出國報告審核表

出國報告名稱：國家科學研究年會論文發表		
出國人姓名（2人以上，以1人爲代表）	職稱	服務單位
李松濤	中校教師	海軍軍官學校
出國期間：100.4.1 ~ 100.4.11		報告繳交日期：100.6.28

計畫主辦機關審核意見

☐1.依限繳交出國報告

☑2.格式完整（本文必須具備「目的」、「過程」、「心得及建議事項」）

☑3.無抄襲相關出國報告

☑4.內容充實完備

☐5.建議具參考價值

☐6.送本機關參考或研辦

☑7.送上級機關參考

☐8.退回補正，原因：☐不符原核定出國計畫 ☐以外文撰寫或僅以所蒐集外文資料爲內容 ☐內容空洞簡略或未涵蓋規定要項 ☐抄襲相關出國報告之全部或部分內容 ☐電子檔案未依格式辦理 ☐未於資訊網登錄提要資料及傳送出國報告電子檔

☐9.本報告除上傳至出國報告資訊網外，將採行之公開發表：

☐辦理本機關出國報告座談會（說明會），與同仁進行知識分享。

☐於本機關業務會報提出報告

☐其他_____

☐10.其他處理意見及方式：

本論文無機密性質

審核人	一級單位主管	機關首長或其授權人員
	一般學科部 部主任蘇家慶	海軍軍官學校 校長王昭彥

說明：

一、各機關可依需要自行增列審核項目內容，出國報告審核完畢本表請自行保存。

二、審核作業應儘速完成，以不影響出國人員上傳出國報告至「政府出版資料回應網公務出國報告專區」爲原則。

出國報告（出國類別：發表學術論文）

美國國家科學教學研究年會論文發表

(National Association of Research in Science Teaching, NARST)

服務機關：海軍軍官學校應用科學系

姓名職稱：李松濤副教授

派赴國家：美國

出國期間：**100/4/3~100/4/6**

報告日期：**100/7/1**

摘要

本文係針對海軍官校應用科學系李松濤副教授前往美國發表學術論文之過程進行報告。報告內容包括會議目的、參加會議經過、與會心得以及建議。本會議爲國際性科學教育學術研究社群每年在美國固定舉辦之年會，其目的在分享各國科學教育學者研究之成果。此次大會共安排了十五項主題，世界各國參與的教授與研究生人數也將近 1100 人。本人此次所發表的論文爲與台灣師大科教所劉湘瑤教授所共同組成的 symposium 場次，係屬於國科會補助研究計畫的部份成果，由計畫主持人與數位兼任研究助理共同合作完成。在大會提出研究報告時，除了呈現我國部份的科學教育研究成果之外，對於日後將這些研討會論文轉寫成期刊論文的過程也提供了相當多具有建設性的意見。

目次

一、 摘要 **2**

二、 目次 **3**

三、 會議目的 **4**

四、 參加會議經過 **4**

五、 與會心得 **5**

六、 建議 **7**

七、 附錄（本人此次參加會議的的發表論文） **8**

一、會議目的

本會議爲國際性科學教育學術研究社群每年在美國固定舉辦之年會，其目的在分享各國科學教育學者研究之成果。

二、參加會議經過

非常感謝國科會科教處的經費支援，使得本人得以在 2011 年 4 月 3 日至 4 月 6 日到美國佛羅里達州的奧蘭多參加由美國國家科學教學研究學會（National Association of Research in Science Teaching, NARST）所舉辦的年會，同時於會中發表學術論文。從 1928 年起，美國國家科學教學研究學會都會在每年 3 至 4 月份固定舉辦這個學術研討會，今年大會選在佛羅里達州奧蘭多的 Caribe Royal 飯店舉行，不僅爲會議的參與者提供了相當完善的報告場地，也讓世界各國的論文發表者可以盡情地分享與討論相關的研究。

