行政院國家科學委員會專題研究計畫 期中進度報告

臺灣文化中推廣節能減碳之張力--個人、學校、網路行為分析(1/3)
期中進度報告(精簡版)

計 畫 類 別 ：個別型
計 畫 編 號 ：NSC 100-3113-S-004-001-
執 行 期 間 ：100 年 04 月 01 日至 101 年 03 月 31 日
執 行 單 位 ：國立政治大學教育學系

計 畫 主 持 人 ：邱美秀

公 開 資 訊 ：本計畫可公開查詢

中 華 民 國 101 年 01 月 20 日

中 文 摘 要 ： 本研究的主要目標是探究學生對社會上能源議題的信念，並且辨識出有效促進節能減碳行為的信念。資料收集的主要工具有二：(1)能源議題信念問卷：由本研究研發，共含 10 個構念，由 5 對具張力的信念所組成，包括：「節能」對「減碳」的知識、「擁有」對「存在」的生活風格、「質疑」對「順從」權威、「科技」對「自然」取向、「未來」對「現今」目標。(2)能源素養問卷：為既有問卷，做為「能源議題信念問卷」的效標問卷，包括知識、情意、行為 3 個構念。4,689 位臺灣 7-12 年級的國高中生參與本研究。驗證性因素分析和內容一致性信度分析顯示，能源議題信念問卷有可接受的信度與效度。5 對具張力的信念間，呈顯著差異。能源議題信念與能源情意、行為間呈中度相關，與能源知識間呈低相關，與性別、年級、社經地位間呈不同程度的相關。正向預測節能行為的變項包括：存在的生活風格、順從權威、自然取向、能源情意、年級、社經地位；負向預測節能行為的變項包括：擁有的生活風格、質疑權威、能源知識。以上述研究結果為基礎，本研究提出能源教育與未來研究之建議。

中文關鍵詞： 信念、節能、能源教育、社會科學議題

英 文 摘 要 ： This study aims to investigate student beliefs relating to energy issues in the society and to identify effective energy-issue beliefs that can motivate energy-conservation behavior. Data were collected with the Energy-Issue Belief Questionnaire (EIBQ) including ten constructs, two in a pair with tensions (energy-saving vs. carbon-reducing knowledge, having vs. being lifestyles, questioning vs. conforming to authorities, technology vs. nature approaches, future vs. present goals), developed in this study. The EIBQ is validated with a criterion questionnaire on energy literacy (knowledge, affect, and behavior). Research participants were 4,689 students of Grades 7-12 in Taiwan. The results of confirmatory factor analysis and internal reliability analysis show that the EIBQ has a desirable validity and reliability. Significant differences are found between the two beliefs in a pair with tensions in the EIBQ. The energy-issue beliefs have medium correlations with the energy affect and behavior, but low correlations with the energy knowledge, and

differential correlations with gender, grades, and socioeconomic status. Energy-conservation behavior is positively predicted by a being lifestyle, a tendency to conform to authorities, a nature approach, energy affect, grades, and socioeconomic status, and negatively predicted by a having lifestyle, a tendency to question authorities, and energy knowledge. Suggestions for energy education and future research are provided based on the findings.

英文關鍵詞： belief； energy conservation； energy education； socioscientific issue

Introduction

Human energy-conservation behavior appears to be an effective and economical way to mitigate global warming. Human behaviors, however, are determined by human beliefs in the long-standing culture and society. It is important to identify effective energy-issue beliefs that may motivate energy-conservation behaviors.

Researchers have posited diverse theories aiming to transform human beliefs or motives into behavior, e.g., Guagnano, Stern, and Dietz's (1995) attitude-behavior-condition model of behavior, and Stern's (2000) value-belief-norm theory of environmentalism. The precedent factors of energy-conservation behaviors may include interactions and tensions between personal cultural values, manifest lifestyle, societal hyper-structure, and the household system (Keirstead, 2006; Weber & Perrels, 2000). Human demographic characteristics, e.g., gender, age, and socioeconomic status, may also play a role in energy-conservation behavior (Chiu, 2011, in press).

