STUDENT INQUIRY LEARNING THROUGH ENVIRONMENTAL HEALTH SCIENCE CURRICULUM: PRELIMINARY FINDINGS

Abstract

The purpose of this study was to examine students' learning through their experience of environmental health science curriculum in terms of inquiry questioning and ideas about approaches to answering their own questions. A total of 200 9th-grade high school students taught by two teachers in one school wrote responses to environmental health issues at the beginning and at the end of 10 week long curriculum. In the pre-journal, students responded to the case as consumers and took on passive roles in inquiry approaches. More students asked about simple information and mentioned passive approaches to answering the questions such as asking the teacher or experts for answers. In contrast, in the post-journal, more students took on a researcher or investigator role as they asked questions more about data analysis, sought an explanation and desired to collect and analyze data to answer their questions. Moreover, students' approaches to answering their questions were more directed indicating their understanding of the connection between questions and inquiry methods. Many students in this study seemed to transform their position in responding to the case after their learning experience with the curriculum.

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Student Inquiry Learning through Environmental Health Science Curriculum: Preliminary Findings

Introduction

This project addresses the current science education goal of achieving scientific literacy for all students (AAAS, 1989; NRC, 1996). In contemporary science- and technology-based society, most people contact with science through many socio-scientific issues both as individuals and as members of society. "Science is no longer the specialized activity of a professional elite" (Wilson, 1998, p. 2048). Science has become part of the world culture and available to all as a way of learning about the material world and as part of societal issues. The modern citizen encounters not only the successes of science but also the risks caused by science. Contemporary science is often characterized by a number of uncertainties. Moreover, science in real life does not come in mutually exclusive disciplines; rather, real science comes in interdisciplinary form in which causal explanations in one discipline depend on those in other disciplines including various sciences, politics, and economics (Rudolph, 2005). Such uncertainty and interdisciplinarity are the nature of science that the contemporary citizen must deal with. Therefore, science education should address the complex nature of science in preparing scientifically literate citizens.

Teaching for scientific literacy involves more than abstract knowledge. Scientifically literate people should be able to understand and respond critically to media reports of science-related issues; be able to hold and express a personal point of view on science-related issues;

appreciate the process of science through an understanding of the ways to establish scientific explanations (AAAS, 1989; DeBoer, 2000; Millar & Osborne, 1998; Shamos, 1995). These capacities cannot be fully developed through didactic teaching. Students need to experience how science works in real life through participating in authentic inquiry activities (Resnick, 1987; Roth, 1995). Moreover, exposure to real science facilitates students' application of school learning to everyday life (Bransford, Brown, & Cocking, 2000).

Environmental Health Science Education Curriculum

Funded by the National Institution of Environmental Health Science, a series of high school science curricular modules were developed under the title of "Hydroville," and refined through pilot implementation for five years. The curriculum goals were in alignment with the goal of current science education reform, i.e., developing scientific literacy by emphasizing development of problem-solving and decision-making capabilities through increased awareness of environmental effect on human health, science content knowledge and inquiry skills. The Hydroville curriculum was based on problem-based learning models in its features, such as deriving question that were anchored in a real-world problem, investigations, final product of investigations, and collaboration (Krajcik, Blumenfeld, Marx, Bass, Fredricks, & Soloway, 1998).

The Hydroville curriculum is composed of four modules. Each of the four modules is designed to last from 9 to 12 weeks. The curriculum features real-world scenarios–based on actual occurrences and real data–that take place in the fictional town called Hydroville. This study focused on one of the four modules, Water Quality. The module starts with watching a video scenario in which the annual water report from the city water department shows that certain pollutants in the water supply have increased significantly, and, for the first time, trace amounts of trichloroethylene are present. After the introduction to the issue, students investigate possible causes of the increase in contaminants in the water supply and work with the council to develop tax measures that will support various remediation efforts. Each team, representing a particular "point of view" of different professionals involved in the investigation decide which tax measure suits its interest and present a two-minute TV spot advocating for that measure. Throughout the unit, students work in teams, collect relevant data through conducting hands-on activities and reading background information. They conclude the unit by voting on the tax measures.

Identifying Problems and Posing Questions

Among various manifestation of scientific literacy, this study focused on capabilities to critically examine socioscientific issues for intelligent participation in decision-making (Shamos, 1995). The ability to critically understand socioscientific issues depends on capabilities to understand science related news reports and identify underlying problems from wider perspectives that lead to a solution for satisfying various stakeholders of the issue (AAA, 1989).