此次大會共安排了十五項主題，包括科學學習與教學、高等教育科學學習、職前與在職科學師資培育、制式與非制式科學教育、科學課程與評量、文化社會與性別、科學史哲、環境教育以及教育政策等。世界各國參與的教授與研究生人數也將近 1100 人，與會人士除了美國當地的科教學者、研究學者與教師之外，還有來自於台灣、日本、韓國、新加坡、馬來西亞、泰國、澳洲、南非、加拿大、德國和紐西蘭，甚至遠至非洲等各世界各地的專家學者，參與氣氛非常熱烈，可以看成是國際學術社群中科學教育研究領域的一次相當重要的會議，除了讓會議的參與者可以和各國學者分享自己的研究成果以外，也有機會可以聆聽與學習各國學者的研究主題，充實自己在科學教育研究領域中的基本知能。

本人這次在 NARST 所發表的論文題目是「**An Exploration of Students' Reading Strategies in Texts of Environment Issues**」此份報告皆係屬於國科會補助研究計畫的部份成果，由計畫主持人與數位兼任研究助理共同合作完成。在大會提出研究報告時，除了呈現我國部份的科學教育研究成果之外，也同時獲得了在場許多學者的建議與回饋，對於日後將這些研討會論文轉寫成期刊論文的過程也提供了相當多具有建設性的意見。

由於機會實在難得，本人也充份地利用這個場合積極學習。例如4月3日上午本人就聆聽了南佛羅里達大學Kala Vairavamoorthy教授的專題演講，題目是「NEW URBAN LEADERS FOR SUSTAINABLE CITIES OF THE FUTURE」。在報告中，他針對現行一些人類科學活動與環境的互動模式提出了一些批判，同時提出呼籲應該將這些批判轉化成爲系統的思考模式，才能夠真正符合「環境友善」與「永續經營」的科學教育理念，相關報告和與會者的討論過程讓本人留下了相當深刻的印象。4月5日上午本人也聆聽了英國Knox college的Tim Kasser教授所做的報告，題目是「**Human Identity and Environmental Challenges**」，在報告中，Tim Kasser教授分享了如何從心理學的角度切入來探討科學教育中的一些議題，其中提到如「自我認同」與「價值觀」等概念，讓與會大眾對於其研究概念的延伸有了耳目一新的感受。4月3日本人則是聆聽了美國史丹佛大學Osborne教授研究團隊的研究成果報告，題目是「**Epistemic Features of Science Teachers' Talk During Argumentation Instruction**」，他們分享了如何透過論證的學習經驗，讓科學教師的論證教學與認識層級可以得到提升，其相關研究的設計、資料的收集以及研究結論等內容都讓本人深感佩服，也學習到很多新的想法。4月4日上午本人則是聆聽了馬里蘭大學 Holliday教授等人的研究分享，他發現，雖然科學學習強調文本的閱讀，但是仍有學生在科學閱讀時並無法理解科學文本的意義，所以鼓勵研究者以探究的概念來幫助學生學習科學文本的閱讀，顯然有關探究的概念可以和閱讀加以結合，也讓本人看到一個新的值得研究的取向。以上相關的這些研究都讓本人在學術研究的方向與方法上都有了一些深刻的啓發。

三、與會心得

（一）大會的細心安排與溫馨氣氛令所有與會者印象深刻

此次大會將會議場地安排在佛羅里達州奧蘭多的 Caribe Royal 飯店舉行，當地氣候宜人，景色優雅，整個環境給人相當舒服的感受。尤其報告場地的相關硬、軟體的支援

非常充足，讓與會者同時分享到休閒與學術的氣氛，可以說是一次兼具知性與感性的學術研討會。此外，大會在 4 月 4 日的接待晚宴與 4 月 5 日中午的頒獎午宴上也都安排了相關的聯誼機會，提供了學者們可以輕鬆互動的另一個舞台，讓來自世界各國的學者們可以暫時放下繁重的研究工作而放鬆心情互相討論與交談，爲日後的友誼或是研究合作奠定了良好的基礎，這些活動的背後，反映了西方文化特有的民俗風情，也爲我們台灣日後舉辦類似活動的規劃思維留下了一個非常好的參考典範。

