行政院國家科學委員會專題研究計畫 期末報告

「科技酷少女」專題式學習：以女性角色電子故事提升對科學態度之研究

計 畫 主 持 人 ： 計惠卿

計畫參與人員 ： 碩士班研究生-兼任助理人員：王心柔
　　　　　　　　碩士班研究生-兼任助理人員：陳宜萍
　　　　　　　　碩士班研究生-兼任助理人員：李依評

報 告 附 件 ： 出席國際會議研究心得報告及發表論文

中 華 民 國 101 年 11 月 19 日

中文摘要： 自然與生活科技的課文內容經常以敘述文體來表述，對於相當比例的國小學童而言，具有閱讀理解的難度，改以圖案來解釋科學概念或原理的故事文體，則能促進國小學童的理解度。本研究嘗試探討國小學童是否在進行「以漫畫來重述國外的或在地的科技發明故事」活動後，男女學童的科學態度會有顯著的改變？實驗組及控制組各有國小五年級之12位男學童及12位女學童，在排除先備科學知識後的共變數分析結果顯示：國外故事組與在地故事組的科技職業態度具有顯著差異、但是男學童與女學童之間則無顯著差異。後續進行類似重述科技故事之實施建議是研究結論的主軸。

中文關鍵詞： 科學態度、數位故事、科學家、科技發明家

英文摘要： Facing the fact that science textbook describes content of scientific and technological inventions in exposition mode mostly, so that elementary pupils are difficult to comprehend. Story with a series of drawings to represent abstract scientific concepts can enhance learning, especially for elementary students. This study was carried out with an objective to discover whether females and males students significantly varied in their attitude after retelling local and global e-stories of science fair and inventions via comic. The study included twenty-four subjects comprising equal number of male and females of 10-11 years of age from a public school in a rural community. An analysis of covariance was used to correct for initial differences of prerequisite scores and attitudes towards science activities among treatment groups. While significant difference of Image of Scientists' Job ($p < 0.05$) exists in local vs. global stories, no significant differences were observed between attitude of male and female participants. Practical implications and recommendations for future research on e-story approach are identified.

英文關鍵詞： attitute toward science； e-Story； scientist and inventors

Elementary Pupils' Attitude Toward e-Stories of Scientist and Inventors

Paper presented at the 2012 IEEE International Symposium on IT in Medicine & Education (ITME 2012), Hokkaido, Japan

Hueyching Janice Jih
Graduate Institute of eLearning Technology
National Hsinchu University of Education
Hsinchu City, Taiwan
jih@mail.nhcue.edu.tw

Abstract

Facing the fact that science textbook describes content of scientific and technological inventions in exposition mode mostly, so that elementary pupils are difficult to comprehend. Story with a series of drawings to represent abstract scientific concepts can enhance learning, especially for elementary students. This study was carried out with an objective to discover whether females and males students significantly varied in their attitude after retelling local and global e-stories of science fair and inventions via comic. The study included twenty-four subjects comprising equal number of male and females of 10-11 years of age from a public school in a rural community. An analysis of covariance was used to correct for initial differences of prerequisite scores and attitudes towards science activities among treatment groups. While significant difference of Image of Scientists' Job ($p < 0.05$) exists in local vs. global stories, no significant differences were observed between attitude of male and female participants. Practical implications and recommendations for future research on e-story approach are identified.

Keywords: attitude toward science; e-Story; scientist and inventors

I. INTRODUCTION

Pupils' interest and attitude towards sciences is considered to be a significant motivational factor of their learning results in science, respectively of pursuing a career in areas related to science as well as technology. Hence, to encourage students' attitude towards science and technology has been a major concerns of educators [1]. Pupils tend to perceive a big gap between their limited capabilities and the scientists that list in the textbooks. The origin of these negative attitudes comes from the neglect of exploration, understanding and reflection in science classrooms. Teachers and textbooks always present a collection of final formats of concepts and rules, instead of the circumstances, processes, and impact of facts and rules finding. As a result, the memorizing tasks are laborious, boring and inefficient. If a teacher can't reach pupils, he/she can't teach them. Pupils will forget these concepts and rules shortly afterwards [2].

