.0228	.905	.366
	Male	2613	520.8358		
Finland					
	Gender	N	Mean	T value	Sig.
Science Achievement	Female	2385	564.5184	.962	.336
	Male	2329	562.2123		

3-2 **Does gender make significant difference to students' science performance: taking socio-economic backgrounds into consideration.**

3-2-1: Gender significance in science achievement in Taiwan: taking socio-economic backgrounds into consideration

In the case of Taiwan, for students from high socioeconomic background, there is no significant gender difference. For students from middle socioeconomic background, there is a significant difference between gender and science performance. ($p<.01$). Boys perform better than girls. For students from low socioeconomic background, there are significant gender differences in science performance. (there is significant difference of gender and science performance ($p <.01$). Boys perform better than girls.

Table 7: Gender significance in science achievement in Taiwan: taking socio-economic backgrounds into consideration

High socioeconomic background					
	Gender	N	Mean	T value	Sig.
Science Achievement	Female	646	596.4274	.502	.616
	Male	748	594.4055		
Middle socioeconomic background					
	Gender	N	Mean	T value	Sig.
Science Achievement	Female	2868	539.4719	-2.931**	.003
	Male	3079	545.9056		
Low socioeconomic background					
	Gender	N	Mean	T value	Sig.
Science Achievement	Female	675	491.3811	-3.220**	.001
	Male	775	506.1902		

3-2-2 Gender significance in science achievement in Japan: taking socio-economic backgrounds into consideration

Japanese students from all three different socioeconomic backgrounds do not show strong significant differences of gender and students' science achievement.

Table 8: Gender significance in science achievement in Japan: taking socio-economic backgrounds into consideration

High socioeconomic background					
	Gender	N	Mean	T value	Sig.
Science achievement	Female	555	567.4782	-.084	.933
	Male	530	567.9457		
Middle socioeconomic background					
	Gender	N	Mean	T value	Sig.
Science achievement	Female	1875	535.7282	-1.080	.281
	Male	1923	538.9735		
Low socioeconomic background					
	Gender	N	Mean	T value	Sig.
Science achievement	Female	501	490.7918	-.180	.857
	Male	478	491.8369		

3-2-3 Gender significance in science achievement in Korea: taking socio-economic

backgrounds into consideration

Korean students from all three different socioeconomic backgrounds do not show strong significant differences of gender and students' science achievement.

Table 9: Gender significance in science achievement in Korea: taking socio-economic backgrounds into consideration

High socioeconomic background					
	Gender	N	Mean	T value	Sig.
Science achievement	Female	395	567.3343	.888	.375
	Male	439	562.3203		
Middle socioeconomic background					
	Gender	N	Mean	T value	Sig.
Science achievement	Female	1751	521.5635	.596	.551
	Male	1760	519.8709		
Low socioeconomic background					
	Gender	N	Mean	T value	Sig.
Science achievement	Female	416	487.0006	.822	.411
	Male	407	482.1097		

3-2-4 Gender significance in science achievement in Finland: taking socio-economic backgrounds into consideration

Finnish students from all three different socioeconomic backgrounds do not show strong significant differences of gender and students' science achievement.

Table 10: Gender significance in science achievement in Finland: taking socio-economic backgrounds into consideration

High socioeconomic background					
	Gender	N	Mean	T value	Sig.
Science achievement	Female	416	602.5503	.427	.670
	Male	398	600.2247		
Middle socioeconomic background					
	Gender	N	Mean	T value	Sig.
Science achievement	Female	1600	562.2916	.422	.673
	Male	1549	561.1002		
Low socioeconomic background					
	Gender	N	Mean	T value	Sig.
Science achievement	Female	363	533.1310	.691	.489
	Male	371	528.9271		

3-2-5 Overview

When the gender difference exists, it always means that boys perform better than

girls.

Table 11: Gender significance in students science achievements in four countries: taking students' socio-economic background into consideration (p<.05)

	High socio-economic status	Middle socio-economic status	Low socio- economic status
Taiwan	X	O	O
Japan	X	X	X
Korea	X	X	X
Finland	X	X	X

NB: O means there is significant differences in science for boys and girls from different socio-economic background; X means there is no significant difference.