（二）國內學者的參與和投入提升了台灣科學教育研究國際化的程度

此次台灣學者參與的教授與研究生人數也相當多，例如台灣科技大學、台灣師大、彰化師大、高雄師大、以及國內各教育大學或是數理教育研究所的教授們以及其帶領的研究生團隊等都給大會帶來許多非常好的研究分享，例如：「**Analysis of Teachers' Views on the Nature of Models in the Development of a New Model based Course**」探討了國內科學教師在建模方面的新興研究方向；「**Innovative Information and Communication Technology Systems to Facilitate Student Learning: A Smart University Classroom in Taiwan**」分享了國內資訊科技系統在科學教育的貢獻；「**Examining Students' Online Searching Strategies and Searching Patterns in Terms of Different Scientific Epistemological Beliefs**」爲國內的科學活動網路學習環境提出整理與建議；「**An Integrative Model for Exploring the Development of Science Teachers' Personal Practical Knowledge**」則針對國內科學教師的專業發展提出建議；「**Investigating the Influences of 5th Graders' Learning Motivation on Dissolution Conceptual Change**」探討了動機對於概念學習的影響；「**Exploring the Structural Relationships between Taiwan University Students' Conceptions of Learning Biology and Epistemological Beliefs toward Biology**」則是針對台灣學生的概念學習與科學認識論之間的關係表現提出看法;「**A Case Study of the Interaction on Science Activities Between Parents and Children in Taiwan**」則是研究家長與學生的科學學習之間的關係，諸如這些非常具有特色的研

究都在會中得到許多很好的回饋，相信對於國內的科學教育界來說，是一次非常難得的學術分享經驗。尤其許多研究生的參與，更是讓人覺得長江後浪推前浪，看到許多年輕朋友如此積極地投入科學教育的相關研究，也讓我們對於台灣未來的科學教育成果與研究內容更充滿了信心與期待。

（三）大會研究主題的多元化提供了各國與會者進一步討論與分享的空間

此次研討會的主題相當多元，從課程、教師、學生、教材以及教學平台與網路環境等面向切入科學教育研究的議題都讓與會者覺得科學教育的研究範疇正在持續地擴展，而其中許多研究所援引的有關心理學、社會學、資訊學甚至文化學的一些相關重要理論更是讓本人獲益良多。尤其是在各場次擔任發表人、主持人、或是中場休息的時候，更可以直接和作者本人或是自己心儀已久的重量級學者進行面對面的互動與溝通，這種經驗著實讓人感到印象深刻，而且可以讓我們產生一種「見賢思齊」的感受。

四、建議

在參加過 NARST 所舉辦的研討會之後，個人深感獲益良多，無論是在科學教育的研究主題、各國的文化理解、大會的活動安排與設計等面向，都讓本人學習到許多以往未曾有的經驗，對於個人未來的研究視野有著一定的正向影響作用。相信與本人具有類似研究背景的學者們對於此類活動一定也會有許多期待，因此建議國科會科教處能夠持續補助國內學者們類似活動的經費，尤其是許多碩、博士班的研究生或者是已經具有科學教育博士學位的中、小學教師們，相信經由這類活動的刺激，一定可以爲台灣科學教育的研究投入更新的能量與績效。

五、附錄（本人此次參加會議的的論文報告）

Innovative teaching and learning in environmental issues: An emphasis on thinking about complexity

organized by Shiang-Yao Liu, Graduate Institute of Science Education, National Taiwan Normal University, Taiwan

Contemporary educators have highlighted the importance of environmental education for science and technology education in a broader scope. The educational goals are to prepare environmentally literate students who can make informed decisions on environmental issues and take environmental friendly actions. The value and importance of such education has been emphasized internationally (UNESCO-UNEP, 1991). Given that environmental issues are increasingly recognized as legitimate social and educational concern, environmental education has emerged as an important part of formal school programs, particularly within science curriculum (Hart, 2003). However, there still are growing research efforts on finding effective ways to reach this goal.

