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Full Length Research Paper

Examining US college students' attitudes towards science: Learning from non-science majors

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This study examined college students' attitudes towards science in a course designed with Science Education for New Civic Engagement and Responsibilities (SENCER) ideals. SENCER uses socially engaging issues to teach basic science to non-science majors. A combination of methods was used to measure changes in attitudes (confidence and interest) and scientific literacy after completing this SENCER course. While a pre/posttest showed a significant increase in knowledge about biological concepts, the study revealed no significant change in confidence or interest in science in general as measured by the SENCER Student Assessment of Learning Gains (SALG) survey. However, a second instrument, the Biology Attitude Scale, demonstrated a significant increase in positive attitudes towards biology in particular. The case study data (including a content analysis of online reflective questions and semi-structured interviews) revealed that students' confidence in science remained the same during the semester even though their interest may have increased. This suggests that an increase in both variables (confidence and interest) simultaneously may not be needed in order to increase scientific literacy. These results have implications for college science teachers designing courses for non-science majors.

Keywords: Science education, non-science majors, scientific literacy, interdisciplinary courses.

INTRODUCTION

SENCER (Science Education for New Civic Engagement and Responsibilities) courses are designed to teach basic science knowledge through unresolved, yet interesting public issues (SENCER ideals, 2004). These courses are designed to be interdisciplinary, which allows students to connect the scientific information to other disciplines and apply it to their daily lives. Student ownership of learning is both a beneficial and challenging characteristic of SENCER-style courses. SENCER courses also focus on capturing the students' interest in science and help them to engage in civic activities using their scientific literacy. This study examined students who participated in a science course based on the SENCER ideals which included teaching science basics by demonstrating both the use and limitations of scientific knowledge in connection with public issues. Faculty representing the disciplines of biology, philosophy/religious studies, social work, science education and physiology/health science were all involved in the development of the course.

SENCER interdisciplinary courses are designed to help students overcome the overwhelming scientific illiteracy apparent in the United States.

"Approximately 95% of the American public is illiterate in science by any rational definition of science literacy" (Goodstein, 1992). Scientific literacy is what the general public ought to know about science (Durant, 1993). Scientific literacy is becoming more and more important in our day to day living. In the 2004 US Presi-dential election, for example, it is possible that most of the general public did not understand the controversial scientific issues that were debated, such as global warming and stem-cell research. Therefore, producing scientifically literate individuals would benefit society on many levels.

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Poor attitudes towards science have also been shown to increase scientific illiteracy. For example, Steiner and Sullivan (1984) found that organic chemistry students who received a grade of a C or lower more frequently self-reported themselves as worried or anxious about the subject. According to these studies, one way to increase scientific literacy is to have a more positive attitude towards science. For example, Steiner and Sullivan (1984) found that the best predictor for success (C+ or better) is a positive attitude towards chemistry, specifically characterized by claiming an interest and confidence in organic chemistry. So, how do educators encourage more positive attitudes towards science?

SENCER ideals try to accomplish this task by, "…focusing on contested issues, [SENCER] encourage student engagement with 'multidisciplinary trouble' and with civic questions that require attention now. By doing so, SENCER hopes to help students overcome both unfounded fears and unquestioning awe of science" (SENCER Ideals, 2004). If this style of course can promote a positive attitude towards science in non-science majors, then it is possible that this course may also improve the students' scientific literacy.

Another problem is that most non-science majors enroll in science courses to fulfill a general education or major requirement and not because they have a personal interest in science (Smith et al., 2004).Non-science majors may not attain a deep understanding of the science material, but they may be able to appreciate the everyday practical applications of scientific knowledge. One specific SENCER ideal explains, "SENCER invites students to put scientific knowledge and scientific method to immediate use on matters of immediate interest to students" (SENCER Ideals, 2004). Examining whether or not the students' attitudes and scientific literacy change towards science by taking this SENCER course may be used as evidence to either support or reject the need for curriculum reform in science courses and may overcome the problems of scientific illiteracy and poor attitudes towards science.

