A Case Study of 5 Graders’ Inquiry in Ecology Diorama:

Setting Natural Energy Facility or Not?

Jung Hua Yeh

National Museum of Natural Science

jung@mail.nmns.edu.tw

Abstract

This study describes science education programme conducted in National Museum of Natural Science, Taiwan, while the museum integrated science education theory into its education practice. The ecological dioramas were interpreted as the representation of biodiversity and ecological uniqueness. Most school teachers confirmed these ecological dioramas were fantastic recourses for education, but hard for teachers to fit in their science teaching schemes. The program expected that all participants could aware of the controversy between development green energy and sustainable environment, perceive the vision from different value and inference, and make decision by way of social certification. The purpose of the project, Inquiry in Gallery, was to scaffold these ecological dioramas as settings, materials and source of evidences for engaging participants in the debate of the dilemma between green energy installation and environment protection. The main scaffold of this project included two questions which the tasks of the participants were: first was “Which Renewable Energy Installations You Would Suggest for the Assigned Diorama?” second was “What Is the priority Order of the Ecology That Your Group Suggests to Build Renewable Energy Installation?” The group presentation for the participants’ inference and decisions were collected as the evidences of achieving the purposes and feed back to age teaching module. The teaching took by the same experienced science educator who believed science knowledge came from social construction. There were 4 classes of 5 graders (10- year-old students total 96 students) participated in the teaching trial of the project. Each class assigned students into 5 groups to participate in the program. The research findings included: all groups were aware of the tension between green power facilities and conservative ecology; primary school students with misconceptions which influenced students’ matching the ecology with natural power facilities, such as hot temperature means much solar power and water power comes from waterfall. This program used the Benzene Ring Heuristic of scientific practice to help students reflective thinking of their visiting experience as a kind of science inquiry. There were discussion and suggestions for the educational meaning of diorama.

Keywords: science museum, inquiry learning, diorama, green energy

**Introduction**

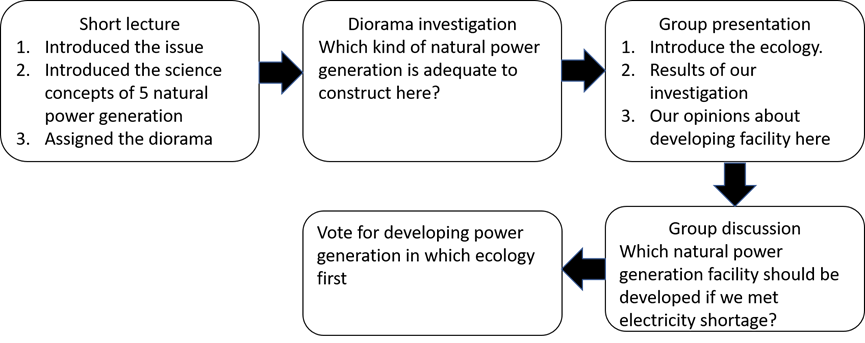
The National Science Council of the Executive Yuan, the predecessor of the Ministry of Science and Technology, funded phase 1 of the National Energy Program (NEP-I) from 2008 to 2015 (National Science Council, 2013). The mid-term report of the NEP-1 established four directions for future energy programs in Taiwan: energy efficiency, energy usage and energy sustainability, renewable energy development and utilization, and the formulation and evaluation of energy technology development strategies. The main purpose of the NEP-1 was to introduce ideas about saving energy and reducing carbon emissions through formal and informal education. In March 2011, the Fukushima nuclear power plant disaster resulted in numerous NEP-1-based projects highlighting the use of green energy (diversified natural power). The NEP-1 funded several projects that evaluated students’ energy literacy (Shen, 2011; Yeh, Huang & Yu, 2017), teachers’ attitudes toward teaching energy issues (Yeh & Ku, 2011), and public constructs of energy values and behaviors (Chiu, 2012, 2013; Chiu, Yeh, & Spangler, 2016). Empirical studies have shown that the program had investigated knowledge about climate change and attitudes toward energy-conservation behaviors (Shen, 2011; Yeh, 2011; Yeh, Huang & Yu, 2017). Moreover, the studies had identified that there were many misconceptions or naïve ideas about energy saving actions and benefits for mitigating climate change (Shen, 2011; Yeh, Huang & Yu, 2017). The final report of the NEP-1 adopted an open-forum approach and concluded that the influence of the program had prompted rational discussion among citizens about energy issues, but that the discussions were based on subjective estimations and value judgment (NEP-1 report, pp.128–129). Chiu, Yeh, and Spangler (2016) analyzed 10 energy saving and carbon reduction declarations that the government publicized through the NEP-1. A factor analysis revealed that these declarations included three value constructs and three behavior constructs, and correlation and regression analyses showed that the value constructs (nature and domestic technology values) predicted easy behavior but did not predict consideration. These studies revealed the same phenomenon: that people had knowledge about global warming and environmentally friendly behaviors but still followed common values rather than considering public welfare, evidence, and scientific knowledge. People adopt energy-conservation behaviors that are easy to implement and will consider behaviors based on other perceived needs, such as quality of life, personal safety, economic status, and timing.