As Wals and van der Leij (1997) reminded over a decade ago, the community of environmental education focuses too much on formulating the content and outcome of environmental education, and too little on the quality of the learning process. Recently, Rickinson's review articles (2001, 2006) again stated that few studies focused on exploring the process of environmental learning. In most cases, according to our observations in Taiwan, environmental education too often focuses on transmission of environmental-related knowledge and awareness to the passive learners. However, evidence has shown that increases in knowledge and awareness did not necessarily lead to pro-environmental behavior (Kollmuss & Agyeman, 2002). Therefore, we agree with the assertion that environmental education should "seek to enable participants to construct, transform, critique, and emancipate" (p. 24, Wals & van der Leij, 1997) their relationships with others and the environment. We also tended to adopt the "reflexive paradigm" that both teacher (instructor) and learner bring knowledge to construct the definition of the environmental problems being investigated in classrooms and everyday life (Gauthier, Guilbert, & Pelletier, 1997). In this paper set, we will propose the design of course or teaching activities that provide students opportunities to learn, think, and act in environmental issues.

These studies were also inspired by the idea of "process-based quality assessment" (Wal & van der Leij, 1997) that enables researchers to detect the perspectives we are using in conceptualizing learning, and the processes or settings through which we see learning taking place (Rickinson, 2006). These five studies integrated several different controversial environmental issues into science or environmental education courses. Environmental issues are complex, often lack of conclusive information, and involving different aspects of

considerations and multi-agent perspectives with various values and beliefs (Gayford, 2002). An understanding of students' thinking and reasoning on the issues becomes an evidential base for teachers to envision their teaching and learning process in environmental education. Data sources in these related papers involved several assessments focusing on exploring students' systems thinking and argumentation ability, reading and information retrieval strategies, and problem framing approach. It is considered that the ability of higher order thinking, effective communications, and democratic debates are the basic abilities for a scientifically and environmentally literate citizen in a modern society (Læssøe, 2010; Norris & Phillips, 2003). Our research attempt was to know how students deal with the complexity involved in environmental issues and to seek for an effective teaching model that engages students in the democratic process in shaping and managing their own environment.

The first paper will present a course design that is based on the soft systems methodology and reflexive approach to teach college students about environmental issues. The second paper discusses an intervention task in a course that was modified from a procedure of strategic environmental assessment, and also analyzes students' problem framing strategies as an account of active participation on environmental debates. The third paper was focused on the assessment of systems thinking ability, while the fourth and fifth papers were on argumentation skills in some teaching activities and reading strategy exploration involving environmental issues. More detailed descriptions about each paper are as follows.

Paper #1: Theoretical foundations and applications of an action-oriented learning cycle for teaching environmental Issues

Presenter: Shiang-Yao Liu, Graduate Institute of Science Education, National Taiwan Normal University, Taiwan

In this paper, we introduce an action-oriented learning model, named as Issue-Tackling Learning Cycle (ITLC), for helping student better structure their thinking and evaluate various actions regarding environmental issues. This learning model is based on the Soft Systems Methodology (SSM) described in the book by Checkland and Poulter (2006). The methodology is "an organized, flexible process for dealing with situations which someone sees as problematical, and situations which call for action to be taken to improve" (p. 4). The typical pattern of soft systems thinking activity includes "finding out", "model building", "discussing/debating", and "defining/taking action". The idea of soft systems refers to the process of inquiry into real world complexity and allows every person to perceive the reality in his/her particular way (and with different worldview). In this study, the SSM is the main theoretical foundation for the design of the course in which the objectives were to help students to better deal with the complex environmental issues. Environmental issues are viewed as a "problematical situation" rather than "a scientific problem", because they are too complex, often lack of conclusive information, and involving different aspects of

considerations and multi-agent perspectives with various values and beliefs. The problematical situation means that something needs to be done, and involves people who are trying to act purposefully.

The design of this course was also referred to the reflexivity orientation introduced in Gauthier et al.'s article (1997). They suggested that a better environmental education should encourage students' participation in problem solving. Educators should also be an actor, one of the problem solvers in the issue, and be sensitive to how students use information and engage in problem solving. The problem solving process was defined into three steps: exploring and defining the problem (or problem-framing), searching for and identifying solutions, and implementing an action and evaluating progress.