With the advent of the new K9 Curriculum, the opportunities for pupils to contact with stories of scientific finds and technology innovations has received new attention in Taiwan recently. However, unless teachers feel that textbooks and learning materials are equipped well to support storytelling activities, then the activity of classroom storytelling will remain the preserve of an experienced storyteller instead of its being regarded as a regular teaching approach in an elementary science classroom. The connections between learners' script memory and contextual learning materials have a positive impact on meaningful learning. Stories convey basic ingredients of creativity and innovation such as science histories, technology innovation events, creative and critical thinking processes, and problem solving

results. Therefore, histories of scientific findings as well as technology innovations would benefit science education especially for elementary pupils. There is an urgent need for better learning resources that empower a deeper comprehension of science via imaginative engagement.

Story is a pedagogical tool that enables learners to make meaning individually and make deeper connections with subject matter content. Our mind seems tuned to capture stories that follow a natural way for our episodic memory. Not only do stories provide insights into how individuals perceive and interpret their environment, they communicate valuable ideas, insights and lessons to others. Researchers have stated that stories are ideal way to connect the gap between learners and the content of science as well as technology. According to Reason and Hawkins [3], story can be used 'either to explain or to express; to analyze or to understand' (p.79). Fulford [4] observes that stories 'are the juncture where facts and feelings meet' (p. 9).

By meaningfully integrating storytelling into the curriculum and infusing the storytelling with digital media, teachers can augment their own pedagogical and professional development [5]. Story is helpful for pupils with fact memorizing difficulty, because stories scaffold learners to access their analytical capabilities and reveal gaps in their knowledge construct [6]. Hence, e-stories expand and diversify content within various curricula [7].

A picture is worth a thousand words. Invention ideas and associated principles can be conveyed with just an image. We all can image that stories have a mysterious power which can lead us into the world created by words. Story mode can support reading comprehension as well as can generate motivation by making links between story episodes and personal experiences. Digital story could serve as a fun and engaging activity for pupils to strengthen basic as well as visual literacy, to build knowledge and skills via mastering a paragraph and using inductive reasoning, and most important to incubate curiosity as well as creativity.

II. THIS RESEARCH

Digital story is an authentic, digital-age pedagogical approach for diverse learners [8]. A topic-related story could serve as an emotional hook on the critical steps of reach and reflect. Demonstration digital stories in classrooms that integrate text, pictures, and animations may initially capture pupils' attention and promote better student involvement [9]. Both local and global aspects e-stories were design and developed by the researcher and research assistants. Each story is made up of many elements including a plot, setting, characters, the basic circumstances, conflict, resolution, and climax (or high point) [10]. The local version consists of stories of young scientists and inventors at Taiwan (*Fig. 1 & 2*). The global version tells invention stories of zipper and food can (*Fig. 3*). Both e-stories are delivered via 'Story eBook' Blog (http://storyebook.blogspot.tw/).

The prototypes of these e-stories were reviewed by two science educators as well as three e-learning designers. Revisions have done according to suggestions on text message as well as illustration graphics.

Figure 1. Sample Screen Sanpshot of Young Inventors' Work

Figure 2. Sample Screen Sanpshot of Young Scientists' Work

The following hypotheses were set.

H1: There is no significant difference in student attitude between the groups when their prerequisite science exam scores as covariate were controlled.

H2: There is no significant difference in student attitude between the groups when their attitudes towards science activities as covariate were controlled.

A pretest-posttest comparison group design was adopted for the study. The control group consisted of participants retelling stories of global inventions. Meanwhile, the experimental group participants retell stories of local scientists and inventors.

Figure 3. Sample Screen Sanpshot of Zipper Invention

This study was conducted at a suburban elementary school of northern Taiwan. Twenty-four fifth graders interacted with the e-story independently and fulfill two online questionnaires on a scale with five degrees of intensity: 5-totally agree, 4-partially agree, 3-no comment, 2-partially disagree and 1-totally disagree. A pre-test questionnaire consists 20 question items to ask attitude toward science activities in classroom and in daily lives. A post-test questionnaire asked 10 question items regarding Image of Scientists' Appearance (i-Appearance), Image of Scientists' Characteristics (i-Characteristics), Image of Scientists' Jobs (i-Job) and Tendency of Science Careers (i-Tendency) respectively.

III. FINDINGS AND DISCUSSIONS

When examining descriptive data (Table 1), it was noticed that image of scientists' appearance has larger standard deviation (10.04) than other three attitude measures. A large standard deviation indicates that the data points are distant from the mean.