The purpose of this study was to examine students' scientific literacy and attitudes towards science in a SENCER course. Attitudes included confidence and inte-rest. Jarrett's (1999) definition of confidence as, "…self-assuredness that arises out of competence in subject matter" and Carpenter's (1983) definition of interest as, "A disposition organized through experience which impels an individual to seek out particular objects, activities, understandings, skills, or goods for attention or understanding" guided this study.

The concept for the course was based upon Eric Schlosser's book "Fast Food Nation" and used SENCER ideals to guide the course goals. The student population in the course was honors students who were non-science majors. Three research questions were the focus of this study: 1) How has the students' scientific literacy changed in this course? 2) How has the students' confidence towards science changed in this course? 3) How has the students' interest in science changed in this course?

The results of this study generated a better understanding of the impact of SENCER style courses and helped to evaluate the effectiveness of SENCER ideals for increasing scientific literacy and creating more positive attitudes towards science. By examining students' attitudes in this interdisciplinary class, it allowed for a better understanding of how interdisciplinary approaches to science impact student attitudes. It has been reported that interdisciplinary courses may promote a more positive attitude towards science, which may, in turn, increase scientific literacy (Steiner and Sullivan, 1984). Identifying courses, and particular aspects of courses, that result in both an increase in more positive attitudes towards science and increased scientific literacy will enable more effective curricular reform within college science courses for non-majors. SENCER course designers hope that these increases in scientific literacy coupled with increases in positive attitudes towards science will lead to a more active and informed citizenry. Furthermore, it may result in an increase in the number of college students selecting science as a major and lessen the continuous decline in persons pursuing careers in the fields of science, technology, engineering and Mathematics (National Science Board, 1986).

METHODS

Subjects

The subjects were the 16 students enrolled in one section of an undergraduate college Honors course at a Midwest university. The course was entitled "Food, Values, Politics and Society", and ran during the Spring Semester, 2005. The course was developed using Eric Schlosser's book "Fast Food Nation" (2001) as the central text. The subjects were all non-science majors, and at least 18 years of age. The class standing for the subjects were 2 sophomores, 7 juniors and 7 seniors.

Data collection

This study employed data triangulation or the use of multiple data collection processes, which involves comparing and integrating quantitative and qualitative methods (Patton, 2002). Bogdan and Biklen (2003) advocate for triangulation of data because, "…multiple sources lead to a fuller understanding of the phenomena you were studying." Triangulation of data attempts to gain a deep understanding of the topic at hand (Denzin and Lincoln, 2000).

Data collection instruments, procedures and analysis

During the first day of class and with the permission of the course instructors, the first author was present to recruit subjects of at least 18 years of age and get their signed informed consent required by the Institutional Review Board (IRB). The instructors introduced the researcher and she proceeded by passing out two informed consent forms to all the students. Once all the students had the form in hand, the informed consent was read aloud, which described the study, what the data was to be used for, and how the data was to be collected, analyzed and kept confidential. The subjects were asked if anyone had questions for clarification purposes. The students were assured that this participation was voluntary and in no way impacted their grade positively or negatively. Once all questions were answered, the students who were willing to participate were asked to sign and date the informed consent forms. Each subject returned one copy and kept the other copy of the informed consent forms they signed. The study included the following three quantitative data collection processes.

Biological concepts exam

The Biological Concepts Exam (developed Dr. William Rogers, Ball State University) was given as a pre-test to the students to determine a baseline of knowledge regarding biological concepts. The exam was a 40-item standard multiple choice object content test that measured biological concepts. The questions were taken from a computerized test bank and were selected based upon whether or not the question's topic would be covered in the Honors course (Dr. William Rogers, personal communication, April 6, 2005).

At the end of semester, the students took the same exam as a post-test. The students were unaware that the post-test was going to be given that day and it was not part of their grade. This was to help ensure that the test measured up to what was learned in the class and not what was studied the previous night.

The exam was graded and the correct scores were recorded. Six exam questions (questions 1, 2, 3, 4, 7, and 30) were dropped because the Honors course did not cover the material included in those questions. The mean of the pre-test score was compared to the mean of the post-test score with a paired samples t test, repeated measures design with an intervention. The t test was used to determine if there were any significant changes in group means from the beginning to the end of the semester.