The above review of literature suggests a need to develop a questionnaire to investigate people beliefs in response to energy issues in the society and to identify effective beliefs in motivating or discouraging energy-conservation behavior. This study, therefore, aim to answer the following four research questions, organized into two sets.

Set 1. The Energy-Issue Belief Questionnaire (EIBQ)

1. What are the construct validity and internal reliability of the EIBQ?
2. What are the differences between the two constructs with tensions in the EIBQ?

Set 2. Energy-issue beliefs as part of motivations for energy-conservation behavior

3. What are the correlations between energy-issue beliefs, energy literacy (knowledge, affect, and behavior), gender, grades, and socioeconomic status?
4. How is student energy-conservation behavior predicted by energy-issue beliefs, energy knowledge, energy affect, gender, grades, and socioeconomic status?

Method

The major research method of this study is a survey of secondary students.

Participants

The research participants were 4,689 Grades-7-12 students (2,384 girls) from 119 classes of 23 schools in Taiwan.

Measures

Three kinds of measures were used in this study: the EIBQ, a criterion questionnaire on energy literacy, and participant demographic characteristics. All the items were examined by six experts from the fields of physics, chemistry, biology, earth science, educational psychology (testing), Chinese, and English. They worked in primary school, junior high school, senior high school, and university and public science education institution. Expert validity was thus established.

The EIBQ. It was developed by this study. It included ten constructs, two in a pair with tensions: energy-saving vs. carbon-reducing knowledge, having vs. being lifestyles, questioning vs. conforming to authorities, technology vs. nature approaches, and future vs. present goals. The first eight constructs included four items for each construct, and the last two constructs included three items for each construct. The EIBQ included 38 items in total. The items were on a five-point Likert scale ranging from 5 (*Agree strongly*) to 1 (*Disagree strongly*). Table 1 shows the items.

The Questionnaire on Energy Literacy (DeWaters & Powers, 2011). It included the aspects of energy knowledge, affect, and behavior. The energy knowledge was measured on a typical maximum-performance test format, choosing one correct answer from five choices. The energy affect and behavior were measure on a five-point Likert scale. The original items in English were translated into traditional Chinese, the official language used in Taiwan and back translated. The experts examined the items for adapting the items to the context of Taiwan and some original items were changed.

The original questionnaire for the energy knowledge included middle- and high-school versions. This study used only the high-school version because the additional items used in the original high-school version appeared to be suitable for both junior- and senior-high school students in Taiwan according to the national curriculum. The original high-school version of energy knowledge in the questionnaire included 38 items. Twelve items (including answers) were changed slightly in order to adapt to the context of Taiwan, e.g., “Which country provided the single largest volume of oil imported to the United States in 2007?” in which the country name “the United States” was changed to “Taiwan” and the answer was changed. Five items were deleted because the experts found the single correct answers hard to be obtained, e.g., “Which resource provides most of the energy used in

Taiwan each year?" to which the experts had different answers. This procedure resulted in 36 items left as the energy knowledge items.

The same items of energy affect and behavior were used in the original version of the questionnaire. All of the 17 items in the energy affect remained unchanged, except for the change in the country name. The original questionnaire included ten items in the aspect of energy behavior. Two items, regarding the use habit of heaters and air-conditioners, were excluded in the Taiwanese version because the descriptions of the behavior appeared to fail to fit to the context of Taiwan. As such, there are eight items for the energy behavior in the Taiwan version.

Table 2 shows that there are similar total percentages of the correct responses (for knowledge) and positive responses (for affect and behavior) to the US and Taiwan versions of the questionnaire.

Participant Demographic Characteristics. The research participants were asked for their genders, grades, parents' vocations, and household cultural and material belongings.

Data Collection

The survey was administered through a Moodle system set up on the websites of a university in Taiwan. The participants individually linked to the websites, keyed in passwords, and filled in the survey under their teachers' supervision.