A one-way of analysis of covariance (ANCOVA) was applied to test hypotheses. The previous science score and attitude towards science activities were set as the covariates. Alpha level of .05 was used for all statistical tests.

The ANCOVA results indicated a significant main effect (F=5.235, p<.05) between the groups on the Image of Scientists' Jobs scores, with the last science exam scores as the covariate (Table 2). However, the result of ANCOVA showed no difference between the female and male groups. Thus the null hypothesis which stated that there is no significant difference in student attitude between the groups when their prerequisite science exam scores as covariate were controlled was rejected. The null hypothesis that no significant difference exits in student attitude between the groups with covariate of attitudes towards science activities was not rejected and should be adopted. Contrary to expectations, this study did not find a significant difference between female and male participants' attitude. A possible explanation for this might be that only two e-stories are not enough to make significant attitude changes.

It is interesting to note that the global version story group demonstrated higher scores than the local version story group. There are several possible explanations for this result. First of all, almost every learning resource of scientist and inventions focus on global characters from western countries. The second possible explanation for this might be that only two e-stories of local young scientists and inventors are not enough to make significant attitude changes. Another possible explanation is the different popularity of products in these stories. Participants are familiar with zipper and food can for years. The products of local young scientists and inventors are brand new to participants of this study.

Past studies on pupils' attitude towards studying sciences and technologies have shown the fact that students do acknowledge the importance of sciences for life and career but have also pointed out a significant decline in their interest in studying relevant subjects [11, 12, 13].

This research result signals that retelling stories of inventors or scientists via comic strategy is a promising teaching method for both female and male students. Therefore, more e-stories of inventors and scientist should be developed and implemented in primary education. Further research is needed to determine how story structured, how illustration constructed, how learning activity designed is associated with academic performance, and also to examine how teachers use the e-story and how this usage could be strengthened for science as well as other domains.

TABLE I. DESCRIPTIVE STATISTICS FOR ATTITUDE SCORES

Aspects	Attitude Scores			
	Group	Mean	Standard deviation	N
Science Image	Local Story	28.67	7.41	12
	Global Story	28.42	12.49	12
	Male	28.75	8.21	12
	Female	28.33	11.97	12
	Sum	28.54	10.04	24
Scientists' Characteristics	Local Story	43.83	7.76	12
	Global Story	47.83	4.63	12
	Male	43.58	8.08	12
	Female	48.08	3.73	12
	Sum	45.83	6.57	24
Scientists' Jobs	Local Story	39.33	6.11	12
	Global Story	44.42	4.68	12
	Male	41.58	6.95	12
	Female	42.17	4.99	12
	Sum	41.88	5.92	24
Tendency of Science Careers	Local Story	38.58	6.46	12
	Global Story	42.92	5.05	12
	Male	40.83	7.00	12
	Female	40.67	5.33	12
	Sum	40.75	6.09	24

TABLE II. ANCOVA OF ATTITUDE WITH SCIENCE COVARIATE

Source of variation	Sum of Square	Mean Square	df	F (p-value)
Covariate (Science)	i-Appearance	19551.042	1	19551.042
	i-Characteristics	50416.667	1	50416.667
	i-Job	42084.375	1	42084.375
	i-Tendency	39853.500	1	39853.500
Main effect (Story version)	i-Appearance	.375	1	.004 (.953)
	i-Characteristics	96.000	1	2.354(.139)
	i-Job	155.042	1	5.235(.032)[a]
	i-Tendency	112.667	1	3.350(.081)
Model	i-Appearance	.375	1	.375
	i-Characteristics	96.000	1	96.000
	i-Job	155.042	1	155.042
	i-Tendency	112.667	1	112.667
Residual (error)	i-Appearance	2319.583	22	
	i-Characteristics	897.333	22	
	i-Job	651.583	22	
	i-Tendency	739.833	22	
Total	i-Appearance	21871.000	24	
	i-Characteristics	51410.000	24	
	i-Job	42891.000	24	
	i-Tendency	40706.000	24	

a. significant at p<.05 alpha level

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行政院國家科學委員會補助國內專家學者出席國際學術會議報告