Section Four: Gender significances in students' attitudes and experience towards science

4-1 Significant gender differences on students views on science, the expectation of a science-related career, the frequency in engaging in scientific activities and their experience in learning

4-1-1 Gender significance in students' attitudes and experience towards science in Taiwan

Table 12 shows gender has significant differences with students' views on science, the expectation of a science-related career, the frequency in engaging in scientific activities and their experience in learning science. All the four items show significant differences (p <.001). Among 4 items, both boys and girls show more positive opinions on the view on science. Boys have more positive views on science than girls, higher expectation of a science-related career and higher frequency in engaging in scientific activities and more experience in learning science.

Table 12: Gender significance in students' attitudes and experience towards science in Taiwan

	Gender	N	Mean	T value	Sig.
the views on science	Female	4145	1.9771	21.024***	.000
	Male	4563	1.7838		
the expectation of a science-related career	Female	4155	2.5841	27.164***	.000
	Male	4560	2.2284		
the frequency in engaging in scientific activities	Female	4168	3.2104	14.726***	.000
	Male	4593	3.0415		
the experience in learning science	Female	4161	2.6540	26.138***	.000
	Male	4566	2.3434		

4-1-2 Gender significances in students' attitudes and experience towards science in Japan

Table 13 shows gender makes significant difference with students' views on science, the expectation of a science-related career, the frequency in engaging in scientific activities and their experience in learning science. All the four items show significant differences ($p < .001$). Boys have more positive views on science than girls, higher expectation of a science-related career and higher frequency in engaging in scientific activities and more experience in learning science.

Table 13: Gender significances in students' attitudes and experience towards science in Japan

	Gender	N	Mean	T value	Sig.
the views on science	Female	2906	2.4204	17.196***	.000
	Male	2962	2.1902		
the expectation of a science-related career	Female	2897	2.9821	12.690***	.000
	Male	2962	2.7358		
the frequency in engaging in scientific activities	Female	2943	3.7234	12.787***	.000
	Male	2984	3.5496		
the experience in learning science	Female	2898	2.8776	17.750***	.000
	Male	2959	2.6153		

4-1-3 Gender significance in students' attitudes and experience towards science in Korea

Table 14 shows gender makes significant differences with students' views on science, the expectation of a science-related career, the frequency in engaging in scientific activities and their experience in learning science. All the four items show significant differences ($p < .001$). Boys have more positive views on science than girls, higher expectation of a science-related career and higher frequency in engaging in scientific

activities and more experience in learning science.

Table 14: Gender significance in students' attitudes and experience towards science in Korea

	Gender	N	Mean	T value	Sig.
Views on science	Female	2548	2.2482	8.154***	.000
	Male	2587	2.1386		
Expectation of a science-related career	Female	2552	2.8686	8.400***	.000
	Male	2591	2.7097		
Frequency in engaging in scientific activities	Female	2561	3.4713	9.256***	.000
	Male	2601	3.3227		
Experience in learning science	Female	2552	2.5887	9.015***	.000
	Male	2598	2.4595		

4-1-4 Gender significances in students' attitudes and experience towards science in Finland

Table 15 shows gender has significant differences with students' views on science, the expectation of a science-related career, the frequency in engaging in scientific activities and their experience in learning science. ($p<.05$). However, unlike other three countries, Finnish girls have more positive views on science, they are more likely to expect a science-related career and they have higher frequency in engaging in science activities. Boys only have more experience in learning science.

Table 15: Gender significances in students' attitudes and experience towards science in Finland

	Gender	N	Mean	T value	Sig.
Views on science	Female	2326	2.1192	-4.746***	.000
	Male	2266	2.1861		
Expectation of a science-related career	Female	2318	2.6948	-4.528***	.000
	Male	2247	2.7808		
Frequency in engaging in scientific activities	Female	2376	3.4545	-2.559*	.011
	Male	2320	3.4957		
Experience in learning science	Female	2307	2.2850	2.259*	.024
	Male	2260	2.2529		

Above all, when the gender difference exists, it always means that boys score higher than girls except Finland. Finish girls score higher than boys in their views of science, the frequency in engaging in scientific activities and experience in learning science.

Table 16: Gender significances in attitudes and experiences in Finland, Taiwan, Japan and South Korea. ($p<.05$)

	View on science	Expectation of a science-related career	Frequency in engaging in scientific activities	experience in learning science
Taiwan	O	O	O	O
Japan	O	O	O	O
Korea	O	O	O	O
Finland	O	O	O	O

NB: O means there is significant differences in science for boys and girls from different socio-economic background; X means there is no significant difference.