A teacher preparation course was designed for students of the College of Science, which is interdisciplinary, but science focused, process providing students the knowledge, skills, and opportunities for investigating and evaluating environmental issues and actions. The course instructor is the first author of this paper, who considers herself a teacher-as-researcher doing action research. All teaching activities in the semester were tape-recorded and reviewed by peers to examine the components of the defined learning cycle. Four phases of the ITLC included: *(1) Finding out the problematical situation:* students choose an environmental issue to tackle with after reading articles and searching information; *(2) Making purposeful activity model:* students describe the various action suggestions held by the different perspective agents; *(3) Using the model to question the real situation:* students generate the debates about the problematical situation and evaluate the different worldviews behind different action suggestions; *(4) Defining/taking the action to improve the situation:* students propose a generally desirable and culturally feasible action suggestion to the problematic situation they choose and define. There were several assessment studies conducted along with the implementation of this curriculum, such as investigations of environmental worldviews and analysis of systems thinking patterns.

Paper #2: Problem framing as a starting point for active participation on the debate of environmental issues

Presenter: Chuan-Shun Lin, Department of Education, National Kaoshiung Normal University, Taiwan

This paper has two main purposes: (1) to exemplify and illustrate the philosophy behind the educational intervention "Learning through strategic environmental assessment", (2) to categorize and analyze the problems students framed while they are involved in the strategic environmental assessment activities. Strategic environmental assessment (SEA) is a procedure for environmental management and refers to a range of analytical and participatory approach that aims to integrate environmental considerations into policies, plans and programs, and to evaluate the inter linkages with economic and social considerations (OECD, 2006). The

project “Learning through Strategic Environmental Assessment (SEA)” has been designed and delivered with the aim of *empowering* people to *take part as active citizens in democratic process* to deal with environmental issues (Læssøe, 2010).

A three-month-long intervention task was designed and involved thirty senior science major students who were taking a course named ”environmental education” in the teacher preparation program in an university of southern Taiwan. The intervention task provides an active participatory learning activity where students choose environmental issues which interest them, evaluated various possible solutions to those issues, framed their own problems as potential research topics, and finally presented their own suggestions regarding the issues. This research is based on the premise that problem framing could be perceived as the bridge between participatory learning and real-world environmental issues. The method of cognitive phenomenology (Roth, 2005) was used to explore how students act to frame problems in the setting of SEA learning process.

The problems framed by students were characterized into three types. The category of *Basic information question* contains students’ questions that focused on the state of the information. Examples are “What is the function of dams?” “ What is greenhouse effect?” The second type was named as *Problem identification question* that focuses on identifying the cause-effect relationship within the environmental issues. Examples are “Is the greenhouse effect caused by human activities?” “What are the effects of the dam on the ecology system?” The most favorable questions are those focuses on the democratic process on the government of the future world, named as *Citizen participation question*. Under this category, students’ questions became more sophisticated, for example, “Besides building the dam, is there any better way for managing the water resources?” “Could the sustainable water use be promoted by raising the water price?”

The types of the problems students framed in the strategic environmental assessment learning process could reflect their approaches to the linkage making between learning and sustainable development. “Basic information” and “problem identification” questions could reflect the approach that environmental education as imparting knowledge to the students. “Democratic participation” could reflect the approach that learning as active participation in the debate on environmental issues as an active citizen. In most cases of environmental issues, there are usually no final solutions and unquestionable answers. People can only make decisions based on the information they have and the values they hold. Therefore, helping learners actively engage in the environmental debate and frame good questions could be a good start point for environmental education. The results of this study may provide an analytic framework for educators to understand and study students’ problem framing.

Paper #3: Promoting systems thinking through an environment course

Presenter: Li-Ting Cheng, Graduate Institute of Science Education, National Kaoshiung Normal University, Taiwan

This study deals with the development of students' system thinking skills in a college course. Data were collected to answer the following research questions: (1) What are the factors influencing the development of students' systems thinking ability? (2) What kinds of relationships are existent among the cognitive components of systems thinking? A general education course, "science and environment", in which the objectives were established to improve students' abilities for making investigations, evaluating environmental information, and taking environmental actions.

Thirty-four college students from various technology-related majors participated in this course. The sources of data included teaching journals, videotaping of teaching, students' assignments and drawings, and interviews. Students' drawings and interviews were the main data for analysis in this paper. The follow-up interviews were conducted to ask students to elaborate their drawings. Data from each student were coded separately and then compared in the substantial analysis.