101 年 09 月 03 日

報告人姓名	計惠卿	服務機構及職稱	國立新竹教育大學副教授
會議 時間 地點	2012 年 8 月 3 日至 5 日 日本北海道札幌市	本會核定補助文號	NSC100-2629-S-134-001
會議名稱	(中文)國際資訊科技在醫學及教育研討會 (英文)IEEE International Symposium on IT in Medicine and Education (ITME 2012)		
發表論文題目	(中文) 國小學童對於科學家及科技發明家數位故事之態度影響研究 (英文) Elementary Pupils' Attitude Toward e-Stories of Scientist and Inventors		

報告內容應包括下列各項：

一、參加會議經過

　　研究者首先將國科會研究計畫(NSC100-2629-S-134-001)的發現成果，依照（Institute of Electrical and Electronics Engineers）會議徵稿格式，編寫成學術論文且投稿至 ITME 2012 大會網站。後於收到 ITME 2012 錄取通知後，依照審查意見修改定稿、上傳至 IEEE 全球資料庫內，並完成 ITME 會議報名的細部規定；最後於 2012 年 8 月 3 日抵達日本 Hokkaido，參加 ITME 2012 會議、且應邀於大會中擔任「Parallel Session C 的 Session Chair」。

　　本屆 International Symposium on IT in Medicine and Education 會議共有三場口頭發表場次(Parallel Session)、32 篇論文獲得口頭發表機會，研究者的「Elementary Pupils' Attitude Toward e-Stories of Scientist and Inventors」排在 Session C；此外，還有 225 篇的海報論文（Poster Session），會議內容相當豐富，與會者主要來自亞洲及澳洲各國，亦有來自歐洲及美洲的的學者。

二、與會心得

　　本屆 ITME 國際資訊科技在醫學及教育研討會的發表論文所探討的研究題材相當廣泛，從尖端資訊科技的教學應用(如，動態立體視覺訊息處理、虛擬實境於技術培訓、雲端科技的安全議題等)到資訊科技應用的基礎議題(如，資訊素養的內涵、市民運動的資訊支援系統等)均有，從研究題材亦可管窺各國/地區的資訊科技應用之發展現況，收穫良多。

三、考察參觀活動(無是項活動者省略)　(無)。

四、建議
積極鼓勵我國學者參與各類型的國際學術會議，讓我國的名聲能在學術界多多發聲。

五、攜回資料名稱及內容
International Symposium on IT in Medicine and Education 2012 會議議程及光碟。

六、其他

表 Y04

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International Symposium on IT in Medicine and Education 2012 會議議程及光碟。

六、其他

國科會補助計畫衍生研發成果推廣資料表

國科會補助計畫	計畫名稱: 「科技酷少女」專題式學習：以女性角色電子故事提升對科學態度之研究
	計畫主持人: 計惠卿
	計畫編號: 100-2629-S-134-001-　　　　　學門領域: 性別與科技研究

無研發成果推廣資料

100 年度專題研究計畫研究成果彙整表

計畫主持人：計惠卿　　　　　計畫編號：100-2629-S-134-001-

計畫名稱：「科技酷少女」專題式學習：以女性角色電子故事提升對科學態度之研究

成果項目			量化			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）
			實際已達成數（被接受或已發表）	預期總達成數(含實際已達成數)	本計畫實際貢獻百分比		
國內	論文著作	期刊論文	0	0	0%	篇	
		研究報告/技術報告	0	0	0%		
		研討會論文	0	0	0%		
		專書	0	0	0%		
	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	3	2	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	1	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（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，請以文字敘述填列。)	本計畫推廣至苗栗一國小，獲得教育部 101 年「資訊科技融入教學創新應用典範團隊」全國優等獎。

	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)	1	科技發明態度量表
	課程/模組	1	漫畫重述故事
	電腦及網路系統或工具	0	
	教材	1	科技發明數位故事
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	1	故 事 看 天 下 (http://storyebook.blogspot.tw/)
	計畫成果推廣之參與（閱聽）人數	3100	故事看天下閱覽人數

國科會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） 本研究成果已發表於日本北海道札幌舉行之「IEEE International Symposium on IT in Medicine & Education」國際研討會。
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） 本研究發現，讓國小學童以漫畫方式來重述近代台灣青少年之科技發明故事，確實能夠引起國小學童對於科普知識技能之應用的動機，且當主角人物能納入女性角色時，具有正面影響。值得發展更多的女性角色故事文案，且以網路社群分享方式來擴散其影響力。