Along with problem identification from various perspectives, posing appropriate questions is the driving force for scientific inquiry (Nickles, 1988). Posing questions is a basic skill required for scientific thinking. Moreover, questions are an important part of scientific inquiry (NRC, 2000) and student-generated questions have substantial educational potential in directing students' inquiry and guiding their knowledge construction (Olsher & Dreyfus, 1999).

Asking research questions in science usually requires a combination of domain-specific declarative knowledge and procedural or strategic knowledge. For example, Scardamalia and Bereiter (1992) reported that students' lack of content knowledge did not change the productivity of students' posing questions but it was related to the quality of questions posed by students. When they had a basic understanding of the topic, students' posed "wonderment questions" that were challenging and beyond basic information seeking. Graesser and Person (1994) also found that the frequency of student questions was not related to their learning. It was quality of questions that was related to student learning outcomes. These studies suggests that the nature of student questions serves as an indication of student understanding of the content as well as thinking skills.

Many research studies identified and categorized student generated questions in order to understand students' thinking processes (e.g., Dillon, 1988; Keys, 1998). Whereas many studies categorized student questions in one dimension on a continuum of high to low levels, Dori and Herscovitz (1999) attended to three dimensions of questions: orientation, relation to the case, and complexity. This study is particularly relevant to the current study because of its similarity in content, i.e., environmental science and its use of similar context of student questioning, i.e., response to cases. On the other hand, there is a dearth of research on understanding students' inquiry capabilities in terms of their approaches to problem solving.

The purpose of this study was to examine students' learning outcomes from their experience of environmental health science curriculum in terms of inquiry capabilities such as inquiry questioning and ideas about approaches to inquiry into their own questions. Research questions included: (1) What are the types of questions students ask and changes in student questions through their experience of problem-based curriculum? (2) What are students' ideas about approaches to inquiry into their own questions?

Literature Review

In this section, we review the literature on student questions in science and how they are related to science inquiry in relation to the current study.

Student Questions in Science Learning

Research on students' questioning has a long history (Dillon, 1988). Our review focused on the ways research has categorized student questions as an effort to understand the level of learning. Several studies have analyzed student questions but the purpose behind those studies has varied and, as a result, the methods of analysis have been variable as well. However, many of analyses of student questions utilized Bloom's Taxonomy (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956), an approach that centered on identifying the cognitive level of a question. This taxonomy has been applied to both teacher questions and student questions over the years. In that taxonomic system low-order questions focused on knowledge, comprehension, and application. High order questions were those that included analysis, synthesis, and/or evaluation. Shepardson and Pizzini (1991) used a modified form of Bloom's Taxonomy to look at how students linked pieces of information and created output questions in relation to a text. Likewise, Graesser, Person, and Huber (1992) developed a hierarchal system of analysis of questions in which they defined deep-reasoning questions in relation to Bloom's taxonomy.

Several studies focused on questions asked by students during the course of a classroom lecture or activity. At the elementary and middle school level, Scardamalia and Bereiter (1992) and later Chin, Brown, and Bruce (2002) classified questions into two categories: requests for basic information and questions that addressed wonderment. At the high school level, Hofstein, Navon, Kipnis and Mamlok-Maaman (2005) classified questions into low-level and high-level. The low-level questions were those that could be answered from the text or could be answered with a single word response. Their high-level questions were those that required additional experimentation or research in the literature (i.e. internet or additional texts) to answer. In the context of questions asked during a high school chemistry classroom, Rop (2003) identified student inquiry questions using three criteria: (a) those related to the content under discussion, (b) those that arose from student curiosity, and (c) those that pursued personal inquiry that went beyond the curriculum.

While the previous examples primarily focused on questions asked during classroom discussions, others have looked at the ability of students to ask researchable questions. At the 7th grade level, Cuccio-Schirripa and Steiner (2000) were interested in researchable questions and in how student interest levels in subjects drove those questions. The first part of their study consisted of a personal interest test to identify subjects of high and low interest to individual students. Subsequently, the students were asked to write questions about the previously identified high and low interest domains. The questions that resulted were classified on a four-level scale of increasing sophistication. Level 1 questions centered around one word or memorized statements. Level 2 questions consisted of explanations, descriptions, classifications, and/or comparisons. Level 3 questions centered around experiments where the variables were not yet identified but included a measurable and/or manipulable approaches. The highest level, Level 4, was similar to level 3 but the students had already identified the variables that they would test. Thus, hypothesis testing had a high rating in their study.

