Iyer, S. et al. (Eds.) (2022). Proceedings of the 30th International Conference on Computers in Education.
Asia-Pacific Society for Computers in Education

Issue-based Guided Inquiry Model with Real Socioscientific Open Data <City Auncel>

Yu-Hao LU *, Ju-Ling SHIH & Geng-De HONG
Department of Network Learning Technology, National Central University, Taiwan
*yuhao.lu@g.ncu.edu.tw

Abstract: Scientific literacy is one of the key learning for modern students to be cultivated. Therefore, the main purpose of this study is to propose a issue-based guided inquiry model wherein students use real open data to solve socioscientific issues. Through hypothesis, students actively conduct content investigation, data collection and interpretation, and ultimately result generalization to build their own resolutions to treat socioscientific issues. Then, students learn from each other about the content interpretations and at the same time hear and compare different results done by the other groups. The results show the online guided inquiry model can increase students' motivation to learn and open-ended questions with appropriate orientation will encourage students to delve deeper.

Keywords: Inquiry-Based Learning, Issue-Based Learning, Socioscientific Issues

1. Introduction

Inquiry is commonly seen as a mode of learning scientific knowledge to understand a phenomenon that arises in the natural and physical world, as a mode of learning experience, as a method of acquiring knowledge and process skills (NRC, 2000), and as a way to satisfy one's curiosity about everything, thereby to satisfy the individual's curiosity about everything, the process of exploring knowledge and summarizing and internalizing it is autonomous (Haury, 1993). Yet, there is still much room to improve the instructional design in terms of its universality and variety to be applied in other disciplines. In the online learning environment, it is fast and convenient to inquire information by exploring the web on the search engines. However, with guided inquiry, students would be limited to confined chosen data and fixed answers while without guided instruction, students might be lost in the open inquiry.

Therefore, the main purpose of this study is to propose a issue-based guided inquiry model wherein students use real open data to solve socioscientific issues. In the model, students have guided steps to approach the issues, but free to explore relevant information in real open data and come up with proposed resolutions from the perspective they assigned to role-play. It encourages active and reflective learning as well as fosters scientific literacy by allowing students to ask questions regarding the social issue, collect data they believe to be necessary, analyze and interpret the data, summarize the results to present their individual perspective with scaffold learning sheets, and hear different perspectives in the post-activity showcases and discussions.

In this study, students are provided with a variety of real open data containing text, values, images, maps, and interactive sites. Students are given inquiry guidance to come up with solutions. Thus, the research question is how the students proceed to the issue-based guided inquiry with real socioscientific open data in the <City Auncel> activity.

2. Related work

2.1 Inquiry-based learning

Inquiry-based learning is seen as a way of transferring the process of scientists' inquiry into knowledge to students' learning (NRC, 1996). Scientists approach problem solving by going through a continuous process of inquiry, through problem discovery and problem solving, in order to facilitate their own approach to explore the material and conceptual world; and by using a structural modeling approach to learning, continuously revising and refining their own unique models of inquiry in the process of inquiry (Buck, 2008). It serves as a link between the self's conceptualization of the world of experience and scientific knowledge (Duit, Roth, Komorek, & Wilbers, 2001) by using an architectural model of learning to continually modify and refine one's own unique inquiry model during the inquiry process (Buckley & Boulter, 2000). This learning model can be seen as a process of constructing knowledge, asking and refining questions, articulating one's ideas and discoveries, and explaining one's findings through direct experience in real-world settings (Song & Kong, 2014). This approach is considered to be a problem-solving approach that involves the application of multiple problem-solving skills (Pedaste & Sarapuu, 2006). Teachers should play a guiding role in the inquiry-based learning process by helping learners to brainstorm, ask exploratory questions, develop plans and conduct investigations, collect data, gather information, and apply the information to analyze and interpret the data (Hakkarainen, 2003). Looi (1998) also states that inquiry-based learning is a learning strategy and a learning strategy and that the primary focus should be on how students actively explore knowledge.