The design of this course was based on Soft System Methodology (SSM) framework (Checkland & Poulter, 2006), which requires students to discuss daily issues and to look for feasible solutions. This inquiry-based teaching unit was focused on a controversial issue regarding bovine spongiform encephalopathy (BSE, so-called mad cow disease). This unit began with the instructor's introduction about what BSE is and a controversial issue regarding imports of U.S. beef, and then students worked in group to discuss why it is a problematical situation. Before the first phase of group discussion, each student had drawn a "system map" representing how he/she analyzed and evaluated the issue by searching information online. In the group discussion, students communicated their system maps with peers and cooperatively built some purposeful activity models they judged to be relevant to the problematical situation. Students were experiencing a process of seeking accommodations between different perspectives and values with their peers. Finally, they had to make their own decision and define the action they would make to deal with the issue. In this teaching activity, students should be able to think as a policy-makers and actors on the environmental issues.

Unit assessments were used to document students' perceptions about the bovine spongiform encephalopathy (BSE). Students' individual views on the BSE issues were ranked into five levels using the hierarchical scheme adapted from Ben-Zvi Assaraf and Orion's scheme (2005): (1) The ability to identify the elements constituting the BSE issue, and the connection between the elements; (2) The ability to describe the relationships among the elements constituting the BSE issue from different dimensions, such as biological dimension, the economic dimension, and the policy dimension; (3) The ability to define the scope of BSE

incidents, and the operations and interactions between elements; (4) The ability to recognize hidden dimensions of the issue, for example, the media's influence on the incident; and (5) The ability to understand that some of the presented interaction within the system took place in the past while future events may be a result of present interactions, for example, using the case of Kuru disease to estimate future impact caused by current policy regarding the BSE issue.

Analysis of individual student system maps revealed that most students were able to identify the elements of the issue from different perspectives, and recognize the operations of and interactions between elements, at the beginning of this teaching unit. After the eight class meetings (four weeks), students' achievements were assessed mainly from their written reports, including essays about the BSE issue and system maps. Results of the post-course assessment showed that student systems thinking traits could be categorized in the level 4 and 5. Many students mentioned more dimensions of elements regarding the issue than those in their first maps. Several students began to anticipate the long term consequences and possible side effects of present actions. In the interviews, students recalled that the activity of drawing system maps had helped them to consider a complex issue comprehensively, and be more considerate while making decision.

Paper #4: The quality of students' argumentation in a socio-environmental debate activity

Authors: Uy-Len Lin, Li-Ting Cheng, & Jeng-Fung Hung, Graduate Institute of Science Education, National Kaoshiung Normal University, Taiwan

Built upon previous research on investigating higher order thinking skills in science learning, this study aimed to investigate the structure of student-student and student-teacher interactions in argumentative dialogues regarding a socio-environmental issue. The categorization for analyzing the quality of argumentation in the teaching activity was defined. Four categories to describe student arguments included (1) supporting their position (STP), (2) rebutting opposing position (ROP), (3) coordinating opposing positions (COP) and (4) looking for teacher's intervention (TI).

The study was conducted with 104 10^{th} grade students in a vocational school. Students were from two intact classes and their science course was taught by two different teachers, Mary and Ben, who were both Ph.D. students of science education. These two teachers integrated a socio-environmental issue regarding the debate of "Su-Hua highway construction" into their science course in the middle of the semester when this study was processing. Within the first four weeks, teachers guided students to build skills for engaging in an argumentative activity, including learning basic scientific concepts, doing library and online research, planning and conducting interviews with authorities or the general public.

Students were also asked to analyze science information from popular sciences periodicals. In the issues discussion, students collected information relative to the issues, analyzed potential consequences and possible resolutions, and planned actions they could take to solve problems in the issues through cooperative learning. Finally, they were asked to present their decision and explain why they made this decision. Besides, they should argue with other students whose points of view were oppositional. In argumentative activities, both teachers use multiple teaching strategies such as role-play and group discussion. The main data sources were the videotapes of small-group interactions in the argumentative activity. Observations and analyses were focused on the features of students' performance in different kind of argumentative dialogues.