Data Analysis

There were no missing data because of the use of Moodle system, which allowed for the setting of no missing responses. The four variables of fathers' and mothers' vocations and household cultural and material belongs were transformed into standardized z scores, separately. The four sets of standardized z scores were summed and transformed into standardized z scores, which formed the variable of socioeconomic status.

Research Question 1 was answered by confirmatory factor analysis (CFA) and internal reliability analysis. Research Questions 2-4 were answered by repeated-measure *t* test, correlation analysis, and regression analysis, respectively.

Results

The four major results in relation to the four research questions, respectively, are presented as follows.

The EIBQ has acceptable construct validity and internal reliability. The analysis of CFA shows that the a priori structure of the EIBQ is generally supported ($\chi^2(620) = 10291.638$, $p < .05$; CFI = .969; NNFI = .965; RMSEA= 0.058). The values of factor loading from the items to the ten constructs are from .964 to .360. The values of Cronbach's α for the ten constructs are from .817 to .567.

Significant differences are found between the two beliefs in a pair with tensions in the EIBQ. Students believe in energy-saving knowledge more than carbon-reducing knowledge, perform a being lifestyle more than a having one, conform to authorities more than question authorities, prefer a technology approach to a nature approach, and aim at the future more than the present for energy issues.

The energy-issue beliefs generally have medium to high correlations with energy affect and behavior, but low correlations with energy knowledge, gender, grades, and socioeconomic status.

Energy-conservation behavior is positively predicted by a being lifestyle, a tendency to conform to authorities, a nature approach, energy affect, grades, and socioeconomic status, and negatively predicted by a having lifestyle, a tendency to question authorities, and energy knowledge. Controlling all the other predictors, girls tend to perform energy-conservation behavior less than boys, although girls have higher energy affect and knowledge than boys, and energy affect can positively predict energy-conservation behavior. Girls also have higher tendency to question authorities, which negatively predict energy-conservation behavior.

Discussion

The results may provide suggestions for energy education and implications for future research.

Energy education interventions can focus on increasing student emphasis on a being lifestyle, a nature approach, and energy affect, and decreasing student emphasis on a having lifestyle. The negative predicting capacity of the tendency to question authorities and energy knowledge suggests that teachers may need to transform student critical thinking of the emerging energy knowledge to energy-conservation behaviors, perhaps through the mediators of the positive predictors identified in this study.

The differences between the constructs in a pair with tensions indicate the dominating beliefs in the society. We especially have to notice the significant predictors of energy-conservation behaviors. Students have a being lifestyle more than a having one, and a being lifestyle can positively predict energy-conservation behaviors while a having lifestyle negatively. Students believe in a technology

approach more than a nature approach, while a nature approach can positively predict energy-conservation behaviors and a technology approach does not significantly predict energy-conservation behavior.

Girls perform less energy-conservation behavior than boys. Past research has indicated that girls show higher pro-environmental responsibility than boys (Chiu, 2010). There appears to be a need for future research to identify reasons why girls cannot transform their pro-environmental affect and beliefs into behavior. As indicated by this study, girls have higher tendency to question authorities, which may play a negative role in girls' energy-conservation behavior. An educational intervention incorporating the concern of this tendency may help girls perform a behavior consistent with their affects and beliefs.

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Table 1

The Items of the Ten Constructs in the Energy-Issue Belief Questionnaire (EIBQ)