2.2 Issue-based learning

Problems arise in the social sciences are essentially philosophical and empirical in nature. Socioscientific issues include debates between different social, economic, and environmental viewpoints, but because these viewpoints are rarely fully aligned, the resulting debates are not suitable for a purely scientific solution. Thus, the problems lie at the intersection of different human interests, values, and motivations. So there is a need for adequate educational exploration treating these issues, the need to train students to recognize the constructive nature of socioscientific issue inquiry in particular the limitations of a purely applied scientific perspective, and conversely, the need for curriculum and pedagogical approaches that are fundamentally constructivism, a model of education in which social science issues are generally considered to be shaped by human interests and social and environmental contexts (Robottom, 2012).

3. Socioscientific Issues and Online System Design

"The endangered Shihu (Leopard Cat)" is used as the theme of the activity of <City Auncel> as the examplary Taiwan socioscientific issue. Factual information is presented based on the Miaoli area in Taiwan where the survival and activity rate of Shihu is currently the highest. Students explore the real open data assigned to use in the inquiry system with guided steps. Real open data and resource sites selected for <City Auncel> include four domains (Figure 1): 1. Water Resources; 2. Land Information; 3. Animal Conservation; 4. Vegetation Distribution. Web forms are used and plugged in to the inquiry system providing information and recording the activity process of learners' explorations. Through the inquiry process, learners quickly understand the in-depth content of the topic, and carry out a complete search for information, and document findings, express their positions regarding to the issues in the system.

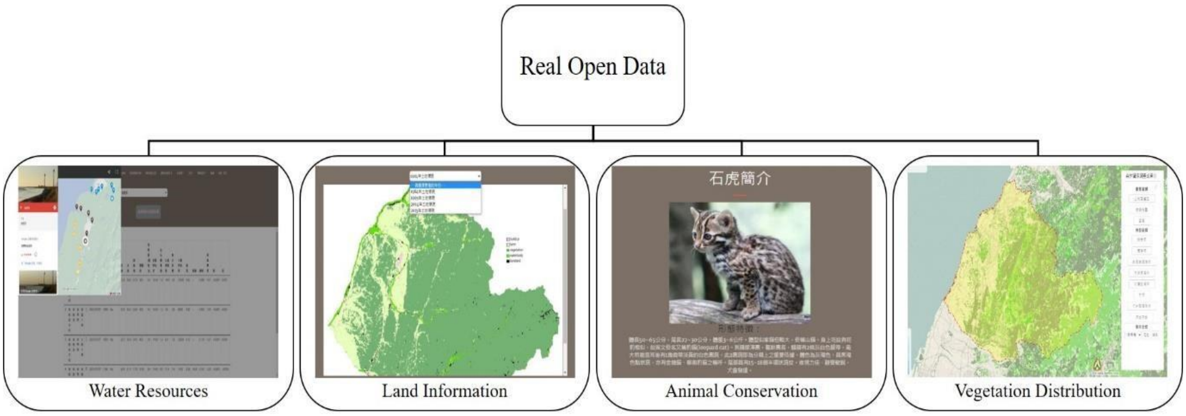

Figure 1 Real open data domains for <City Auncel>

The endangered Shihu issue comprises six key factors: (1) the excessive development of the land leads to the disappearance of Shihu habitat; (2) the development and construction of the road fragmented Shihu habitat; (3) road kills; (4) traps for hunting poultry and livestock that accidentally caught Shihu; (5) pesticides and poisonous bait, accidentally poisoned Shihu, or reduce Shihu's food supply; (6) human beings hunt Shihu to eat the meat. The inquiry is open inquiry without disclosing the six factors to the students but to guide them to explore the reasons that affect the survival of Shihu. With the real open data of the above four domains, students gain insight into the composition of causes, describe phenomena, and make action plans.

The inquiry starts from the introduction to Shihu's endangerment (Figure 2). After the introduction, students were asked to form groups of three with respective roles. Through diverse real open data, students complete their individual task in the role. Once the individuals submit the investigation report with action plans, they have discussions within groups to gain insights from perspectives of different roles. Thus, students learn from each other about the content interpretations and at the same time hear and compare different results done by the other groups.