SENCER student assessment of learning gains (SALG)

The second instrument used was the SENCER SALG surveys, developed by SENCER administrators, where the instruments used to measure the students' perceptions of their confidence and interest in science, the students' opinions on scientific literacy and civic engagement, and demographic information. This survey was a requirement for the SENCER grant that funded the development of the Honors course. On the first day of class, the subjects were given an assignment to complete the SENCER SALG pre-survey online before the next class period. Each student was provided with a username, password and instructions on how to access and complete the survey. This survey was completed on the students' own time and took approximately 5 – 10 min. In a similar manner, the students also completed the SENCER SALG mid-survey about 8 weeks into the course and completed a post-survey during the last week of the course semester. All of the SENCER SALG data were collected by Dr. Sue Lottridge, one of the SENCER administrators and sent back to the first author via the Internet.

Biology attitude scale

A Biology Attitude Scale was developed by Russel and Hollander (1975) in an attempt to quantify changes in attitudes. Russell and Hollander's scale included a total of 22 items, the first 14 items were Likert-type scale and the last 8 were a semantic differential scale. The present study, similar to Rogers and Ford (1997), used only the 14 Likert-type statements. The Biology Attitude Scale had 14 statements, some positive and some negative, that the students rated on a scale from 1 – 5 (strongly disagree – strongly agree). Questions 1, 4, 5, 7, 10, 11, 13 and 14 were positive questions and the remaining questions 2, 3, 6, 8, 9, and 12 were negative.

On the first day of the class, a Biology Attitude Scale pre-survey was given to the students to examine their attitudes towards biology. The students knew they were taking an Honors course that fell under the "Life Sciences" category, therefore surveying their attitudes towards biology fit in this class. During the last class meeting, the students took the same Biology Attitude Scale as a post-survey in order to measure change in attitudes over the semester.

The students' responses were reported on a scale of 1 – 5 and were reversed for the negative questions. All 14 questions were averaged for each subject for the pre-survey and post-survey. A paired samples t test, repeated measures design with an intervention was used to determine if there were any significant changes in the means from the beginning to end of the semester.

The numerical results from these instruments were coupled with the qualitative data collected by way of participant observations, student responses to online reflective questions and transcripts and field notes created by the first author based on semi-structured interviews she conducted with the students.

For the confidence and interest factors, scores were averaged for each student in the class for the pre-survey, mid-survey and post-survey. For example, all of the confidence questions were rated by the students, on a Likert-scale ranging from 1 – 5. All of the confidence questions' scores were averaged for each student in class. Each student's means for the pre-, mid- and post-surveys were compared using a one-way within-subjects (repeated meas-ures) ANOVA to determine if there were any significant changes. Post hoc analyses were performed when statistical significance was found. The same procedure was conducted for the interest questions.

Qualitative procedures and analysis

Participant observations

The first author helped to develop the Honors course under investigation in this study. As part of the instruction team, she had a fairly active role in the class and served as the participant observer. She was present at most class meetings, and conducted 6 formal observations of the class. According to Fritschner (2000), one classroom observation, as opposed to multiple observations, does not allow for changes over time in the classroom to be observed by the researcher. The observer sat in the front of the class, off to one side of the room or the other, in order to have a good view to observe the students' body movements and eye contact with the instructor. Notes were recorded on a laptop computer, focusing on verbal and non-verbal communication about the students' interest and confidence in this course. Immediately after each class session, without even speaking to anyone about the class, the observer went to her office and recorded (typed on personal computer) the observer's comments for that class period. Notes were made about different subjects' interactions, how the observer was perceived by the students (i.e., as an insider versus an outsider), interactions between instructor and students, and what the observer saw, heard and experienced in class. The observer memos were a reflection of the data collected each day and included: how the classroom was arranged; specific activities that took place during class; characteristics and mannerisms of students and instructors; the researcher's own person frame of mind and

Table 1. Means and standard deviations for biological concepts exam scores (N = 16)

Timing of test administration	M	SD
Pre-test	17.56	3.39
Post-test	21.25*	3.04

*p = .00026

emotions; how the observer felt about conflicts or problems in the classroom and the resolutions to those problems.

