出國報告（出國類別：出席國際會議）

參加亞太科學中心協會(ASPAC) 2013年研討會

服務機關： 國立科學工藝博物館
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派赴國家： 南韓
出國期間： 2013 年 5 月 06 日至 10 日
報告日期： 2013 年 7 月 25 日

摘要

亞太科學中心協會每年舉辦的研討會是各博物館之間重要的交流與互動管道，本次研討會是該協會成立以來第13次的研討會，會議從2013 年5月6 日至5 月10日止，承辦單位爲韓國大田市國立中央科學館(National Science Museum of Korea, Daejeon, Korea)。本館同仁陳玟岑及閻映丞運用國科會補助本館「奈米國家型人才培育計畫」計畫經費與成果，代表計畫團隊研提論文發表。本報告就參加研討會與參訪韓國國立科學博物館兩方面提出心得與建議，重點在於展示手法及趨勢，以之作爲「奈米國家型人才培育計畫」中「奈米展示專區」第二期內容構思與發想的參考。

關鍵詞：科學博物館、科學展示

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壹、計畫目的

亞太科學中心協會(The Asia Pacific Network of Science & Technology Centres，簡稱ASPAC)成立於1997 年，雖名爲「亞太」科學中心協會，但除了亞太地區各國會員外，亦有許多來自北美及歐洲的博物館、科學中心，以及展示設計製作公司參與，因此其實質上也是跨區域的博物館國際組織(參見http://aspacnet.org/ns/)，成立至今已有20多個國家的會員參與。協會成立的目的在於促進亞太地區之科學中心、科學博物館，以及其它相關機構之間的溝通與合作。

其中每年舉辦的研討會提供各博物館及個人會員之間絕佳的交流與互動管道，每年的研討會由各會員機構輪流舉辦。本次研討會是該協會成立以來第13 次的研討會，承辦單位爲南韓大田市國立中央科學館(National Science Museum of Korea, Daejeon, Korea)，會議時間爲2013年5月06日至5月10日。本館同仁陳玟岑及閻映丞運用國科會補助本館「奈米國家型人才培育計畫」計畫經費與成果，代表計畫團隊進行論文發表，本次發表題目爲「**奈米科技知識的轉化—『看不見的尺度』特展**」 (Bringing Nanotechnology to the Public through Special Exhibition: “The Invisible Scale”)及「**科學博物館奈米科普活動促進高中學生科學學習情境興趣之研究**」(Increasing Situational Interests of Senior High Students' Science learning by Informal Nanometer-related Activities at a Science Museum)兩篇文章，論文內容詳如附錄一與附錄二。

本次與會主要目的如下：

一、 以國科會補助計畫之研究成果發表論文。

二、 參與研討及學習活動，增進博物館科普教育推廣與專業知能之交流。

三、 參觀國立中央科學館，吸取相關展示經驗。

貳、參與研討會

一、參與研討會過程

依研討會議程安排，本館人員行程如表一所示。

表一、 本館人員出席會議行程表

日　　期	活動內容
05.06(星期一)	啓程(高雄→韓國大田)及準備日
05.07(星期二)	參加發表論文、分組研討等議程
05.08(星期三)	參加發表論文、分組研討等議程 參觀南韓國立中央科學館
05.09(星期四)	參加發表論文、分組研討等議程 參觀 Expo park
05.10(星期五)	回程(韓國→高雄)

2013 年研討會以「將科學與社會連結(Engaging Society with Science)」爲主要議題，探討科學博物館與科學中心應如何與社會連結，成爲培育大眾了解科學、增進科學知識的搖籃，並依據主議題細分爲四個次議題，分別爲：

1. 非制式科學教育(Informal Science Education)
   將科學知識傳達給一般民眾爲科學中心最重要的使命之一，尤其是未來主導社會的年輕學子們，此議題主要爲分享科學中心如何協助學校進行科學教育。
2. 全球科學議題於科學博物館及科學中心(Global Science Issue and Science Museum & Centers)
   現今許多全球問題如：氣候變遷、傳染性疾病、資源短缺及能源危機，皆期待最新的科學與科技來解決，因此科學及科技在人類的生活中越來越重要，此議題主要爲探討科學中心在現今的全球議題中所扮演的角色。
3. 透過學科整合的創造性方案(Creative Solutions through Convergence of Disciplines)
   當今社會中，許多議題無法由單一專業領域或學科解決，因此需結合多種領域，如科學、藝術及人文學科等，透過多重角度來發想，以獲得解決方案。此議題爲探討科學中心及科學博物館如何整合多種領域，來激發孩子們的創新想法及創造力。
4. 科學博物館及科學中心的永續經營(Sustainable Science Museum & Centers)
   探討科學中心如何在21世紀的科學基礎上，成爲一個連結大眾與科學的重要的機構。

在多類議題中，與會者可根據自己的興趣及想了解的內容，於不同會議廳進行聆聽及討論，各議題主要討論內容如表二。

表二 研討議題與內容

議題	內容
非制式科學教育	學校外的創造力品格教育 以家庭為對象的科學課程 創新的科學、科技、工程、藝術及數學教育 非制式教育資源
全球科學議題於科學博物館及科學中心	與全球議題相關的展示計畫，如氣候變遷、能源短缺等 科學議題的新型態連結計畫 科學中心在變遷中的社會及環境裡所扮演的角色
透過學科整合的創造性方案	整合藝術與科學的展示計畫 整合計畫之成果及未來正確的走向 透過合作進行學科整合 針對學科整合的示範性科學教育計畫
科學博物館及科學中心的永續經營	科學中心為一終身教育機構 科學中心對社會變遷之回應 推廣科學的展示計畫及活動 對於交流的新方法或嘗試