4-2 Gender differences in students' attitudes and experience towards science in 4 countries: taking socio-economic backgrounds into consideration

4-2-1 Gender differences in students' attitudes and experience towards science in Taiwan: taking socio-economic backgrounds into consideration

In Taiwan, students from high, middle and low socio-economic backgrounds, they all show significant gender differences in their views on science, the expectation of a science-related career, the frequency in engaging in scientific activities and the experience in learning science. All the four items have shown p <.001. Boys have more positive view on science, higher expectation of a science-related career, higher frequency in engaging in scientific activities and have more experience in learning science. Moreover, what these students from the different backgrounds have in common is that they all show big gender differences about boys and girls expectation of a science-related career.

Table 17: Gender differences in students' attitudes and experience towards science in Taiwan: taking socio-economic backgrounds into consideration

High socioeconomic background					
	Gender	N	Mean	T value	Sig.
the views on science	Female	641	1.8656	9.968***	.000
	Male	738	1.6426		
the expectation of a science-related career	Female	641	2.4516	11.128***	.000
	Male	736	2.0592		
the frequency in engaging in scientific activities	Female	641	3.0577	7.995***	.000
	Male	744	2.8161		
the experience in learning science	Female	643	2.3945	10.412***	.000
	Male	743	2.1110		
Middle socioeconomic background					
	Gender	N	Mean	T value	Sig.
Views on science	Female	2837	1.9811	18.258***	.000
	Male	3046	1.7810		
Expectation of a science-related career	Female	2847	2.6028	23.024***	.000
	Male	3046	2.2404		
Frequency in engaging in scientific	Female	2857	3.2157	12.236***	.000

activities	Male	3064	3.0492		
Experience in learning science	Female	2850	2.5481	19.857***	.000
	Male	3047	2.2911		
Low socioeconomic background					
	Gender	N	Mean	T value	Sig.
the views on science	Female	664	2.0670	6.259***	.000
	Male	765	1.9215		
the expectation of a science-related career	Female	664	2.6324	9.721***	.000
	Male	762	2.3367		
the frequency in engaging in scientific activities	Female	667	3.3346	4.122***	.000
	Male	769	3.2239		
the experience in learning science	Female	665	2.5846	6.847***	.000
	Male	760	2.4072		

4-2-2 Gender differences in students' attitudes and experience towards science in Japan: taking socio-economic backgrounds into consideration

In Japan, students from high, middle and low socio-economic backgrounds, they all show significant gender differences in their views on science, the expectation of a science-related career, the frequency in engaging in scientific activities and the experience in learning science. All the four items show significant differences ($p < .001$). Boys have more positive views on science, are more willing to engaged in science-related career, have higher frequency to engage in scientific activities and have more experience in learning science. Moreover, what these students from the different backgrounds have in common is that they all show related low frequency in engaging in scientific activities.

Table 18: Gender differences in students' attitudes and experience towards science in Japan: taking socio-economic backgrounds into consideration

High socioeconomic background					
	Gender	**N**	**Mean**	**T value**	**Sig.**
Views on science	Female	553	2.2743	6.695***	.000
	Male	523	2.0660		
Expectation of a science-related career	Female	552	2.7516	4.378***	.000
	Male	526	2.5378		
Frequency in engaging in scientific activities	Female	554	3.5987	4.446***	.000
	Male	528	3.4280		
Experience in learning science	Female	549	2.7491	7.538***	.000
	Male	523	2.4883		
Middle socioeconomic background					
	Gender	N	Mean	T value	Sig.
Views on science	Female	1848	2.4271	14.584***	.000
	Male	1902	2.1898		
Expectation of a science-related career	Female	1834	3.0127	11.389***	.000
	Male	1900	2.7413		
Frequency in engaging in scientific activities	Female	1870	3.7324	11.304***	.000
	Male	1912	3.5462		

Experience in learning science	Female	1839	2.8947	14.947***	.000
	Male	1902	2.6212		
Low socioeconomic background					
	Gender	N	Mean	T value	Sig.
Views on science	Female	487	2.5493	7.541***	.000
	Male	470	2.2960		
Expectation of a science-related career	Female	494	3.1201	4.655***	.000
	Male	471	2.9179		
Frequency in engaging in scientific activities	Female	501	3.8250	5.234***	.000
	Male	474	3.6899		
Experience in learning science	Female	493	2.9526	6.693***	.000
	Male	469	2.7146		