Online reflective questions

The students were required by the course to respond to 4 different reflective questions, which were sent to them via email. Seng and Mohamad (2002) found that the online learning environment helped to increase participation and quality of work. Each online reflective question was distributed to the class via email by the researcher and the students were instructed to respond within one week. The first reflective question was distributed during the third week of class and the second was to be completed by the eighth week of class. The third reflective question was a written assignment to wrap up the civic engagement project due by the thirteenth week of the semester and the fourth reflective question was distributed during the last week of class. The responses were analyzed using the constant comparative method described below.

Constant comparative method data analysis involved a five stage process, as described by Riley (1996), which was adapted from Strauss and Corbin (1990). The five stages were: 1) familiarization with the transcribed data and subject, 2) fragmenting and labeling the data, 3) conceptual categorization or grouping the labels into sets of relationships, 4) higher level conceptual categories or grouping the previous conceptual categories, and 5) comparing the categories to find common themes or patterns in students' responses. This data analysis process was used to help organize and code the semi-structured interview transcripts, online reflective question responses, reflective memos and field note data. This analysis helped to identify themes generated by the word data for the discussion and hopefully to help answer the original research questions.

Semi-structured interviews

Once the students completed the SALG mid-survey, the original intentions of the study were to compare the changes in the raw data from the pre-survey to the mid-survey to determine which category the student fit. Not knowing the exact results of the emerging SENCER SALG data, the three main categories in which we expected the students belong were: 1) students that demonstrated an increase in both confidence and interest in science (Gogolin and Swartz, 1992; Sundberg et al., 1994), 2) students that demonstrated no change in both confidence and interest in science (Carpenter, 1983; Gabel, 1981) or 3) students that demonstrated a decrease in both confidence and interest in science (Gardner, 1976; Sadava, 1976). Since there was a problem with the original administration of the SALG pre-survey, purposeful sampling was used to select the interviewees and ultimately the case studies (Patton, 2002). More specifically, criterion sampling was used to pick one subject to fit each of the new categories. New categories were described since a change in confidence and interest could not be measured from the SALG mid-survey data alone. The new categories included a student who ranked: 1) both high in confidence and high in interest, 2) both moderate in confidence and moderate in interest; and 3) both low in confidence and low in interest. To determine where the subjects' confidence level ranked, each score (ranging form 1 – 5) for the 19 confidence questions from the mid-survey were averaged together. The mean for each student was then ranked from low to high score (1 – 16). The interest questions and ranking were determined in the same manner. From there, the subject that ranked high in confidence and interest was selected for an interview. The same process took place for the moderate and low levels of confidence and interest. Extreme or deviant case (outlier) sampling was also used because one subject had extreme split results of high confidence and low interest.

At this point, one subject per category was involved in a 30 – 60 min audiotaped, semi-structured interview. This interview took place about 10 – 12 weeks into the semester. The tape recorder was placed in a discreet place so as not to distract the interviewees or make them feel uncomfortable. Some observer comments were made during the interview by the researcher, but not so much as to ignore the interviewee. The interview had some predetermined questions but the data from the pilot study and direction of the interview ultimately determined the entire pool of questions. Even questions that were not predetermined still were guided by the original three research questions. Semi-structured interviews were chosen to ensure that comparable data were collected across all subjects and to focus on particular topics that emerged from the participant observations and online reflective questions (Bogdan and Biklen, 2003). As stipulated by grounded theory, many interview questions were shaped based upon analysis of participant observations and online reflective question responses. Once the interview was completed, the researcher personally transcribed the audiotapes onto her computer. The transcribed data were then analyzed using the previously described constant comparative method.

RESULTS

Biological concepts exam

A paired-samples t test was conducted on the Biological Concepts Exam scores to evaluate whether the students' scientific literacy in biology changed after taking the Honors SENCER course. The means and standard deviations for the Biological Concepts Exam scores are presented in Table 1. The results indicated that the mean post-test scores (M = 21.25, SD = 3.04) were significantly greater than the mean pre-test scores (M = 17.56, SD = 3.39), $t(15) = 5.56$, $p = .00026$.There was a significant correlation between the pre-test and post-test scores ($p = .01$).