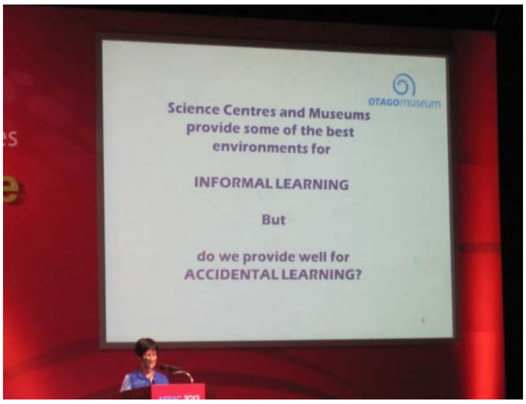
二、心得與建議

本次研討會除了主要議題、會前工作坊及專題演講外，同時有各地科學博物館及科學中心的科學演示，並邀請當地中學生參與觀賞；研討會亦設置展銷空間，開放各地科學博物館、科學中心及展示公司於研討會期間進行推廣及展銷。讓參與者能夠透過展示、科教、蒐藏等不同面象了解各國科學中心。

2013 ASPAC 開幕式演講

(一) 議題分享

本次發表的內容中，有許多與博物館展示設計執行面相關的議題，如國際巡迴展的發展(The Evolving International Traveling Exhibition World)、誰會讀展板圖文(Who Reads Graphics?) 、利用偶發事件促進學習(Learning by Accident)等。其中「利用偶發事件促進學習(Learning by Accident)」，來自Otago 博物館的講者Helen Horner提出，科學博物館提供了優良的非制式學習(Informal Learning)環境，但是否提供良好的偶發學習(Accidental Learning)也是相當重要的一環，Helen Horner認為，透過娛樂性，如頑皮(naughty)、嚇人(scary) 甚至是一點點恐怖(creepy)的展品設計，也許更能激發觀眾的學習興趣。此議題獲得與會人員認同，與會人員也針對如何在娛樂性與教育性間取得平衡進行討論。



專題演講：利用偶發事件促進學習(Learning by Accident) -- Helen Horner

此外，也有與會人員介紹博物館或科學中心是如何與當地發生的社會事件相連結。如日本2011年發生劇烈地震及海嘯，不只造成許多人無家可歸，當地的博物館及藏品皆受到嚴重破壞，因此，為了鼓舞博物館及災難的受害者(尤其是兒童)，日本國立自然科學博物館執行了一個計畫，透過這個計畫，與各地博物館進行合作，幫助修復災區博物館的展品，請學者至災區進行演講，並於災區舉行展覽，由於災區的許多博物館受創甚劇，甚至改由在災區活動中心進行展示。透過這個計畫，不只拯救了受創的展品，並透過展示，將保留各地人文、歷史特色的展品呈現，讓當地民眾能夠再次認識自己生活的地方。經與會人員詢問後得知此一計畫僅由2人企劃執行，其餘皆透過志願者幫助完成計畫，此一計畫利用博物館凝聚日本當地社會的力量，為科學博物館與社會結合的優良範例。

(二) 科學秀觀摩活動

本次研討會中安排了3小時的科學演示，由來自7個國家，10多組單位的同仁分享他們設計的科學秀活動，這些科學秀的主題包含物理、化學、生理學等等，將科學原理以有趣而吸引人的方式介紹給觀眾。透過筆者觀察，演示的特色如下：

1. 展現日常生活的科學原理

在此次活動中，許多組演示團隊不約而同推出與大氣壓力、熱脹冷縮等相關演示，說明了日常生活中相關的科學原理為科學教育的基礎，將日常生活中存在的現象化為有趣的演示能夠讓小朋友更願意親近科學。

科學演示：低溫實驗　　科學演示：情感、動力及真空火箭砲

2. 生動的表演秀

演示中許多部分透過結合聲光效果、生動肢體及有趣的工具材材料，創造出變魔術般的表演秀，如科學演示—魔術秀、水的故事透過音樂及燈光變幻的結合，吸引許多人的目光。但從另一個角度思考，科學演示的核心為透過具娛樂性的演示傳達科學意涵，如何避免著重娛樂性而失去教育意義，並取得娛樂性與教育性的平衡，也是值得探討之部份。

科學演示：魔術秀　　科學演示：水的故事

3. 透過演示傳達正確觀念

菲律賓許多鄉村地方仍有許多人透過巫醫治療疾病，他們聲稱能夠

用巫術開刀，把不好的東西取出。來自菲律賓The Mind Museum的講者現場演示巫醫是如何透過血包、手法及模擬器官的材料，遮蔽大家的眼睛，這種透過演示教導觀眾正確醫療及健康觀念的方式，與本館防疫戰鬥營利用教具教導小朋友正確的防疫觀念相似，充分體現科學博物館在非制式教育上扮演的角色。


科學演示：巫醫

4. 「切身」相關的演示

在眾多利用道具、聲光效果的演示中，其中一位演示者未帶道具，只請現場觀眾跟著做簡單的動作，並講解原理，讓觀眾對自己的身體有更清楚的認識。這種去除道具、效果的表演，讓觀眾能著重在自己及表演者「身上」的模式，能讓每個觀眾皆有參與感，提升觀眾的興趣，值得參考。