4-2-3 Gender differences in students' attitudes and experience towards science in South Korea: taking socio-economic backgrounds into consideration

In Korea, students from high, middle and low socio-economic backgrounds, they all show significant gender differences in their views on science, the expectation of a science-related career, the frequency in engaging in scientific activities and the experience in learning science. (students from high socioeconomic background, all 4 items are $p<.05$; students from middle socioeconomic background, all 4 items are $p<.001$; students from low socioeconomic background, all 4 items are $p<.01$.) Boys have more positive views on science, are more willing to engaged in science-related career, have higher frequency to engage in scientific activities and have more experience in learning science. Moreover, what these students from the different backgrounds have in common is that they all show related low frequency in engaging in scientific activities.

Table 19: Gender differences in students' attitudes and experience towards science in South Korea: taking socio-economic backgrounds into consideration

High socioeconomic background					
	Gender	N	Mean	T value	Sig.
Views on science	Female	394	2.0783	2.242*	.025
	Male	438	2.0019		
Expectation of a science-related career	Female	393	2.7518	3.056**	.002
	Male	436	2.5938		
Frequency in engaging in scientific activities	Female	395	3.2473	2.770**	.006
	Male	438	3.1225		
Experience in learning science	Female	393	2.3955	2.960**	.003
	Male	439	2.2845		
Middle socioeconomic background					
	Gender	N	Mean	T value	Sig.
Views on science	Female	1741	2.2533	6.906***	.000
	Male	1746	2.1434		
Expectation of a science-related career	Female	1742	2.8759	6.665***	.000
	Male	1747	2.7235		

Frequency in engaging in scientific activities	Female	1749	3.4883	8.344***	.000
	Male	1755	3.3290		
Experience in learning science	Female	1742	2.5989	7.586***	.000
	Male	1750	2.4695		
Low socioeconomic background					
	Gender	N	Mean	T value	Sig.
Views on science	Female	412	2.3891	3.584***	.000
	Male	398	2.2679		
Expectation of a science-related career	Female	416	2.9493	4.010***	.000
	Male	403	2.7808		
Frequency in engaging in scientific activities	Female	416	3.6122	2.822**	.005
	Male	403	3.5170		
Experience in learning science	Female	416	2.7289	3.637***	.000
	Male	404	2.6067		

4-2-4 Gender differences in students' attitudes and experience towards science in Finland: taking socio-economic backgrounds into consideration

In terms of high socioeconomic background students, Finnish students have shown significant gender differences ($p < .05$). Boys perform better than girls. The other three has no significant gender differences.

In terms of middle socioeconomic background students, the only item which does not have significant gender differences is their experience in learning science. As for their expectation of a science-related career ($p < .001$), their view on science ($p < .001$) and the frequency in engaging in scientific activities ($p < .05$), there is significant gender differences. Moreover, girls obvious perform better than boys in all three items.

As to low socioeconomic background students, the only item which does not have significant gender differences is their experience in learning science. Interestingly, all three items have shown that girls perform better than boys.

Table 20: Gender differences in students' attitudes and experience towards science in Finland: taking socio-economic backgrounds into consideration

High socioeconomic background					
	Gender	N	Mean	T value	Sig.
Views on science	Female	409	1.9739	-.578	.564
	Male	389	1.9927		
Expectation of a science-related career	Female	411	2.4945	-.907	.365
	Male	379	2.5383		
Frequency in engaging in scientific activities	Female	416	3.3902	1.268	.205
	Male	397	3.3384		
Experience in learning science	Female	409	2.1391	1.984*	.048
	Male	387	2.0726		
Middle socioeconomic background					

	Gender	N	Mean	T value	Sig.
Views on science	Female	1565	2.1317	-4.003***	.000
	Male	1508	2.1995		
Expectation of a science-related career	Female	1554	2.7142	-3.764***	.000
	Male	1504	2.7990		
Frequency in engaging in scientific activities	Female	1595	3.4562	-2.425*	.015
	Male	1547	3.5036		
Experience in learning science	Female	1549	2.2966	**1.937**	.053
	Male	1507	2.2636		
Low socioeconomic background					
	Gender	N	Mean	T value	Sig.
Views on science	Female	349	2.2312	-2.671**	.008
	Male	363	2.3278		
Expectation of a science-related career	Female	350	2.8422	-2.248*	.025
	Male	358	2.9472		
Frequency in engaging in scientific activities	Female	361	3.5189	-2.778**	.006
	Male	369	3.6242		
Experience in learning science	Female	346	2.4030	**.205**	.838
	Male	360	2.3957		

4-2-5: Overview

When the gender difference exists, it always means that boys score higher than girls except Finland. In Finland, girls from middle and lower socio-economic backgrounds score higher than boys.