The aim of this study was to construct scaffolding for museum energy education that addresses the tension between energy facilities and nature conservation. Special attention was given to how different age groups make their decisions and how they view the conflict between energy development and nature conservation. This study was conducted in Taiwan, where the use of technology has resulted in a materialistic lifestyle; however, the focus of the government and public is shifting to a low-carbon future.

**Method**

The teaching trials for 4 classes of 10-year-old students were a total of 96 students participated in the trials. Two partner teachers helped me observe the participants’ behavior while students observed the diorama and engaged in group discussions. The teachers observed each group for 3 minutes and completed a behavior checklist.

The teaching process was illustrating as fig 1.



*Fig.1* the teaching process of the program.

Research Findings

Table 1. Responses from the fifth-grade students

|  |  |  |  |
| --- | --- | --- | --- |
| Diorama | Alternative power facility | Reasons | Decision of whether to implement the selected power facility in this ecological environment |
| Canadian Tundra | Wind power | Animals that live here look furry, so this place might be cold and windy  It is too cold to produce solar photovoltaic power | Decided to develop this area  Reasons:   1. Few animals and plants 2. Few trees 3. No international conservation species |
| Solar power | High latitude area with a lot of sun in summer  No forests, so it is good for solar power |
| Manchurian Temperate Forest | Solar power | Not good for all types of alternative power, put solar power panels on tree tops might barely use | Disagreement to develop this area first.  Reasons:   1. The facility would require the removal of many trees 2. Tigers are an internationally protected species 3. No power facility should be built in this environment |
|  | Not an adequate option | 1. Too many trees would shadow solar power panels 2. A high-latitude location with a short day length, not good for solar power 3. Forest grows densely because there are no strong winds 4. River is not large enough to develop a hydroelectric generator |  |
| East African Savanna | Wind power | Few trees, winds might be strong here  Space between wind power generators could enable animals to move. Solar power panels would become a barrier for animal movement | Decided not to develop this area  Reasons:   1. Numerous animals living here 2. Most of the animals are internationally protected species 3. The animal populations are large and they need a large area to find food, developing the power facility here would damage their environment |
| Solar photovoltaic | Not enough trees andmountains to shadow the sun.  Africa experiences droughts often, so it is a suitable environment for solar power |
| Sonoran Desert | Solar power | Only cactuses thrive here. The sun is intense here | Decided to develop this area  Reasons:   1. Few animal and plant species 2. Solar power panels could provide shelter for animals 3. The power facility would not cause harm here |
| Borneo Mangroves | Wind power | Coastlines are windy  The mangroves are not very high, the wind might be strong here | Decided not to develop this area  Reasons:   1. A wind power facility would disrupt waterfowls 2. Many mangroves would need to be removed, and mangroves are a protected species |

**Discussion**

The participants in this study were aware that alternative power facilities do not protect the environment. The students accepted the high scaffolding task without negative emotion. The program show that students responded by discursive logical reasoning or misconceptions. If the educator corrected these mistakes immediately might make students focus on right/wrong answer then making their own reasoning.