SENCER SALG

Confidence

A one-way within-subjects ANOVA was conducted with the factor being the timing of survey administration during in the semester and the dependent variable being the SALG confidence question scores. The means and standard deviations for SALG scores for confidence are pre-

Table 2. Means and standard deviations for SALG confidence scores (N = 16).

Timing of survey administration	M	SD
Pre-survey	3.07	0.43
Mid-survey	3.00	0.51
Post-survey	3.22	0.58

Table 3. Means and standard deviations for SALG interest scores (N = 16)

Timing of survey administration	M	SD
Pre-survey	1.85	0.32
Mid-survey	1.88	0.58
Post-survey	1.93	0.65

Table 4. Means and standard deviations for SALG civic engagement scores (N= 16)

Timing of survey administration	M	SD
Mid-survey	2.93	0.59
Post-survey	2.90	0.62

Table 5. Means and standard deviations for biology attitude scores (N = 16)

Timing of survey administration	M	SD
Pre-survey	3.31	0.52
Post-survey	3.58*	0.57

*p = .02

presented in Table 2.The results for the ANOVA indicate no significant time effect or no significant difference between means, Wilks' Λ = .87, F (2, 14) = 1.01, p = .39, multivariate η^2 = .13. For the confidence questions, the scale was found to be reliable for all three administrations (α_{pre} = .83, α_{mid} = .90, α_{post} = .93).

Interest

A one-way within-subjects ANOVA was conducted with the factor being the timing of survey administration during the semester and the dependent variable being the SALG interest question scores. The means and standard deviations for SALG scores for interest are presented in Table 3. The results for the ANOVA indicate no significant time effect or no significant difference between means, Wilks' Λ = .98, F (2, 14) = 0.12, p = .89, multivariate η^2 = .02. For the questions pertaining to interest, the scale was found to be reliable for all three administrations (α_{pre} = .68, α_{mid} = .88, α_{post} = .90).

Civic engagement

A paired-samples t test was conducted on the civic engagement scores to evaluate whether the students' attitudes towards civic engagement changed after taking the Honors SENCER course. The means and standard deviations for SALG scores for civic engagement are presented in Table 4.The results indicated that the mean post-survey scores (M = 2.90, SD = 0.62) were not significantly different from the mean mid-survey scores (M = 2.93, SD = 0.59), t (15) = 0.20, p = .84. The scale was found to be reliable for both administrations of the civic engagement questions (α_{mid} = .91, α_{post} = .92). The pre and post-surveys were significantly correlated (p = .03).

Biology attitude scale

A paired-samples t test was conducted on the Biology Attitude Scale scores to evaluate whether the students' attitudes towards biology changed after taking the Honors SENCER course. The means and standard deviations for the Biology Attitude Scale scores are presented in Table 5. The results indicated that the mean post-survey scores (M = 3.58, SD = 0.57) were significantly greater than the mean pre-survey scores (M = 3.31, SD = 0.52), t (15) = 2.59, p = .02. Cronbach's alpha for this scale was .89 on the pre-survey and .91 on the post-survey. The pre and post-surveys were significantly correlated (p = .002).