科學演示：認識人體

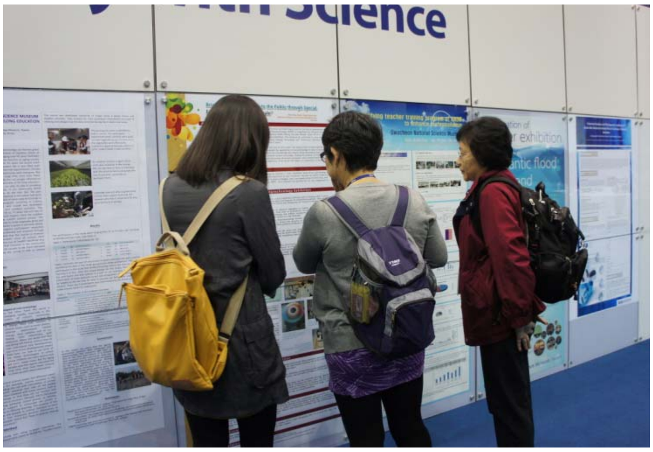
(三) 展示推銷空間

會議期間亦設立展示推銷空間，筆者走訪發現其中不只有展示設計公司參與展出，也有科技媒體公司推銷最新技術及各地博物館推銷教具、巡迴展、館內特色展品等，皆吸引與會者駐足。

會場設置展銷空間

(四) 資訊及意見交流

本館人員參與本次研討會發表奈米計畫成果，亦得到許多回饋，如新加坡的中小學教師對本館執行之奈米人培計劃整合學校教育與博物館教育，將新興科技知識帶給學生持讚許態度，並對奈米動手做實驗及奈米展抱持相當大的興趣。此外，交流中得知泰國國立科學博物正著手籌劃奈米展示，並與其人員交流各國奈米認證制度，期望提供第二年奈米展策劃構想。



與其它國家與會者交流

參、韓國國立中央科學館參訪

本次會議安排在韓國大田市國立中央科學館舉行，本館與會人員於會議空檔參觀該中心，將參訪過程分爲博物館簡介、展覽簡介及心得建議三部份：

一、博物館簡介

國立中央科學館建於 1990 年，該館的建立主題爲「自然與人類和諧發展」。

館內分爲常設展廳、特展廳、科學廳、科學營、天體館、生物館、磁浮列車、戶外展示、創意 Narae 館等，加上 Expo park 內的尖端科技中心及今年開放的宇宙科學公園，將大自然的奧妙到科學技術的原理帶給觀眾。

圖片截取自官網

- 地點：南韓大田廣域市儒城區九城洞 32-2
- 開放時間：
  09:30~17:50 (週一及國定假日休館)
  戶外展示全年開放
- 入館費用

<u>展廳</u>

	Exhibition Halls	Maglev Train	Planetarium	Parking
Adult	₩2000(₩1000)	₩1000	₩1000(₩500)	₩2000 (bus or ban)
Youth (4~19 yrs)	₩1000(₩500)	₩500	₩500(₩200)	₩1000 (car)

<u>創意 Narae 館</u>

場次

	Part 1	Part 2	Part 3
Experience hours	09:30~11:30	13:00~15:00	15:00~17:30
Personnel positions	300 people	300 people	300 people

費用

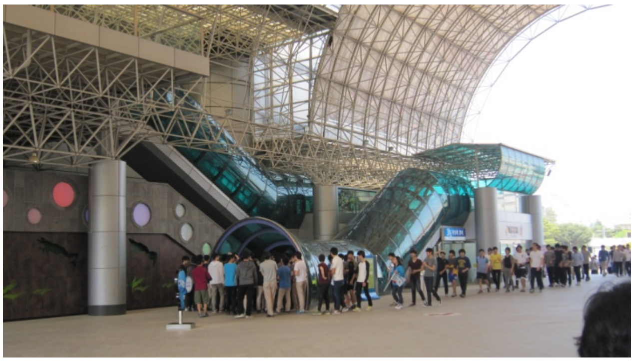
	Adult	Groups (30 or more)	Youth
Interpersonal	₩2,000	₩1,000	Over the age of 20

Postmark	₩1,000	₩500	4 years to 19 years old
Infant	Free (free admission ticket or on-site ticketing sajeonbalgwon required)		Less than 36 months
Paid Membership			Membership present at ticketing

二、展覽簡介

1. 常設展廳

進入常設展廳有兩種方式，建議參觀路線為乘坐電扶梯直達頂層，由三樓開始進行參觀，在電扶梯旁亦設有入口，進入後為展廳 2 樓，在人多時可避免人群壅塞，達到分散作用。



常設廳主要入口（電扶梯）

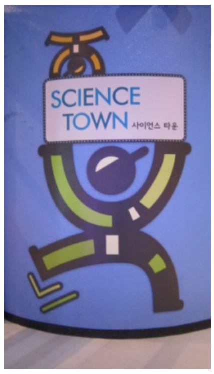
常設廳 2F 入口

常設展廳展示主要分為四大主題，由三樓開始分別為自然史、科學工藝史、基礎科學及工業科技，除了互動展示外，也有許多模型及工藝展品。整個展廳的展示空間為開放式，未針對不同主題設置展廳區隔，展廳一樓至三樓為挑高空間，二樓、三樓之展示圍繞中央挑高空間，並未利用水泥牆區隔展示主題，可以清楚看出各類型展品位置。

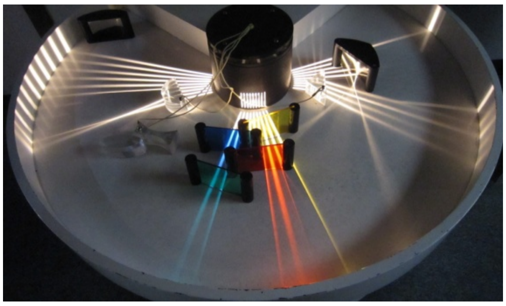
常設展廳中央挑高空間

科學城

由二樓入口進入後，立即被色彩豐富的科學城吸引目光，科學城主要爲科學性大型互動展品， 以色彩豐富的城鎮風貌插圖搭配互動展品呈現科學城主題，內容從離心力、電漿球、發電機到光學原理等等，性質與本館之科學開門相似，透過動手學習基礎科學原理。