In the education program, the information that supported the students’ reasoning and decisions came from the diorama inquiry. This inquiry with their preconceptions for the relationship between climate and landscapes. The program could make students aware the tension between alternative power facility and environmental protection. But the researcher can not predict this perceive would be good for environmental education or not.

References (Please refer to APA 6th edition format)

Abu-Shumays, M., & Leinhardt, G. (2002). Two docents in three museums: Central and peripheral participation. In G. Leinhardt, K. Crowley, & K. Knutson (Eds.), Learning conversations in museums (pp. 45 – 80). Mahwah, NJ: Erlbaum.

Banchi, H., & Bell, R. (2008). The many levels of inquiry. Science and Children, 46, 26–22.

Bruner, J.S. (1961). The act of discovery. Harvard Educational Review, 31, 21–32.

Chiu, M., Yeh, H. & Spangler, J. (2016) Public Constructs of Energy Values and Behaviors in Implementing Taiwan's ‘Energy-Conservation/Carbon Reduction’ Declarations, International Journal of Science Education, Part B, 6:1, 46-67, doi:10.1080/21548455.2014.969357

Collins, A., Brown, J. S.,&Newman, S. E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In L. B. Resnick (Ed.), Knowing, learning, and instruction: Essays in honor of Robert Glaser (pp. 453–494). Hillsdale, NJ: Erlbaum.

Cox-Petersen, A. M., Marsh, D.D., Kisiel, J., & Melber, L. M. (2003). Investigation of guided school tours, student learning, and science reform recommendations at a museum of natural history. Journal of Research in Science Teaching, 40(2), 200-218.

Davidson, S. K., Passmore, C., & Anderson, D. (2010). Learning on zoo field trips: the interaction of the agendas and practices of students, teachers and zoo educators. Science Education, 94(1), 122-141.

Davis, E. A., & Linn, M. C. (2000). Scaffolding students’ knowledge integration: Prompts for reflection in KIE. International Journal of Science Education, 22, 819–837.

Erduran, S., & Dagher, Z. R. (2014). Reconceptualizing the Nature of Science for Science Education, Contemporary Trends and Issues in Science Education 43, London: Springer. DOI 10.1007/978-94-017-9057-4\_4.

Falk, J. H., & Dierking, L. M. (2000). Learning from museums: Visitor experiences and the making of meaning. Lanham, MD: AltaMira Press.

Gutwill, J. P. & Allen, S. (2010). Group inquiry at science museum exhibits. CA: Exploratorium.

Han, M. S., Phillips, B. C., Evans, E. M., Block, F., Diamond, J. & Shen, C. (2016). Visualizing biological data in museums: visitor learning with an interactive tree of life exhibit. Journal of Research in Science Teaching, 53, 895-918.

Hmelo-Silver, C. E., & Barrows, H. S. (2006). Goals and strategies of a problem-based learning facilitator. Interdisciplinary Journal of Problembased Learning, 1, 21–39.

Hmelo-Silver, C.E. (2004). Problem-based learning: What and how do students learn. Educational Psychology Review, 16, 235–266.

Jackson, S., Stratford, S. J., Krajcik, J. S., & Soloway, E. (1996). Making system dynamics modeling accessible to pre-college science students. Interactive Learning Environments, 4, 233–257.