Subscales and Items
Energy-Saving Knowledge
1. Earth's resources are limited and will be used up one day.
2. Human activities spend a lot of energy, which is the main reason why Earth's resources are running out.
3. Humans conserving energy can prevent Earth's resources from being used up so fast.
4. "Using less electricity" can conserve energy.
Carbon-Reducing Knowledge
5. The Earth's temperature keeps rising, which causes climatic anomaly.
6. Green house gas produced by human movements (e.g. CO2) is the main reason why Earth's temperature keeps rising.
7. Reducing green house gas produced by humans can slow down Earth's increase in temperature.
8. Using less electricity can reduce the release of green house gas
Having Lifestyle
9. Making lots of money is important.
10. If I were rich, I would choose to live in a mansion.
11. Having a car (especially expensive cars) is very important.
12. Being able to shop often is important.
Being Lifestyle
13. Being able to lead a simple life is bliss.
14. Living in a healthy, energy-conserving home is important.
15. Use personal cars only when it's necessary.
16. I only buy what I need.
Questioning Authorities
17. Powerful countries need to use more resources. (Reversed)
18. The government needs to use more energy than the common public. (Reversed)
19. Major industries need to use more energy. (Reversed)
20. Rich and powerful people need to use more resources. (Reversed)
Conforming to Authorities
21. Powerful countries should lead everyone to reduce carbon exhaust.
22. If the government introduces good "energy conservation and carbon reduction" policies, I'd be pleased to follow them.
23. If powerful people (e.g. the President, school principals, business owners, major industries) take parts in "energy conservation and carbon reduction," I would follow

their action.

24. Religious people will follow “energy conservation and carbon reduction” movements led by religious leaders.

Technology Approaches

25. Employ a “complete switch to renewable energy” method to promote “energy conservation and carbon reduction”.
26. Employ an “invent energy-conserving electronics and vehicles” method to promote “energy conservation and carbon reduction.”
27. Employ a “Choosing eco-friendly, energy-conserving materials to build houses” method to promote “energy conservation and carbon reduction.”
28. Employ a “reinforce eco-friendly and energy-conservation-related industries” method to promote “energy conservation and carbon reduction”

Nature Approaches

29. Employ a “Plant trees and protect forests” method to promote “energy conservation and carbon reduction”
30. Employ a “back-to-nature farming” method to promote “energy conservation and carbon reduction.”
31. Employ a “buy natural, eco-friendly merchandises” method to promote “energy conservation and carbon reduction.”
32. Employ a “reinforce local production of goods” method to promote “energy conservation and carbon reduction.”

Future Goals

33. “Energy conservation and carbon reduction” is to allow our future generations to have a better life.
34. “Energy reduction and carbon reduction” is to prevent humans’ liveable environment from early obliteration.
35. “Energy conservation and carbon reduction” is to allow humans to thrive for a long time.

Present Goals

36. “Energy conservation and carbon reduction” has a direct relationship with my current life.
37. “Energy conservation and carbon reduction” is to prevent natural disasters.
38. “Energy conservation and carbon reduction” is to allow us to lead a better life in the present.

Table 2

Percentages (%) of Correct/Positive Responses to the Questionnaire on Energy Literacy

	Knowledge			Affect			Behavior		
	MS	HS	average	MS	HS	average	MS	HS	average
DeWaters & Powers (2011, p. 1702)	40	44	42	73	74	74	66	63	65
This study	32	51	42	67	81	74	60	68	64

國科會補助計畫衍生研發成果推廣資料表

日期:2012/01/16

國科會補助計畫	計畫名稱: 個人、學校、網路行為分析(1/3)
	計畫主持人: 邱美秀
	計畫編號: 100-3113-S-004-001- 學門領域: 能源國家型科技人才培育計畫

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：邱美秀	計畫編號：100-3113-S-004-001-
計畫名稱：臺灣文化中推廣節能減碳之張力--個人、學校、網路行為分析(1/3)	

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	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	1	1	100%		Chiu, M.-S. (2011). Energy education for all: Development of knowledge, affect, and behavior in relation to global warming. Paper presented at the 2011 Taiwan Education Research Association International Conference on Education, National Sun Yat-sen University, Kaohsiung, Taiwan. December 15-18.
		專書	0	0	100%		
	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	1	1	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	1	1	100%	篇	Chiu, M.-S. (in press). Gaps between valuing and purchasing green-technology products: Product and gender differences. International Journal of Technology and Human Interaction. (EI)
		研究報告/技術報告	0	0	100%		
		研討會論文	1	1	100%		Chiu, M.-S. (2011). Gaps between public values and behaviors in implementing energy-conservation/carbon-reduction declarations in Taiwan. Paper presented at the New Zealand