科學城互動裝置


離心力體驗設施

能源展示

能源展示區主要利用模型及影片介紹各種能源利用,如水力發電、海浪發電、火力發電及核能發電等，雖可清楚介紹其運轉機制，但缺乏趣味性，較難吸引小朋友駐足。


自然史展示

展廳內除了科學性展示外，尚含括自然史、科學工藝史等主題，可看到如長毛象骨架模型、水族箱、各類礦石、蝴蝶標本，在學習科學的同時，也能同時對身處的大自然有更深入的認識及瞭解。


科學工藝史

展廳內蒐集了許多韓國過去的科學工藝品，其中一區更設立了互動遊戲，可操縱工藝品的模型，與螢幕內的動畫相連結，如轉動石磨模型，即可看見螢幕內的韓國傳統媽媽同時轉動石磨，將米磨成米漿的過程。此種方式相對於僅展示工藝品更能引起觀眾興趣，達到使觀眾認識國家工藝發展的目的。



2. 戶外展示

<u>宇宙公園</u>

於今年5月6日開放的宇宙公園位於常設展廳後方的戶外空間，展出韓國過去研發的火箭 KSR-Ⅰ、Ⅱ、Ⅲ和 KSLV-Ⅰ實物大小的模型，及火箭發射台、火箭研究和實驗整流罩等，使此公園成爲展示韓國火箭發展歷程的地方，並預計再新增研發中的火箭 KSLV-Ⅱ（將於 2021 年進行發射）。

<u>水的展示</u>

位於戶外的大型水展示，設置有阿基米德水車、視覺暫留噴泉還有充滿童趣的鯨魚洗手台等，使中央科學館在炙熱的太陽下多了一些涼意，提供觀眾一個可以在炎炎夏日邊戲水邊了解水的科學的場所。




3. 創意 narae 館

創意 Narae 館是以大型互動展品及體驗設施爲主的收費展廳，1、2 樓爲體驗展覽空間、3 樓爲科教活動場地。

<u>圓形展覽室</u>

擁有 6 層的複式結構，由不同主題構成韓國科學的時間艙，踩著圍繞圓形展覽室的階梯向上，能夠一步步了解韓國科學技術的昨天、今天及未來。

體驗設施

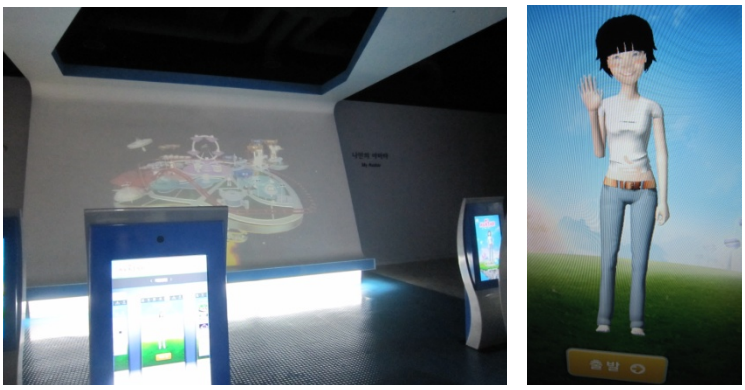
利用簡潔線條及色系營造科技感的體驗展覽館，以充滿娛樂性的體驗設施爲主，科學意涵融入程度較低，內容有電氣展示、黑暗迷宮、4D體驗等設施，爲一創意體驗空間。值得一提的是，其中的大型雲霄飛球體驗設施並非著重於球體滑下過程之呈現，而是在如何將球送上軌道，此設施提供了三種方式：旋轉方向盤、踩腳踏車及夾娃娃機，其中夾娃娃機的方式需要精準移動夾子將撞球夾起並掉進洞口才能將球送上軌道，連現場人員皆難以達成，充份體現會議中來自Otago博物館的講者Helen Horner所提出的利用刁難的手法激發兒童的學習興趣的方式。


雲霄飛球：提供三種方式將撞球送上軌道

四則運算：感應數字進行四則運算，最先完成 100 分的人獲勝

雷射光體驗：聽完介紹後，模仿電影中的神偷，彎曲身體通過層層雷射光關卡

12 公尺感應媒體牆：利用雙手感應操控，可聽音樂、
看影片、玩遊戲，最多能容納 30 人同時操作



阿凡達：拍攝自己的樣子做出虛擬形象，體驗網路空間中的另一個自己

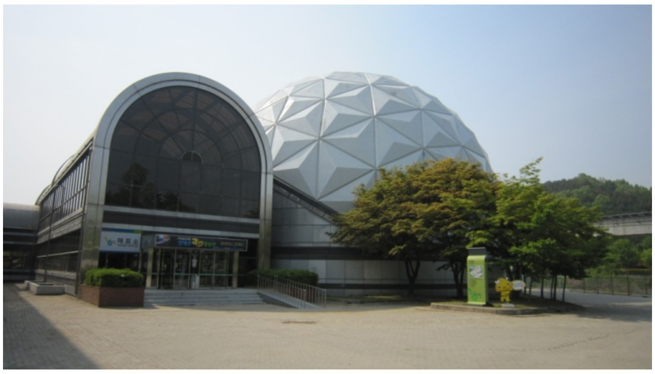
樹林中的科學庭院

隱藏在樹林及燈光造景中的科學教室，可以進行積木體驗及付費科教活動，加上一旁的潺潺流水，讓人彷彿置身於樹林之中。




4. 天體館

擁有吸睛外型的天體館，以 23 公尺圓頂形螢幕播放影片，部份場次由現場人員搭配影像進行即時解說，播放主題以宇宙科學爲主。



5. 磁浮列車

磁浮列車體驗爲收費設施，一天共 7 場來回於國立中央科學館及世博科學公園，搭乘前先透過模型及現場人員解說了解磁浮列車的原理，並在軌道旁的教學室，實際觀察磁浮列車前進後退的移動方式；了解運作原理後，再實際進行搭乘，體驗磁浮列車運轉時的安靜及穩定性。此體驗設施結合了科教、展示與實際體驗活動，比起僅體驗搭乘更能使觀眾對磁浮列車有全面性的了解。