In the dialogue of supporting their position (STP), which is the first stage that students made their assertions and learned how to cooperate as a team, observations showed that most students were unable to generate reasons or claims even when they were prepared. By working in group, students tended to follow others opinions and cooperatively construct the group opinion to a higher quality one. This finding supports the theory that by working cooperatively students could improve their ability of argumentation (Zohar & Nemet, 2001). In the debate activity, students were actively engaged in making rebuttals, especially when they deal with low-quality arguments. However, students tended to criticize their peers' arguments without caring what they had communicated. This finding implies the need of guidance for students' debate making in this kind of teaching activity. Even so, we are still optimistic about the effectiveness of the debate activity. When engaging in rebutting dialogue, students would have opportunities to evaluate the low-quality arguments and learn that rebuttal has to be based on evidence. Compared with STP and ROP, coordinating opposing positions (COP) consists of more higher-order thinking ability (e.g., Clark &Sampson, 2008; Kuhn, 2005), students have to first realize both positions exist sound reasons of their own, and then generate "sense-making reasons" to coordinate the opposite points of view. In this stage of argumentation, teacher's intervention plays an important role in guiding student to reflect what the opposite argument is and how to apply appropriate qualifier to coordinate it. Analyses conducted in this study could be a resource to make recommendations for supporting and promoting argumentation discourse in the teaching context that involves such complex, controversial issues.

Paper #5: An exploration of students' reading strategies in texts of environmental Issues

Authors: Sung-Tao Lee, Department of Applied Science, Naval Academy, Kaohsiung, Taiwan; Fu-Pei Hsieh, Kuang-Hua Primary School, Kaohsiung, Taiwan; and Yen-Wen Lin, An-Chao Primary School, Kaohsiung, Taiwan

This study was focused on exploring students' reading strategies toward different

persuasive texts of the issue of “greenhouse effect.” The research questions guided this study are: (1) What are the possible reading strategies students used to read the texts? (2) Are there any variations in students’ reading strategies when different level students read different persuasive forms of issue texts? The components of Toulmin’s argumentation pattern (TAP) were used as the reference framework when developing the “greenhouse effect” texts (Toulmin, 1958) and all these texts were designed to be persuasive arguments with the forms of “one-sided”, “two-sided refutational” and “two-sided non-refutational” proposed by Hynd (2001). Nine 5^{th} graders from three elementary schools participated in this study. These students were divided into high (N=4), medium (N=2) and low (N=3) level readers based on their mandarin language abilities.

After two to three weeks of “thinking-aloud” training and practices, students were invited to read different forms of “Greenhouse effect” texts. The thinking aloud protocols were audio-taped and transcribed verbatim for analysis. Through weekly or monthly meetings, the consensus of the hierarchical categories of the codes represented students’ reading strategies was reached. The average inter-rater reliabilities were ranged from 0.78 to 0.82.

It is found that students’ reading strategies can be divided into five progressive categories with thirteen codes (Table 1). Although these emerged categories and codes can be informative with regard to students’ abilities in reading strategy applications, this empirical framework did not reveal the expected specific strategies needed in reading “greenhouse effect” texts, such as looking for claims, searching for evidence, and evaluating different evidences. For the purpose of the attainment of a scientifically literate society, teaching of reading strategies regarding controversial issue texts and its structures should be a basic and important issue worth concerning for science educators. The reading strategies frequency comparisons between two high level readers in one-sided argument revealed that more than 50% of their cognitive processes were focused on more advanced strategies, e.g. meta-cognition and critical thinking. Those low-level readers showed limited reading strategies and often questioned about the definitions of the terms in the texts. It is implied that low-level readers might be insufficient in background knowledge or in their abilities to organize related information to comprehend the meanings of the text. The comparisons between different level students’ reading strategies further indicated that the higher the reading level, the more diversified strategies were found and the more advanced reading strategies are easier to be found in high-level students’ protocols. This study was intended to explore how students understand the environmental information in the texts. Results could provide references for environmental teaching. The two-sided non-refutational texts designed in this study may be used to induce more reading cognitive operations when the forms of arguments are taken into considerations. When the contents of science reading materials are presented via two-sided non-refutational forms, a more diversified and advanced reading strategies in students’ cognitive processes can be reasonably expected.