Jarvis, T., & Pell, A. (2005). Factors influencing elementary school children’s attitudes toward science before, during and after a visit to the UK National Space Centre. Journal of Research in Science Teaching, 42(1), 53-83. Journal of Science Communication, 7(4). Retrieved from http://jcom.sissa.it/archive/07/ 04/Jcom0704%282008%29C01/Jcom0704%282008%29C02/Jcom0704%282008%29C02.pdf

Kisiel, J. F. (2010). Exploring a school-aquarium collaboration: An intersection of communities of practice. Science Education, 94(1), 95-121.

Leinhardt, G., & Karen, K. (2004). Listening in on museum conversations. Oxford: Altamira press.

National Energy Program One Executive Office (2015). Energy Technology and Environment: Report of National Energy Program One. Department of International Cooperation and Science Education, Ministry of Science and Technology, Taiwan.

National Institute of Educational Resources and Research. (2003). Education yearbook of the republic of china. Taipei City: National Institute of Educational Resources and Research.

National Research Council (NRC). (1996). National science education standards. Washington, DC: National Academy Press.

Quintana, C., Reiser, B. J., Davis, E. A., Krajcik, J., Fretz, E., Duncan, R. G. (2004). A scaffolding design framework for software to support science inquiry. Journal of the Learning Sciences, 13, 337–386.

Reiser, B. J. (2004). Scaffolding complex learning: The mechanisms of structuring and problematizing student work. Journal of the Learning Sciences, 13, 273–304.

Reiser, B. J., Tabak, I., Sandoval, W. A., Smith, B. K., Steinmuller, F. & Leone, A. J. (2001). BGuILE: Strategic and conceptual scaffolds for scientific inquiry in biology classrooms. In S. M. Carver&D.Klahr (Eds.), Cognition and instruction: Twenty-five years of progress (pp. 263–305). Mahwah, NJ: Erlbaum.

Russell, T. (1994). The enquiring visitor: Usable learning theory for museum contexts. Journal of Education in Museums, 15. Retrieved from http://www.gem.org.uk/ resources/russell.html/

Scott, M. (2010). The Pleasures and Pitfalls of Teaching Human Evolution in the Museum. Evo Edu Outreach:3,403–409.

Shen, Y. (2011) Study on Misconceptions of Global Warming for Primary School Students and Teachers. Master thesis, Graduate Institute of Environmental Education, National Taiwan Normal University.

Stocklmayer, S., & Gilbert, J. K. (2002). New experiences and old knowledge: towards a model for the personal awareness of science and technology. International Journal of Science Education, 24(8), 835-858.

Toth, E. E., Suthers, D. D., & Lesgold, A. M. (2002). “Mapping to know”: The effects of representational guidance and reflective assessment on scientific inquiry. Science Education, 86, 244–263.

Tran, L. U. (2007). Teaching science in museums: The pedagogy and goals of museum educators. Science Education, 91, 278-297.

White, B.Y., & Frederiksen, J.R. (1998). Inquiry, modeling, and metacognition: Making science accessible to all students. Cognition and Instruction, 16, 3–118.

Yeh, J. H. (2017). Museum Science Teaching: Museum Educators’ Personal Episteme and The Learning Experiences They Created for Visitors. In Partrisha, P. eds.: Preparing Informal Science Educators. Springer Netherlands.

Yeh, J. H. & Ku, C. C. (2011). The Impact of Counting Carbon-footprint During the Energy Education Teacher Seminar: Cognition, Attitudes and Motivation toward Energy Conservation Actions. Paper presented in 2011 International Forum for a Low Carbon Vision, Taipei.

Yeh, S., Huang, J. & Yu, H. (2017). Analysis of Energy Literacy and Misconceptions of Junior High Students in Taiwan. Sustainability, 9, 423; doi:10.3390/su9030423

Yoon, S. A., Elinich, K. Wang, J. Van Schooneveld, J. B. & Anderson, E. (2013). Scaffolding informal learning in science museums: how much is too much? Science Education, 97, 848-877.