原理解說室

實際觀察列車跟軌道間磁浮狀況

磁浮列車

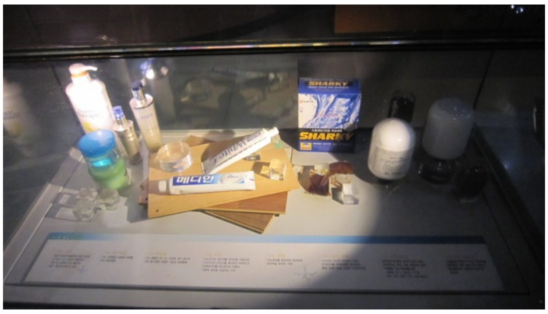
Science Museum Station			Expo Station		
1st	10:00	Max. Passengers 44	1st	10:10	Max. Passengers 44
2nd	11:00		2nd	11:10	
3rd	13:00		3rd	13:10	
4th	14:00		4th	14:10	
5th	15:00		5th	15:10	
6th	16:00		6th	16:10	
7th	17:00		7th	17:10	

Ticket Price Information			
Ticket Price[one-way]	Adult	1,000 KRW(One-way)	Group Discount Not Available
	Youth	500 KRW(One-way)	

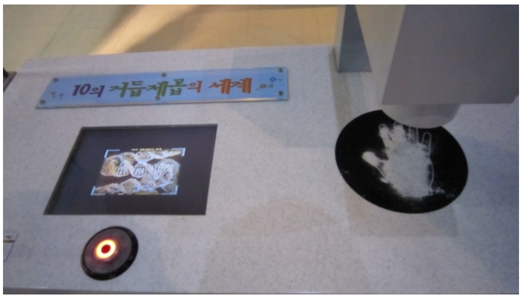
6. 奈米相關展品

爲了進行第二年度奈米展示規劃，筆者亦專注搜尋奈米相關展品的蹤跡。中央科學館常設展廳內設置了一個奈米科技的小型展示區塊，多以展示奈米產品、播放專業影片及展示說明文字爲主，佐以 2 座互動展品。介紹內容有奈米產品、奈米塗料、奈米纖維、奈米醫療及尺度的概念

抽取式奈米說明文字板　　奈米科技介紹影片



奈米相關產品展示



奈米醫療介紹

互動展品：手放至顯微鏡下啟動裝置，可看到皮膚放大到DNA的影像。

三、心得與建議

<u>展品解說少有雙語標示，實屬可惜</u>

在此次參觀博物館中發現，幾乎所有展板僅使用單一語言—韓文，並無設置英文說明，導致許多操作方式及原理只能靠猜測，無法深入了解展示內容，實屬可惜。

<u>運用豐富色彩，使展示更加生動</u>

無論是常設展廳或戶外展示皆大量運用豐富的色彩、插畫來營造氛圍，藉此吸引小朋友的目光，也替冷冰冰的科學添加了溫度，使科學更加平易近人。

服務人員態度親切、衣著合宜

在創意 Narae 館及磁浮列車體驗設施都有工作人員在現場進行解說及演示，工作人員皆身著襯衫、西裝背心或西裝外套。其中負責創意 Narae 館泰斯拉線圈（人造閃電）單元演示的工作人員甚至身著裝飾滿亮片的銀色燕尾服進行演示，不只吸睛也令人體會到服務人員的用心。

肆、附錄：發表論文

附錄一、奈米科技知識的轉化—『看不見的尺度』特展

Bringing Nanotechnology to the Public through special Exhibition: "The Invisible Scale"

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Abstract

Many countries focus on nano research and education since R. P. Feynman provided inspiration for the field of nanotechnology in a breakthrough talk in 1959. In Taiwan, National Program of Nanotechnology (NPNT) is supported by National Science Council (NSC) from 2003, and makes valuable contributions in various fields during the past decade. From 2012 to 2015, National Science and Technology Museum (NSTM) will develop a nano exhibition. The theme of the exhibition in every year will be the following highlights of research which includes Biomedicine, Energy Technology and Traditional Industry; and a completely exhibition including the three themes will open after these 3 years.

The exhibition was named "The Invisible Scale", which shows the tiny size of nano scale. The theme of the 1st year exhibition is Biomedicine; we use video and mechanical exhibits to introduce people the application of nanotechnology in cancer treatment. Besides, visitors can operate some interesting hands-on exhibits to learn knowledge and observe some phenomena about nano. Through this interactive exhibition, we hope to spark people's interest in new technology. During the process of transforming nano knowledge to an exhibition, we found that combination and connection of science education, nano research and daily life is the most important work in the process of developing this exhibition. This article will share our experience of developing exhibit in NSTM.

Keywords: Nanotechnology, science museum

I. Foreword

National Science and Technology Museum (NSTM) was appointed to develop a "nano exhibition" from 2012, and develop a completely exhibition in three years. The process of developing this exhibition is very complicate, because we need to make an effort on combining and transforming many resources. We need to make strategies, topic and construction of every year, and also need to combine the achievements of other subprogram in NPNT. This research will provide the 1st year experience of planning the special exhibition: “The Invisible Scale”.