Participant Observations

The researcher engaged in participant observations during 6 different class periods. These 6 class sessions were during the first half of the semester. The researcher sat in two different locations to gain different perspectives. Consistency across the observations was addersed by using the same process for observation each of the 6 class periods. For example, the same researcher was performing the observations, using the same mode of data collection by typing on her laptop, recording the same type of participant information that would possibly help to answer the research questions. During these observations, there was only a small amount of discussion between the instructors and the students. The observational data did not produce the insight into the data that were intended. The research questions for this study focused on the students' perception of confidence, interest and scientific literacy. The observational data supplement the other forms of data collected. In a pilot study (Cook, 2005), there was a large amount of discussion and interaction between the students and the professor. According to the professor, the discussion levels during class when the researcher was present were a good representation of the average discussion levels in the class from day to day (Adam Hott, personal communication, June 29, 2005). This allowed for frequency of participation patterns to be collected. Similar research purposes were intended in this present study, but the discussion during the six observations was limited and did not result in the same kind of observational data the researcher had experienced in the pilot study. During the observations, five types of participation by the stud-ents were focused upon. Participation types were coded in the following way: "spoke up (talked out in class without raising hand), raised hand (before speaking), answered a question posed by the professor, volunteered to present information to class (without being called on by professor) and asked the professor a question". The researcher was unable to collect a sufficient amount of data to make whole class generalizations. On the other hand, the data were used to supplement data gathered in the case studies and with the students' self-reported data regarding participation levels.

Online reflective question themes

Online reflective question #1

When the students were asked if they had any reservetions about the class at the beginning of the semester and if so, how had their attitudes changed since then, a range of 1 – 2 word descriptions were included, such as excited, glad, interested, apprehensive, worried, confused and not clear. Most students indicated that they didn't know what to expect out of the class quite yet and some pointed out not having any reservations at all. A couple of students expected the class to be a "regular" or "traditional" science class, but most students expressed being excited/glad/interested that the class was not a regular science/biology class.

The students were given a chance to convey their thoughts about the class at that point in time (week 3 of class) and most students liked the class thus far. There were a few comments on appreciating the light workload in the class. Other descriptors used about the class were okay, disappointed, nervous, excited, disjointed, unorganized and intrigued.

"How confident are you in doing well in this class?" was another question the students were asked to answer and 11 out of 16 students commented on being confident about doing well in this class. There were also 14 out of 22 (some students made more than one comment) comments made signifying that the class was interesting to the students so far. The last questions the students replied to were, "In what ways can the class instruction improve to increase your confidence in this science class?" and "What can be changed to make the class more interesting?" The most common theme expressed was better organization and preparedness in the course as a whole. Some other suggestions were the need for new material, include more specific science information and more activities like labs, field trips, films and class discussions.

Online reflective question #2

Just before spring break, the students were asked to describe a critical moment or 'a-ha' moment they had experienced in class. The most frequent answer, 8 responses, pointed to some eye-opening fact they had learned about nutrition. Another recurrent theme in 5 responses was a realization of the impact civic engagement project the day the representative from the Trustee's office came to class. In contrast, two students commented on not having an 'a-ha' moment and 1 student was really engaged by the lab experiment.

Online reflective question #3

The third online reflective question was part of a written assignment that the students were given to wrap up the civic engagement project. Only part of the assignment was relevant to my research. Parts of the assignment have been extracted out of the essays that were beneficial in helping to answer the research questions. Only questions #1 and #5 from the assignment are included for further discussion.

The first question asked the students to discuss their overall reflections regarding the information they have learned in class. This question asks them to articulate in what areas they have become more scientifically literate. The most common response was an increase in knowledge about proper nutrition and healthier eating habits. Another response given was an attitude change towards fast food. A few negative comments addressed the research performed for the nutritional pamphlet was superficial and not valuable in promoting learning.

The other question from the assignment asked the students about how they felt about this model for learning about science. Most students liked the connection of social and science topics as well as the application or relevancy of material learned. Another common response was the students liked ownership of learning and having to "teach" the material they learned. A few negative responses about the SENCER model by the class were the disjointed nature of the course and the students did not perform any scientific research.

Online reflective question #4

The students were asked to write a word or phrase to describe their experiences in this course. Below that phrase, the students were to rate those experiences on a scale from 1 to 5 with 5 being the highest. The responses were: random – 4.25; new – 3; eye-opening – 4; positive – 5; conglomeration – 4; interesting, education and not demanding – 5; interactive and interdisciplinary – 4.5; unique – 4; unusual, interesting – 4; average – 3; interesting – 3.5; unattached – 3; unorganized – 3; compulsory – 3; and different – 5. The mean rating of the class by the students was 3.88, definitely above average.