As a method to assess student learning out of a high school environmental course, Dori and Herscovitz (1999) analyzed questions that students posed in response to an environmental case. They categorized the questions into three: Orientation, Relation to case study, and Complexity. Complexity was the main ranking system for evaluation of learning, and it largely hinged on whether the students asked questions that went beyond what could be determined from the readings. The complexity category was further subdivided into four categories: (a) application and/or analysis, (b) interdisciplinary approach, (c) judgment and/or evaluation, and (d) taking position and/or personal opinion.

The analysis of student questions has even gone beyond the classroom. Baram-Tsabari, Sethi, Bry, and Yarden (2006) looked at 4th to12th grade student questions that were sent to an “ask-a-scientist” website. At the cognitive level, these authors categorized the questions into three levels: (a) questions about phenomenological properties, (b) questions about comparisons, and (c) questions about causal relationships. In addition, they further classified the questions based on the type of information requested. The type of information ranged from general information to predictions related to a hypothesis, and to open-ended on the dimension of complexity of the information.

The studies about student questions in general examined the cognitive levels either in terms of complexity or in terms of types of information. These studies imply that students who ask more cognitively high-level questions such as questions about causal relationships as opposed to simple description of phenomena have more sophisticated understanding of the concept.

Classroom Inquiry and Student Questions

The current science standards promote inquiry as a central component of science and as an approach to science learning. Inquiry approaches include opportunities for students to find solutions to real world problems by asking scientific inquiry questions, designing and conducting investigations, gathering evidence, making claims based on evidence, and communicating findings (NRC, 2000).

A few studies demonstrated the effects of inquiry approaches on student learning. Schauble, Klopfer, and Raghavan (1991) found that students' long-term engagement in science inquiry developed students' reasoning about scientific phenomena. Roth and Roychoudhury (1993) demonstrated that students' engagement in authentic science inquiry activities helped students learn how to select research problems and design investigations to answer their questions. Moreover, the students in their study became more sophisticated at identifying variables and searching for relations between variables.

Among the many features of the inquiry approach to science learning, asking inquiry questions is the key element of science inquiry and promoted as one of essential educational goal in science (NRC, 1996). Whereas there is some research on student questions as reviewed in the previous section, there is a dearth of research on student questioning during inquiry activities. Krajcik et al. (1998) examined what middle school students do during an inquiry class. They analyzed how students generated inquiry questions and the nature of questions. Similar to other studies reviewed in the previous section, student questions were grouped into two: questions about phenomena ("descriptive questions") and questions about relations between variables ("relational questions"). Interestingly, students in their study generated questions based on their everyday experiences, and evaluation of inquiry questions in terms of scientific merit was not part of the process of decisions on inquiry questions. The students in the study based their decisions on inquiry questions on personal interest or preferences. Apparently, students' questions demonstrate their background knowledge (Scardamalia & Bereiter, 1992), personal interest, and their everyday experience. On the other hand, the study pointed out the needs for supporting student learning of what counts as scientific questions that can lead to productive scientific inquiry.

Methods

Participants

The students in this study included 200 9th graders who were enrolled in a course entitled "Science Inquiry" in a suburban high school in the US. The high school is located in an affluent suburb of a city of about a half million population. At the time of the study, the school had an enrollment of about 2,400 students with about 33% of minority population (7% ELL). For high school graduation diploma, the state mandated two years of science courses with a grade of C- or better, and the school required the "Inquiry Science" course for all 9th graders except those who were ready to take college preparatory biology course. About a half of 9th graders were taking the course while some sophomores were re-taking the course to recover their grades. Mrs. L taught five sections of the course (109 students). Mr. D taught three sections of the course (91 students). The two teachers were Caucasian and had less than 3 years of teaching experience. It was the first time for the two teachers to implement the water quality module, but they used a different module of the Hydroville in the previous year. Therefore, they were familiar with the format and pedagogy promoted in the curriculum. According to the teachers' self report, both teachers covered common parts of the curriculum about 80% (measured by sections of the curriculum covered) except the students in Mrs. L's class did not present their results to the whole class because Mrs. L finished the curriculum early for a leave.