Table 1: Categories of reading strategies in reading persuasive science texts

Categories	Codes	Definitions in protocols
Pre-strategy	Repeat	When common words in texts are repeated
Integration	keywords	When important words or terms in texts are mentioned
	Main sentence	When main sentences in texts are mentioned
	Summary	When conclusions or ideas about texts are raised
	Experiences	When past cognitive experiences are mentioned
Questions	What questions	When questions of definition about texts are raised
	Why questions	When questions of explanation about texts are raised
	How questions	When questions about procedures about texts are raised
Meta-cognition	Ask & answer	When questions are simultaneously asked and answered
	Contrast	When contents in texts are mutually compared
	Inference	When inferences are made based on contents in texts
Critical thinking	Doubt	When doubts about contents in texts are raised
	Rebuttal	When different viewpoints about texts are raised

References

Ben-Zvi Assaraf, O., & Orion, N. (2005). Development of system thinking skills in the context of Earth System education. *Journal of Research in Science Teaching, 42*, 518-560.

Checkland, P., & Poulter, J. (2006). *Learning for action: A short definitive account of soft systems methodology and its use for practitioners, teachers and students*. West Sussex, England: John Wiley & Sons Ltd.

Clark, D. B., & Sampson, V. (2008). Assessing dialogic argumentation in online environments to relate structure, grounds, and conceptual quality. *Journal of Research in Science Teaching, 45*(3), 293-321.

Gambro, J. S. & Switzky, H. N. (1999). Variables associated with American high school students' knowledge of environmental issues related to energy and pollution. *The Journal of Environmental Education, 30*(2), 15-22.

Gauthier, B., Guilbert, L., & Pelletier, M. L. (1997). Soft systems methodology and problem framing: Development of an environmental problem solving model respecting a new emergent reflexive paradigm. *Canadian Journal of Environmental Education, 2*, 163-182.

Gayford, C. (2002). Controversial environmental issues: A case study for the professional development of science teachers. *International Journal of Science Education, 24*, 1191-1200.

Hart, P. (2003). *Teachers'Thinking In Environmental Education: Consciousness and Responsibility.* New York: Peter Lang.

Hynd, C. (2001). Refutational texts and the change process. *International Journal of*

Educational Research, 35, 699-714.

Kollmuss, A., & Agyeman, J. (2002). Mind the Gap: why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research, 8*, 239-260.

Kuhn, D. (2005). *Education for thinking.* Boston: Harvard University Press.

Læssøe, J. (2010). Education for sustainable development, participation and socio-cultural change. *Environmental Education Research, 16*, 39-57.

Norris, S. P., & Phillips, L. M. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education, 87*, 224–240.

OECD (2006). *Appling Strategic Environmental Assessment.* Paris: OECD.

Palmer, J. (1995). Environmental thinking in the early years: Understanding and misunderstanding of concepts related to waste management. *Environmental Education Research, 1*, 47-58.

Rickinson, M. (2001). Learners and learning in environmental education: A critical review of the evidence. *Environmental Education Research, 7*, 207-302.

Rickinson, M. (2006). Researching and understanding environmental learning: Hopes for the next 10 years. *Environmental Education Research, 12*, 445-457.

Roth, W.-M. (2005). *Doing qualitative research: Praxis of method.* Rotterdam / Taipei: Sense Publishers.

Toulmin, S. (1958). *The uses of argument.* Cambridge: Cambridge University Press.

UNESCO-UNEP (1991). Changing minds-earthwise. *Connect, 23*, 1-69.

Wals, A. E. J., & van der Leij, T. (1997). Alternatives to national standards for environmental education: Process-based quality assessment. *Canadian Journal of Environmental Education, 2*, 7-27.

Zohart, A., & Nemet, F. (2002). Fostering students' knowledge and argumentation skills through dilemmas in human genetics. *Journal of Research in Science Teaching, 39*(1), 35-62.