This reflective question allowed for the students to list the positive aspects of this course. A universal theme surrounded the learning/teaching styles demonstrated in the course. Some specific styles noted were inquiry, discovery, group collaboration, discussion, hands on activeties like labs and student involvement in designing pamphlet. Some other frequent positive aspects of the course were the light workload, the application of mate-rials to life and the social application of science. The teachers and service learning project were less common themes.

Conversely, the students were given the opportunity to list the negative aspects of the class. By far, the largest negative theme was disorganization and lack of structure in the course. Other negative comments implied that the class wasted time or there was too much discussion about the pamphlet. The last theme demonstrated that the course had too many random ideas and needed better connection between the topics.

"Looking over the entire semester, have your confidence in science increased, decreased or stayed the same?" was another question to which the students responded. Thirteen comments stated that their confidence stayed the same and 6 comments said their confidence increased slightly and only in certain aspects of science (not all science in general). Researching for the nutriational pamphlet was the general explanation of what specifically had caused that change or increase in confidence.

Along with confidence, the reflective question asked. "How has your interest in science changed over the entire semester?" This was a split response. There were 9 comments indicating an increase in interest and 9 comments on interest remaining the same. When prompted to describe what specifically caused that change in interest, the themes generated were research on the nutritional pamphlet, application of science information, lab experiments and the book Fast

Food nation

The students were given another opportunity to express what suggestions they had for this class. Similar themes to the first reflective question were better preparation, specifically for the service learning project, more structure or organization and a more defined syllabus and schedule. The students also articulated the need to connect the science and social aspects of the material.

Lastly, the students were asked to share if they had any other thoughts or ideas. Most of the students who answered this question remarked that they enjoyed the class or thought it was a good class.

DISCUSSION AND CONCLUSIONS

Class themes

Several themes emerged from the online reflective questions completed by the class. Most of the students liked the class overall, but definitely felt it lacked structure and organization. In general, the students liked the teaching and learning styles of the course and the nutritional content. Specifically, the students enjoyed the group work and individual research on the nutrition pamphlet. On the other hand, there were a very limited number of comments made about the bacteria material that was covered during the second half of the semester. This material did not appear to be as interesting or significant to them.

The civic engagement project was perceived by most, but not all students, as being beneficial. Some students felt there was a good connection between the science and social topics in the course. However, others did not have the same opinion. This may not be just a difference in opinions, but possibly a lack of explanation of the word connection. Students liked how the material studied in class could be applied socially or to their everyday life. The negative comments about the lack of connection between science and social topics may have been more about the perceived disorganization of the class and how the class topics did not flow logically from day to day.

At the beginning of the semester, most students were confident that they would do well in the class and at the end of the semester their confidence in science remained the same. This was supported by the SALG confidence data that demonstrated no change in science confidence. Interestingly, a few students developed an increase confidence level in a specific area of science, such as nutrition.

The students were fairly interested in the course to begin with, that is why they reportedly enrolled in it. By the end of the semester, about half of the students expressed that their interest in science had remained the same and the other half reported that their interest had increased. However, the SALG data showed no change in science interest. In the last reflected question, three students used a one word descriptor of the class as interesting. The students noted their reason for the increased interest was mainly due to the applicability of the nutritional information to their lives.

Most increases in confidence and interest were attributed to a small specific area of science, for example nutrition, and not science in general. Maybe this is why the Biology Attitude Scale revealed a significant increase in attitudes toward biology at the completion of the SEN-

CER course. Whereas, the SALG attempted to mea-sure attitude changes in the broader field of science.

The class themes that emerged were very similar to the themes that emerged from the case studies. Application of the material and disorganization of the class were two key similarities between the class and case study data. There do not appear to be any differences between the two groups.

The central research questions for this study focused on the students' perceptions of confidence, interest and scientific literacy. The final conclusions are interpretations of how the preceding data and themes combined are relevant to the three original research questions.