Data Collection

In order to examine students' learning through the curriculum, multiple sources of data were used, but this study focused on student written responses in pre- and post-journals that required the students to respond to environmental health cases. Using environmental health cases in tapping students' ideas seems to be authentic to the goal of science education for scientific literacy. We tried to assess students' learning through their response to environmental health issues just like regular citizens encounter science through media such as TV news or newspapers.

In the pre-journal (administered at the beginning of the unit), students watched a case of water quality issue on VCR and answered several questions including defining the problem, posing questions, and suggesting ways to answer the questions. In the video case, there was a TV news report on environmental health hazards about water in the town and the town residents' reactions to the news. In the post-journal (administered at the end of the unit), students were given a new environmental health issue in faux newspaper reports in which contaminated chicken feed allegedly caused the death of chickens and mutations of chicken offspring (Boston University Center for Interdisciplinary Research in Environmental Exposures and Health, 2007). Students answered the same questions regarding the new case. Although the two cases were different in formats (VCR format vs. written newspaper report) both cases were new to the students and described explicitly environmental health problems that might influence human health, hinted at possible causes of the problem, and identified relevant agencies involved in solving the problems.

Data Analysis

All the students' written responses were typed in MS Word. Two researchers read the data in separate and coded within two categories: (a) types of student questions and (b) approaches to answering the questions. Informed by the literature on student questioning and discussion after initial coding, we agreed on nine subcategories of types of student questions that were grouped into three later and four categories of approaches to answering the questions for initial coding. With regards to types of student questions, we assigned 95% to the same categories in the pre-journal data analysis while 94% to the same categories in the post-journal data analysis. With regards to approaches to inquiry, we assigned 93% to the same categories in the pre-journal data analysis while 96% to the same categories in the post-journal data analysis. The final results eliminated the data coded inconsistently between the two researchers.

Findings

In this section, we discuss first the types of questions students asked about the case, then their ideas about how to find answers to their questions, and finally connections between types of questions and ideas about inquiry methods. By comparing the types of questions and ideas about approaches to answers in their pre-journals with those in post-journals, we aimed to identify the degree to which students learned about doing inquiry in the area of complex, interdisciplinary scientific problems anchored in real world.

Types of Student Questions

Many students asked more than one question about each case, and the number of questions was not significantly different between pre- and post-journal responses (2.1 questions per student in both pre- and post-journal). Initially, nine different types of questions were identified in the data as the students asked about eight different aspects of each case and/or reacted to each case with a question. The nine types of questions include: (1) Questions about events or phenomena that can be observed in relation to the case presented (P). (e.g., “What’s going to happen to Hydroville if the water’s danger level rises?”) (2) Questions about data presented in the case that required data analysis to answer the question (A). (e.g., “At the rate it’s going up, how soon will it be unsafe?”) (3) Questions about the processes that led to the event/phenomenon that required causal analysis to answer the question (CA). (e.g., “I would like to know the source of the contaminants and how they got there.”) (4) Questions about something that might be connected or correlated to the phenomenon that required correlation analysis to answer the question (CR). This was differentiated from CA because the questions did not explicitly ask about the cause although implied sometimes. For example, a question, "Are there contaminants in the feed?" assumed that the feed might be the cause of the event but not explicitly stating the feed as the "cause" for the phenomenon in questioning. (5) Questions about what the solution would be (S). (e.g., “What can you do to prevent it from happening again?”) (6) Questions about socio-political context of the problem (SC). (e.g., “Is there a law against polluting the water?”) (7) Questions about simple and/or random information regarding the case (I). (e.g., “How long did it take to notice the feed was contaminated?”) (8) Questions about "how to" find out answers or solutions (M). (e.g., “Where do you go to test the water?”) This type of question is different from the analysis type questions (A) because these questions are about generic method of how to solve the problem rather than how to analyze data. (9) Reaction to cases: a few students reacted to the case in the form of questioning (R). (e.g., “Is that true?”) The frequencies of the types of questions from the two teachers’ classes were very similar and hence, the data were combined.