II. Learning in science museum

Exhibits in science museum are very different from teaching materials in school. In the process of designing exhibits, we need to think: what do audience and children need? How to make an attractive and systemic exhibition? How to present scientific content? Basically, children operate the scientific exhibits because it’s fun and interactive, so they are willing to learn the principles from the exhibits. If the process of learning is pleasant, they will want to get more.

American educator J. Dewey had been referring a concept that learning is through “discovery” and “exploration”, and Bruner further advocate the “discovery learning”. Learning takes place in the same context in which it is applied (Lave and Wenger, 1991). During the learning, if we can put students in the specific situated context, then we can spark students’ interesting in science.

III. Develop the Construction of Nanotechnology Exhibition

1. Two Challenges

It’s a three years program that an exhibition will set up every year, and a completed exhibition will be finished after 3 years. Therefore, we separate the applications of nanotechnology into three parts and expand the exhibitions gradually. Base on this strategy, we have two challenges: combination of the nano research in Taiwan and displaying the concept of nanoscale.

Challenge 1: Create unique characteristics

From the applications of nanotechnology, we choose three types of research highlights in Taiwan, Biomedicine, Energy Technology and Traditional Industry, to be the theme of each year. First year, in biomedicine, we want to display the nano applications in cancer research such as nanoscissor, infrared therapy and Fe@Au nanoparticles. The researches are complicated and still in lab, so how to make it clear and acceptable for visitors is a big challenge.

Another Taiwanese feature of nanotechnology is nanoMark. Since Naonotechnology became one of the most important technologies in 21th century, many nanoproducts appear as well. To protect the interests of consumers and promote the upgrading nano industry in Taiwan, the government is promoting the "Nano-product certification system plan".

Challenge 2: Display the concept of the invisible scale

Many people are confused at the term "nanometer". It's a length scale like meter and millimeter, not an object. Because nanometer is an invisible scale for naked eyes, people cannot understand the world under the nano scale. For this reason, we need to transform the concept of nanometer into concrete exhibits, like amplifying objects to mimic or display the nature phenomenon in nanoscale**.**

2. Exhibition Planning

This exhibition focuses on phenomenon and applications of nanometer but just introduces nano research. In first year, the basic construction of the exhibition was done. We briefly introduce history of nanotechnology, nano phenomenon, nano materials, measurement tools, and nano research of biomedicine and the first nanoMark of the world. In second year, we plan to put nano research of energy technology which is in accordance with tends of energy conservation around the world. At third year, we'll focus on nano research of traditional industry to show the importance of nanotechnology in daily life.

Outline of exhibition	**Detail**
A. Introduction	A1. History of nanotechnology
	A2. Feynman's literature
B. Nature phenomenon of nano	B1. Iridescent effect
	B2. Lotus effect
	B3. Nano GPS
C. Science under nanometer	C1. Properties of nano materials
	C2. Tools for observation
	C3. Nano in biology
D. The near future	D1. Cancer treatment
E. nanoMark	E1. Significance of nanoMark
	E2. Beware of the fake nano
	E3. The concerns of nanotechnology

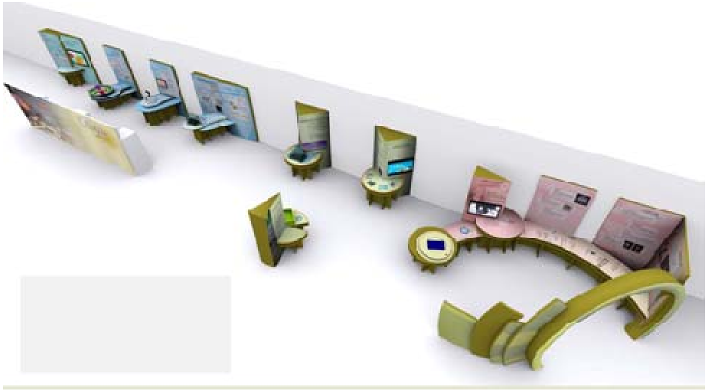

Figure 1. There are 5 sections in this exhibition

Figure 2. The photo of the exhibition.

The major visual image of the exhibition is from the circular form of microscope eyepiece and adjustment knob. In the central of visual image, the exhibition name with perspective arrangement shows that the exhibition can bring people into the “microcosmic world”.

Figure 3. The major visual image.

In this exhibition, people can observe the nano phenomenon, recur the classic experiment, and simulate the science principles through the interactive exhibits**.**

1. Observation of nano phenomenon- some sections emphasizes observations of natural phenomenon**.**

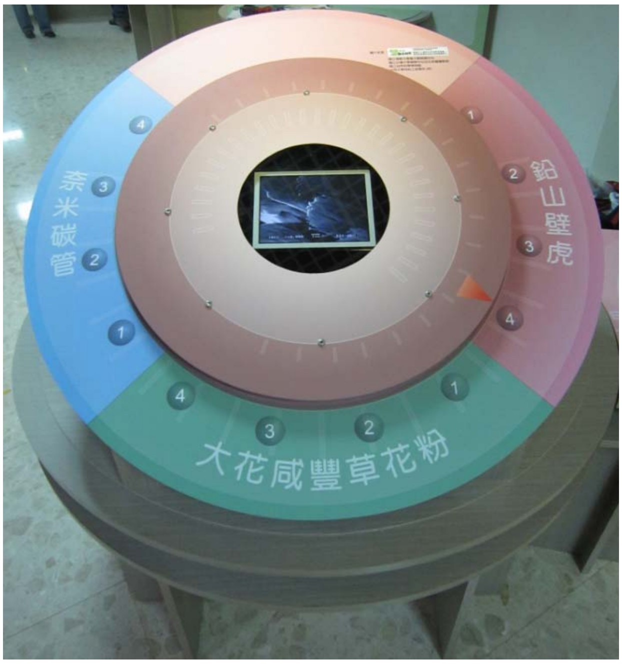

Figure 4. Look closer: observe the images of organisms and materials from naked eyes to micro and nano scale.