Figure 2 Activity Flow

4. Research design

4.1 Research Framework

The online socioscientific inquiry activity was conducted in an in-service graduate course at a university in Taiwan. Twenty-four students, 14 males and 10 females, are with information technology and education backgrounds. The age of the participants were between 24 and 50 years old. They were randomly divided into groups of three with total of 8 groups.

The research process of this study is as *Figure 3*. Before the start of the inquiry activity, the introduction of the topic and the system operation instructions were carried out. After the inquiry, the students do reflection and feedbacks.

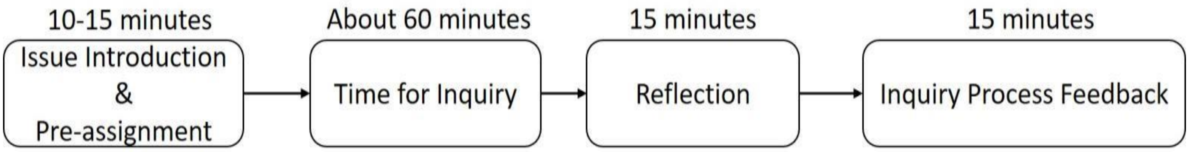

Figure 3 Research Process

4.2 Research Tools

Table 1 shows the guided inquiry 5-step process and content of <City Auncel>. The first step is to explore the context with an open-ended question. In <City Auncel>, we asked "Where do you expect to conserve or develop?". The second to forth steps guide the students to explore the real open data within the given domains points to the factors of targeted issue. In <City Auncel>, each of the guided questions aims to address certain crisis factor for endangered Shihu. Students conduct in-depth investigations of the plantations of the chosen area, the altitude of land, road and commercial development, etc. The last step is hrough this topic, students can have a further understanding of the existential crisis of Shihu in the process of inquiry learning.

Table 1. *Guided Inquiry Model*

Step	Guidance	Question Type	<City Auncel> example
Step 1	Explore the issue context	open-ended	Where do you expect to conserve or develop? (Choose an area with predicted reasons.)
Step 2	Explore real open data with assigned domain	guided to explore	How is the water quality in the chosen area?
Step 3		guided to explore	What are the forest types at the chosen area?
Step 4		guided to explore	What is altitude of the chosen area, and are there road development?
Step 5	Explore real open data beyond assignment	close-ended	Is the chosen area on the Shihu's corridor?

5. Results

5.1 Domains of Inquiry

For step 1, the open-ended question, students make their action plans in their roles. Their plans were analyzed and categorized in the unit of words and sentences in terms of the content items that students mentioned in their reports. Total frequencies of analysis categories are shown in Table 2.

The total frequencies of students inquiry items out of 8 groups are 54, among which the domain of Land Information is mostly mentioned. From the interviews, it is known that the students have overviewed step 2 and 3 about investigations to Water Resources and Vegetation Resources, so they put more informatioin related to land and Shihu in step 1. Meanwhile, students also mentioned information beyond the assigned 4 domains including culture, population, and role perspectives.

Table 2 *Total frequencies of inquiry items in data categories*

Data Domains	Total Frequencies of Inquiry Content Items
Water Resources	8
Land Information	21
Animal Conservation	13
Vegetation Distribution	2
Culture	1
Population	2
Role Perspective	7
Total Items	**54**

5.2 Inquiry beyond Domains

Figure 4 shows the domains and categories of the data content investigated by students.