The nine categories provided initial insight into the pattern of student questions. However, we simplified the nine types of questions into three by combining questions of similar nature that could indicate different levels of students’ inquiry skills because we intended to assess student learning outcomes from the Hydroville curriculum. Questions about phenomena (P), solution (S), random information (I) and unspecified method for searching solutions (M), and simple reaction to the case (R) were grouped as generic questions because these questions did not indicate any commitment to solving the problem that is actively looking for solutions; rather, these questions seemed to be asked either for the sake of asking a question or from the perspective of consumers rather than inquirers. In addition, these questions required cognitively simple procedures to answer. Therefore, the expected learning outcomes from answering the questions were low. On the other hand, active inquiry questions that consisted of questions about data analysis (A), cause of the case (CA), and correlations among factors in the case (CR) were grouped together because they indicated students' understanding of the case from a scientific inquiry perspective and/or a commitment to the case as an inquirer. Moreover, these questions required high-level cognitive processes to answer. Therefore, the expected learning outcomes from answering the questions were high. Finally, questions about socio-political contexts of the case were separated from the other types of questions because those questions were different from scientific inquiry skills while central to understanding of the case from a broader perspective (Table 1).

Table 1. Types of Student Questions in Response to Environmental Health Issues

Types of student questions	Pre	Post	Difference (post-pre)
(P) Questions about events or phenomena that can be observed in relation to the case presented	4.6%	8.2%	3.6%
(S) Questions about what the solution would be	10.4%	6.9%	-3.5%
(I) Questions about simple and/or random information regarding the case	31.1%	11.9%	-19.2%
(M) Questions about "how to" find out answers or solutions	5.4%	1.3%	-4.1%
(R) Reaction to cases: a few students reacted to the case in the form of questioning	3.0%	4.4%	1.4%
Total Generic Questions	54.5%	32.7%	-21.8%
(A) Questions about data presented in the case that required data analysis to answer the question	3.3%	7.2%	3.9%
(CA) Questions about the processes that led to the event/phenomenon that required causal analysis to answer the question	24.3%	39.9%	15.6%
(CR) Questions about something that might be connected or correlated to the phenomenon that required correlation analysis to answer the question	5.7%	11.6%	5.9%
Total Active Inquiry Questions	33.2%	58.8%	25.6%
(SC) Questions about socio-political context of the problem	12.3%	8.5%	-3.8%

Compared with the pre-journal responses, students asked about 22% less simple information-seeking questions and about 26% more inquiry questions in the post-journal. There was no significant change in students' asking socio-political questions.

Approaches to Answering Questions

Not all students provided specific ideas about how to answer their questions. Many students provided generic responses such as "investigate the problem," "think of all possible ways to fix the problem," or "gather more information." These types of answers were excluded in the final analysis because they lacked information on students' knowledge about how to do inquiry. In so doing, about 80% of student responses in both pre- and post-journals were included in the final analysis.

Students' ideas about approaches to answering their own questions were coded based on the sources of knowledge/information indicated in the responses. Four categories were drawn: (1) text media such as Internet, books, reports, etc. (T) (e.g., "I would probably go to the website for further information."); (2) hiring or asking experts to do the investigation (E) (e.g., "Talking to specialist, like the hydrogeologist etc."); (3) Collecting data from field or lab; analysis of data; gathering information (D) (e.g., "You can go to [the Creek] to find and test the water for your chemicals."); (4) Collecting data based with a clear goal or hypothesis of data collection (DH) (e.g., "Test chemical and possible places to see if those places discharge that chemical in some way.").

Table 2. Student Approaches to Answering Questions

Categories of approaches	Pre	Post	Difference (post-pre)
(T) Text media such as Internet, books, reports, etc.	27.3%	35.1%	7.8%
(E) Hiring or asking experts to do the investigation	30.2%	4.5%	-25.7%
(D) Collecting data from field or lab; analysis of data; gathering information	28.1%	27.0%	-1.0%
(DH) Collecting data based with a clear goal or hypothesis of data collection	14.4%	33.3%	18.9%

Compared with pre-journal responses (Table 2), students suggested more hypothesis-based, goal-oriented approaches in post-journal responses (about 19% increase) while utilizing experts was reduced dramatically (about 26% decrease). This comparison indicated that the students became more specific in coming up with ideas about how to answer their question and took a more active inquirer's position rather than a passive consumer of science position.

Relationship between Types of Questions and Approaches to Answers

It was one thing to be able to ask inquiry questions and it was another to take active approaches to inquiry such as data collection and analysis as inquirers as opposed to asking experts. Asking inquiry questions might be more about students' understanding of the case from a scientific inquiry perspective, i.e., seeking for understanding causal relationships or mechanisms of the case to explain the phenomenon. On the other hand, suggesting ways to answer their questions might indicate knowledge about how to inquire into the phenomenon and/or willingness to actively engage in inquiry.