2. Recurring of classic experiment- In 1990, researchers in IBM used the scanning tunneling microscope (STM) to arrange 35 atoms on nickel surface forming the word IBM. To simulate this experiment, we develop an “atom manipulate” hands-on exhibit, that people can experience the experiment by playing the exhibit. Also, we prepare an atomic force microscope (AFM) simulation system to show the process and principle of AFM.

Figure 5. Atomic manipulation: arrange the balls (atoms) within limited time, and experience the process of arranging atoms by STM.

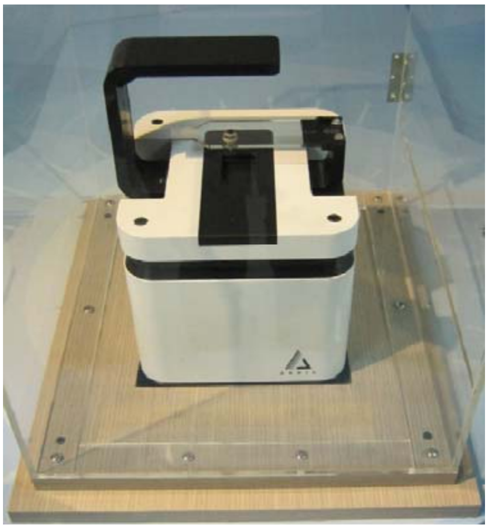

Figure 6. AFM Stimulator: show the manipulative process and principle of AFM (This instrument was provided by Ardic Instruments: http://www.ardic.com.tw/)

3. Animation and simulation of science principle- We use dynamic models and animations to display the principles of nanoscissor, infrared therapy and Fe@Au nanoparticle. The cancer researches are from Pro. Dar Bin Shieh's group in National Cheng Kung University. Besides, "The nano detection tool in human body-antibody", which use jigsaw puzzle mode, shows the specific binding of antibody and antigen.

IV. Education of nanoscience in exhibition

1. Integrated Science Education is critical

Students rarely have opportunities to satisfy their curiosity in today's science classrooms. Some important issue today, such as climate change and nanotechnology, cannot just cover by one discipline. For this reason, museum, one of the informal science education, can integrate multiple disciplines to help students to realize these topics.

2. Nanotechnology in Daily Life

Nano is so tiny; so many people do not know what it can do in our daily life. Therefore, we also focus on the applications of nano in this exhibition. The most important part of technology is creative invention, and education provides a creative way to learn technology.

3. Learning through operation

The science skills, concepts, knowledge and creativities which students need can be cultivated through operation and discussion (Shing Ho Chiang and Vincent Tang, 1999; Shyan Jer Lee, 2001). Students can learn about the processes and knowledge related to technology in science museum (ITEA, 2000). The exhibits in museum are in keeping with the essence of technology education, so learning through operating exhibits is considered a feasible strategy to realize technology. Visitors can get knowledge from hands-on exhibits, which is not only just by watching but also doing themselves.

V. Conculsion

During the process of transforming nano knowledge to an exhibition, we found that combination and connection of science education, nano research and daily life is the most important work in the process of developing this exhibition. In additions, the interactive exhibits which combine observation and realization are useful in exploration of nano world. The 1st year exhibition will display at NSTM on April, 2013. The interaction between visitors and interactive exhibits, and the understanding of nanotechnology from visitors are the next project we want to do.

VI. Acknowledgement

This work was supported by the National Science Council, Taiwan, R.O.C under the grants NSC 101-2120-S-359 -001. The authors wish to thanks the members under these projects for their support.

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附錄二、「科學博物館奈米科普活動促進高中學生科學學習情境興趣之研究」

Increasing Situational Interests of Senior High Students' Science learning by Informal Nanometer-related Activities at a Science Museum

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Taiwan

Abstract

The interest of a student plays a vital role in science learning. As students progress through schools, their interest in science appears to decline and a parallel trend has been observed with students' performance on science standardized exams. Nanotechnology is emerging a scientific field that contain concepts and phenomena that are not usually addressed significantly in traditional science curricula, but in which students might be interested. And through informal nanotechnology related activities might increase students' science learning interests. Thus, this study investigates the relationship between senior high schools students' interest and teaching in informal nanometer-related activities including nanotechnology introduction, nano-umbrella making, nanogold particle experiment, photo catalyst and AFM demonstration etc held by National Science and Technology Museum (NSTM) in Taiwan in 2012. A questionnaire of 102 students was administered to collect data of student's situational interest. Data were analyzed with paired sample t-test and ANCOVA. The preliminary results showed that after the informal nanometer-related activities, the senior high school students' situational interest increased（t=6.175***, d＝.68）, included triggered situational interest（t=7.574***, d＝.53）, maintained situational interest-feeling（t=4.186***, d＝.89） and maintained situational interest-value（t=3.548***, d＝.35）, especially for low-level interest group students（t=7.29***, d＝1.87）and female students（t=6.30***, d＝.78）. The results also showed that after the informal nanometer-related activities, the senior high school students' nanotechnology concepts increased significantly.（M_{pre}=49.8, M_{post}=74.65, t=14.79***, d＝1.57）, in different levels interest group and in different genders. The source of situational interest analysis found diverse activities may mediate students producing the differential senses of value, novelty, instant enjoyment, achievement, challenge, and exploration to enhance differential student's situational interest. The findings suggest that to increase situational interest of senior high school students, science museums and schools are encouraged to work together by offering differential teaching activities for different levels interest students by producing the differential

senses.