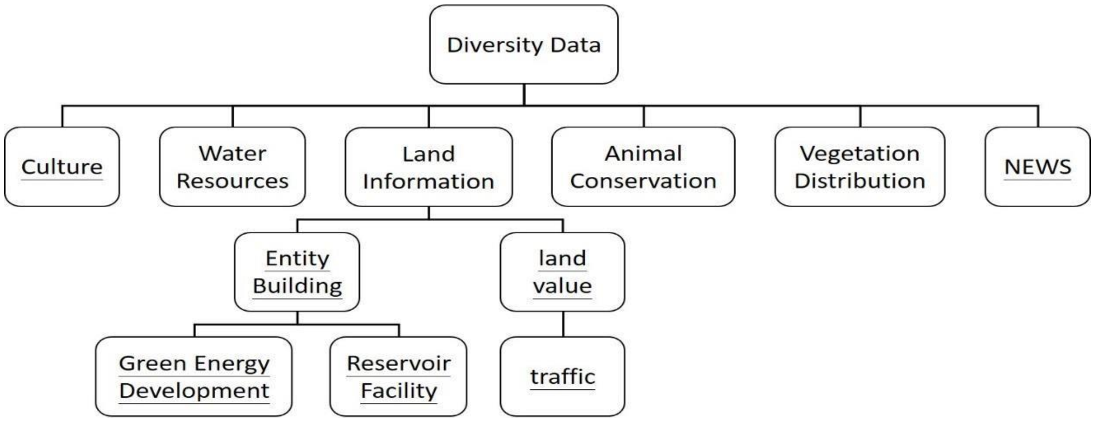

Figure 4 Inquiry Model

It is found that students explore beyond the original four domains of data on land information, water resources, animal conservation and vegetation, and have more explorations into entity building, land value, green energy development, reservoir facility, and traffics. It is evident that they have interest in the inquiry model to explore more for resolving the issues. Nevertheless, in this study, students focus more in the land information domain since it is the only open-ended question. Questions leading to other domains are guided questions that limited students' motivation and curiosities to conduct free explorations in those domains. It is to conclude that open-ended questions with appropriate directions would encourage students to do in-depth inquiries.

6. Conclusion

In this study, we propose an issue-based guided inquiry model that allows learners to explore a variety of real open data. Through hypothesis, students actively conduct content investigation, data collection and interpretation, and ultimately result generalization to build their own resolutions to treat socioscientific issues. The online learning system allows learners to explore the content they wish to know through other means other than the content designed by the researcher, which in fact shows the learners' commitment to the exploration of the topic. It is evident that the online guided inquiry model can increase students' motivation to learn.

Acknowledgements

This study is supported in part by the National Science and Technology Council (previously known as Ministry of Science and Technology) of Taiwan, under MOST 108-2511-H-008 -016 -MY4.

References

Boulter, C. J., & Buckley, B. C. (2000). Constructing a typology of models for science education. In *Developing models in science education* (pp. 41-57). Springer, Dordrecht.

Buck, L. B., Bretz, S. L., & Towns, M. H. (2008). Characterizing the level of inquiry in the undergraduate laboratory. *Journal of college science teaching*, *38*(1), 52-58.

Duit, R., Roth, W. M., Komorek, M., & Wilbers, J. (2001). Fostering conceptual change by analogies—between Scylla and Charybdis. *Learning and Instruction*, *11*(4-5), 283-303.

Hakkarainen, K. (2003). Progressive inquiry in a computer-supported biology class. *Journal of research in science teaching*, *40*(10), 1072-1088.

Haury, D. L. (1993). Teaching science through inquiry. *Striving for excellence: The national education goals*, *2*, 71-77.

Looi, C. K. (1998). Interactive learning environments for promoting inquiry learning. *Journal of Educational Technology Systems*, *27*(1), 3-22.

National Research Council. (1996). *National science education standards*. National Academies Press.

National Research Council. (2000). *Inquiry and the national science education standards: A guide for teaching and learning.* National Academies Press.

Pedaste, M., & Sarapuu, T. (2006). Developing an effective support system for inquiry learning in a web-based environment. *Journal of computer assisted learning*, *22*(1), 47-62.

Robottom, I. (2012). Socio-scientific issues in education: Innovative practices and contending epistemologies. *Research in science education*, *42*(1), 95-107.

Song, Y., & Kong, S. C. (2014). Going beyond textbooks: A study on seamless science inquiry in an upper primary class. *Educational Media International*, *51*(3), 226-236.