We examined possible connections between the types of questions students posed about the case and their ideas about how to answer their own questions. We were interested in finding out whether different levels of inquiry questions were related to students' ideas about ways to answer questions. We focused on active inquiry questions (CA, CR, A) that could obviously lead students to active scientific inquiry (Table 3). Compared with pre-journal responses (Table 3) students' inquiry questions that were connected to their positions to take an active role in answering their questions increased by about 29%. In other words, students who were able to ask specific inquiry questions (CA, CR, A) became more knowledgeable about inquiry methods and/or took more active stance toward how to answer their questions. On the other hand, students who suggested to find answers by asking experts (passive position toward inquiry) decreased by about 9%.

Table 3.

	Pre	Post	Difference (post-pre)
Inquiry questions (CA, CR, A) & active approaches (D, DH)	37.8%	66.3%	28.5%
Inquiry questions (CA, CR, A) & passive approaches (E)	16.5%	7.6%	-8.9%

Discussion and Implications

The purpose of this study was to examine students' learning outcomes from their experience of environmental health science curriculum in terms of inquiry questioning and ideas about approaches to inquiry into their own questions. In the pre-journal, students responded to the case as consumers and took on passive roles when asking questions about the case and identifying approaches to answering the questions. Many students asked about simple information and mentioned passive approaches to answering the questions such as asking the teacher or experts. After experiencing the Hydroville curriculum, in contrast, more students became analytical by asking more questions about data analysis and sought explanations in terms of correlations or causal relations in the case. These changes indicated students' increased understanding of environmental health issues from the perspective of science (Dori, & Herscovitz, 1999). Moreover, more students took on a researcher or investigator role as they suggested collecting and analyzing data to answer their questions rather than asking experts for answers. At large, students seemed to transform their position in responding to the case. At the end of 10 weeks' of their Hydroville curriculum experience, the students responded to a environmental health case more like researchers and thought that data collection and analysis were something they could be a part of than acted like all of that must be done by somebody else.

The changes in the ratio of students who connected inquiry questions to active inquiry approaches signaled another important learning outcome. Students who asked inquiry questions and suggested taking on active approached to answer their questions indicated their understanding of the connection between questions and inquiry methods. Therefore, the increase in the ratio of the students who connected inquiry questions to active approaches signaled an increase in knowledge about and/or capabilities to conduct scientific inquiry.

The findings of this study are consistent with those of Roth and Roychoudhury (1993) and Chin, Brown, and Bruce (2002) in which they found that students generated inquiry questions that reflected students' speculations on possible explanations for the phenomenon when they were engaged in problem-solving activities. Similarly, Hydroville, a problem-based curriculum, seemed to play a role of supporting students' scientific questioning at a deeper level. Students' higher level questioning indicates not only their increase in inquiry skills but also their increase in deep learning approaches (Chin & Brown, 2000). The increased connection between students' inquiry questions and their active stance toward inquiry approaches in this study suggests that students who ask inquiry questions at a high level become more knowledgeable about inquiry approaches to problem solving after their experience of the Hydroville curriculum.

The findings of this study provide some insight into the diffusion of the curriculum in other schools in similar sociocultural contexts. Considering that students from the two teachers produced similar results, when the curriculum is taught in full (i.e., 80% or more) to students of schools in affluent suburban areas similar effects on learning may be found. Further research on the effects of the curriculum on student learning in different school contexts will shed light on the educational value of the curriculum in depth.

The positive outcome of the Hydroville curriculum on student learning is promising in achieving parts of its goals, i.e., developing inquiry skills and scientific literacy. However, further thorough research will help assess its strength in achieving the curriculum goals in full. The current study lacks data on students' actual inquiry performance. Judging students' learning from their written responses to the case and suggestions about inquiry methods demonstrate only the potential of students' doing of inquiry. Further analysis of actual performance and its connection to students' written responses will shed light on the positive learning outcome in terms of students' capability of doing inquiry. Moreover, understanding how some elements of the curriculum helped the students to transform their positions will provide some insight into curriculum development and classroom enactment.

The aspects of scientific literacy dealt with in this study include understanding environmental health issues from a scientific perspective and becoming knowledgeable about inquiry methods. This may lead to an appreciation of the process of science. Further research on other aspects of scientific literacy such as expressing personal point of view on science-related issues and developing arguments based on scientific understanding as potential outcomes of the Hydroville curriculum is currently underway. The findings will provide a more complete view of the effect of the curriculum on developing students' scientific literacy in the area of environmental health science.

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