							Psychological Society Conference, Queenstown, New Zealand, August 20-11.
		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。)	以一美國人發展的問卷為效標，並可做跨文化比較研究。 1. DeWaters, J. E. (美國人)提供她們的「能源素養問卷」全文(DeWaters, J. E., & Powers, S. E. (2011). Energy literacy of secondary students in New York State (USA): A measure of knowledge, affect, and behavior. Energy Policy, 39, 1699-1710.) 轉為中文後，經專家審查，並且因應台灣狀況，做了部分修改，DeWaters, J. E.期望知道，此計畫對其問卷做了哪些修改。本計畫則是自編「能源議題信念問卷」，以 DeWaters, J. E. 的「能源素養問卷」為效標問卷，也可將台美的結果做比較。目前資料已收集完畢，也已完成大部分的統計分析、撰寫報告中。 2. 二問卷的施測對象均為：國高中生。 3. 統計結果：大致看來，在各方面(能源知識、情意、行為)，台美狀況，頗為近似。知識中偏低(平均低於 50%正確率)，情意、行為較高；能源知識與行為的相關程度低，情意與行為的相關程度較高。

科教處計畫加填項目	成果項目	量化	名稱或內容性質簡述
	測驗工具(含質性與量性)	1	本研究的主要目標是為回答以下二個研究問題：(1)「臺灣節能(減碳)文化量表」評量工具的信度、效度為何？(2) 臺灣人在此工具上的反應為何？以去年的國科會計畫研究(NSC 99-3113-S-004-001)成果為基礎，將發展上述評量工具，專家將提供意見，建立專家效度。問卷施測對象為國高中生 4000 多人(平衡性別、年齡與居住區域)。驗證性因素分析的統計方法將用來建立此工具的建構效度；並以 Cronbach's α 建立此工具的內部一致性信度。透過此工具，能了解臺灣人的節能(減碳)文化；此工具也可用來評估現階段能源政策與教育的實施成效，並提供未來能源政策與教育的建議。
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	

	計畫成果推廣之參與（閱聽）人數	0	

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)

已發表一篇期刊論文、二篇會議論文；另有二篇期刊論文、一篇會議論文已投稿，審查中。一篇期刊論文撰寫中。

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）

(1)學術成就

已發表一篇期刊、二篇會議論文如下：

Chiu, M.-S. (in press). Gaps between valuing and purchasing green-technology products: Product and gender differences. International Journal of Technology and Human Interaction. (EI)

Chiu, M.-S. (2011). Gaps between public values and behaviors in implementing energy-conservation/carbon-reduction declarations in Taiwan. Paper presented at the New Zealand Psychological Society Conference, Queenstown, New Zealand, August 20-11.

Chiu, M.-S. (2011). Energy education for all: Development of knowledge, affect, and behavior in relation to global warming. Paper presented at the 2011 Taiwan Education Research Association International Conference on Education, National Sun Yat-sen University, Kaohsiung, Taiwan. December 15-18.

另有二篇期刊論文、一篇會議論文已投稿，審查中。一篇期刊論文撰寫中。

(2)技術創新

1、量表的研發，可增益學術知識、可為日後其他研究使用。也能據以了解影響能源行為的深度社會科學議題信念，而能發展適當的教學設計，有利能源政策的推動。

2、以既有的學校 server、使用免費的 Moodle 系統，施測網路問卷至 4000 多位國高中生。

(3)經濟效益

1、因為使用既有的學校 server 與電腦，節省資源的使用。

2、節省資料輸入時間與經費，將此經費回饋給學生。

(4)社會影響

1、施測全台國高中生 4000 多位，包括全台北中南東 23 所國高中 119 學生，也包括偏鄉學校學生。

2、問卷中，包括少量質性資料的收集，學生表示由填寫問卷，了解到能源議題的重要性與能源問題的深度。