Table 21: Gender significances in students' attitudes and experiences in science: taking socio-economic backgrounds into consideration ($p<.05$)

	High socio-economic status				Middle socio-economic status				Low socio-economic status			
	View	Career	Frequency	Learning experience	View	Career	Frequency	Learning experience	View	Career	Frequency	Learning experience
Taiwan	O	O	O	O	O	O	O	O	O	O	O	O
Japan	O	O	O	O	O	O	O	O	O	O	O	O
Korea	O	O	O	O	O	O	O	O	O	O	O	O
Finland	X	X	X	O	O	O	O	X	O	O	O	X

NB: O means there is significant differences in science for boys and girls from different socio-economic background; X means there is no significant difference.

Section 5: Discussion:

5-1 Gender, class and science achievement

Among four countries, the only country shows significant gender differences is Taiwan. When further taking socio-economic factors into consideration, again none of the three other countries (Finland, Japan and S. Korea) shows any gender differences. However, unsurprisingly, the authors notice that there is no significant gender difference for students from high socio-economic background in Taiwan, only students from middle-socio-economic and lower-economic backgrounds show significant gender differences.

5-2 Gender, class and related attitudes and experience in science

Without taking socio-economic background into concern, all four countries show significant gender differences for their related science experiences (students' views on science, the expectation of a science-related career, the frequency in engaging in scientific activities and their experience in learning). While the gender difference exists, it always means boys score higher than girls except Finland. Finish girls score higher than boys in their views of science, the frequency in engaging in scientific activities and their experience in learning science.

Then, again when we take socio-economic background into considerations, we find gender significances exist in Japan, Taiwan and Korea regardless students' socio-economic backgrounds. Moreover, when the gender difference exists, it always means that boys score higher than girls.

Finland has presented a very unique case here. In terms of the views on science, the expectation of a science-related career and the frequency in engaging in scientific activities, there are no significant gender differences for students from high socio-economic background. Finnish males only score higher than females in learning experience. However, for students from middle and lower socio-economic backgrounds, there is no gender significances in their learning experience in science. While their views on science, the expectation of a science-related career and the frequency in engaging in scientific activities do show significant gender differences, females actually score higher than males in all three aspects.

While achievement is less a concern now, we can still see gender still makes significant difference in students' attitudes and experiences towards the subject. More interestingly, the finding in Finland's case has been very surprising. It is suggested that further qualitative and in-depth research should be conducted in order to find out why Finnish girls from middle and low socio-economic background would have more positive attitudes and experiences towards science.

5-4 The PISA 2006 Science Result: does gender significance have any relevance with Gini Index and GEM and GDI?

As mentioned in 1-3, Taiwan is the only country classified as Type Two (strength of the relationship between performance and socio-economic background not statistically significantly different from the OECD average impact) while three other countries are classified as Type Three (strength of the relationship between performance and socio-economic background below the OECD average impact). Also, Finland always ranks first of the overall performance of GDP (PPP) per capital, gini coefficient, GEM, GDI and HDI in these four countries, while South Korea ranked bottoms for the Indexes of GDP (PPP) per capital, GEM, GDI and HDI.

With the above information in mind, when we look at the gender significance in science achievement, we found that the only country which shows gender significance is Taiwan except its high socio-economic group even though its GEM is ahead of Japan and S. Korea and its GDI is ahead of S. Korea.

When comparing the above socio-economic indexes to gender significance of students' attitudes and experiences towards science. Finland is the only country which shows fewer significant gender differences. However, surprisingly, even though it is mostly students from middle and low socio-economic background show more significant gender differences, girls actually have more positive attitudes towards the *views on* science, the expectation of a science-related career and the frequency in engaging in scientific activities .

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