Keywords: informal learning, nanometer related activity, situational interest

Background

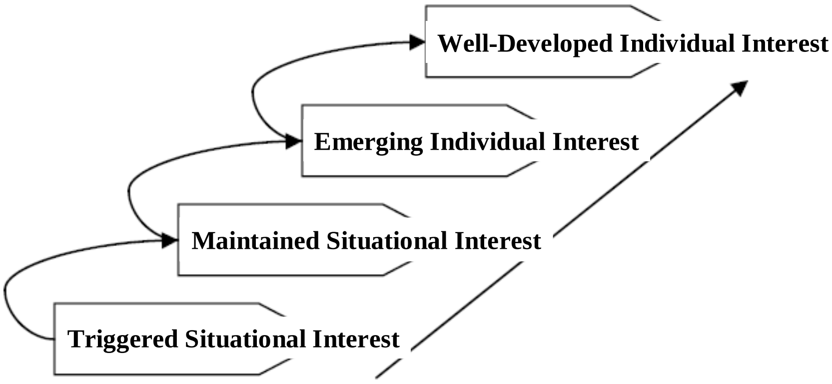
Nanotechnology is an emerging application science and technology nowadays. Many nanotechnology products have been used in our living life. To enable K-12 students to face “the society of nanotechnology”, it is essential to enable each student owns the literacy of nanotechnology.. Nanotechnology is an inter-discipline, and brand-new scientific knowledge in K-12 school science curricula, therefore we have some difficulty for students to learn nanotechnology, i.e. the very small dimensions of nanoscale structures are difficult for K-12 students to comprehend and the instrumentation required to manufacture or detect nanoscale structures are far more sophisticated than instruments commonly utilized in K-12 programs (Roco, M. C., 2008; Bryan, L.A., Daly, S., Hutchinson, K., Sederberg, D., Benaissa, F., & Giordano, N.,2007).

Interest plays an important role in learning. Learning interest means individual engages the work of learning, which is produced by one’s enjoyment or the interaction between the individual and environment. It produced a kind of positive physiological mental state and motive individual further to learn. Interest theorists typically differentiate between two main kinds of interest: individual interest and situational interest. Individual interest has a dispositional quality, residing in the person across situations. In contrast, situational interest emerges in response to features in the environment. Students come into the learning environment with different individual interests, it is difficult for teachers to impact individual interest directly, teacher can control and manipulate the environment to trigger situational interest (Hidi & Anderson 1992; Hidi, 2001). We hoped students can enhance situational interest and nanotechnology concepts, then inducing highly learning engagement for nanotechnology in nanoscience camp.

Research Questions

1. Could the informal nanometer-related activities curriculum enhance senior high students' learning situational interest in nanoscience camp?
2. Could the informal nanometer-related activities curriculum enhance senior high students' nanotechnology concepts in nanoscience camp?
3. How to enhance senior high students' learning interest in nanoscience camp by different kinds of teaching strategies?

Rationale



The Four-Phase Model of Interest Development

(Hidi & Renninger, 2006)

Method

We adopted a questionnaire of situational interest by Lisa L.G., Amanda M. D. & AnneMarie M. C. (2010). The questionnaire of nanotechnology concepts was made by K-12 nanotechnology seed teachers. Two questionnaires of 102 students was administered to collect data of senior high school student's situational interest and nanotechnology concepts. Data were analyzed with paired sample t-test and ANCOVA. We also adopted semi-structured interviews and content analysis to investigate how to enhance senior high students' learning interest in nanoscience camp by different kinds of teaching strategies

Result

1. The informal nanometer-related activities curriculum could enhance senior high students' learning interest in nanoscience camp, especially for triggered SI and maintained SI-feeling, but maintained SI-value were hard to enhanced.

Table 1. The change of interests of senior high students' science learning by informal nanometer-related activities at a science museum

		Mean	**Difference**	**SD**	***t***	***Sig***	***d***
Individual interest	Pre-test	33.65	0.76	4.54	1.763	.081	0.17
	Post-test	34.41					
Situational interest	Pre-test	47.97	3.79	9.25	4.212	.000***	0.40
	Post-test	51.76					

****p* $<$ *.001*

Table 2. The change of situational interest of senior high students' science learning by informal nanometer-related activities at a science museum

		Mean	Difference	*SD*	*t*	*Sig*	*d*
Triggered SI	**Pre-test**	15.7					
	Post-test	17.0	1.3	3.93	3.442	.001**	0.33
Maintained SI-feeling	**Pre-test**	15.7					
	Post-test	17.3	1.6	4.07	4.312	.000***	0.41
Maintained SI-value	**Pre-test**	16.7					
	Post-test	17.4	0.7	3.23	2.404	.018*	0.23

****p* $<$.001*

2. The informal nanometer-related activities curriculum could enhance senior high students' nanotechnology concepts in nanoscience camp.

Table 3. The change of nanotechnology concepts of senior high students' science learning by informal nanometer-related activities at a science museum

		Mean	Difference	*SD*	*t*	*Sig*	*d*
Nanotechnology concepts	**Pre-test**	49.8					
	Post-test	74.65	24.85	16.89	14.79	.000***	1.5

****p* $<$.001*

3. Diverse teaching activities may mediate students producing the differential senses of value, novelty, instant enjoyment, achievement, challenge, and exploration to enhance differential student’s situational interest.

Suggestion

1. In School, it’s difficult to adequately teach the different developed interest of students for teacher, especially more developed and little or no interest of students. Schools and informal educational institution such as museums should corporately develop some scientific activities into the classroom to enhance students’ interest of science learning.
2. Productive participation in informal scientific learning should enable help“ low achievement and low interest “ students enhance situational interest by novel, vivid, involvement and meaningfulness, therefore these students could want to

reengage in science learning

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