Research question #1

How has students' scientific literacy changed in this course? For this study, scientific literacy was defined as, "…an understanding of (1) the nature and limitations of science, (2) the basic concepts and principles (laws and theories) of science, (3) the technological applications of science, (4) the value of science as a contributor to the decision making process of the major societal issues of our time, and (5) the uses of scientific knowledge in public policy decisions" (Adams, 1990). Just by looking at the definition, the task of wanting to measure a change in scientific literacy appeared to be quite a challenge. As Laugksch (2000) mentioned, there are many factors involved in the concept of scientific literacy and that makes measuring scientific literacy very difficult. As demonstrated in the literature review, there was no agreed upon way of quantifying scientific literacy. Meas-uring a change in scientific literacy was one goal of this study, but this proved to be most difficult.

On the SENCER SALG pre-survey, the subjects were asked 11 questions about their opinions of scientific literacy on a scale of 1– 5 (strongly disagree – strongly agree). The average scores for all the questions by each student ranged from 3.18 – 4.45. Each student had an average score of at least greater than three, which suggested a tendency towards agreement with the scientific literacy questions posed. This was similar to the findings of Gogolin and Swartz (1992), which was revealed through interviews, that the majority of students expressed an awareness of the importance of science.

Even though scientific literacy proved to be too broad of an area to measure, this study focused on a more spe-cific area of science to quantify change. Since the Honors course was listed as a class to fulfill the life sciences requirement in the honors college, this study focused on literacy of biological concepts, instead of the all encom-passing scientific literacy. In this regard, many students in their first online reflective question made comments about the class being similar to a biology class. With a more focused area to monitor change, the students showed a statistically significant increase in biological concepts literacy. Students did not know they were going to take post-test during the last class period and they were not graded on it. Therefore, the students more than likely did not study for post-test and the statistical signi-ficance is in all probability due to the learning in class.

The first part of the third online reflective question asked the students to reflect on what they had learned in the class so far. The most common response, without a doubt, was how much they had learned about proper nutrition and healthier eating habits. A handful of other responses included change in attitude toward fast food and how they felt the in-depth research they conducted was applied superficially in order to reach the level of the clients. As shown by the students' responses, their liter-acy in the specific area of nutritional science increased. However, the third reflective question resp-onses did not give any indication that the students believed their overall scientific literacy had changed in one way or the other.

Research question #2

How has students' confidence in science changed in this course? The SENCER SALG, which asked questions relating to confidence in science, showed no change in confidence level between any of the surveys. These re-sults supported the findings of Gabel (1981) and Carpen-ter (1983). Confidence levels were ranked on a scale from 1 – 5.The class average for confidence scores for all three SALG surveys was just above 3, or as the survey described it, somewhat confident.

The Biology Attitude Scale, on the other hand, demon-strated a significant increase in positive attitudes towards science from beginning to end of the semester. On a scale from 1 –5, the average score for the class went from 3.31 to 3.58 (moving towards agreement). So, why was there the discrepancy between the SALG data and the Biology Attitude Scale? Maybe the term science is too wide-ranging to use for confidence when assessing changes. The Biology Attitude Scale focused on specific attitudes in one subject area, biology. This increase in confidence towards science supported the findings of Gogolin and Swartz (1992) and Sundberg et al. (1994).

At the beginning of the semester, the first online reflec-tive question revealed that 11 out of 16 students were confident to 'do well' in this course. The students were confident they would receive a good grade in the class, but they did not comment on their confidence in science. The students in this class were honors students and get-ing good grades was common for them. At the end of the semester, the final online reflective question showed that 13 out of 16 students stated that their confidence level in science remained the same or unchanged. This result was similar to the SENCER SALG results. Only three people indicated an increase in confidence and two of those made comments that pointed to an increase in a focused area, such as nutrition, and not in the general context of science. In contrast, there were several written comments about why their confidence was unchanged, such as, “I do not feel like I learned that much science” or “It was an introductory amount of material we were given and I really don’t know if that is enough to boost anyone’s confidence in any subject” or “It is hard to say that this was a great science course, more of a social class than anything. ”These comments suggested that the term science may be too general to evaluate the changes that may or may not have occurred due to this course.

Another possibility for the lack in change was that the honors students already had high levels of confidence and therefore a significant increase in confidence may not be likely. For example, a few student comments were, “I came into the science course pretty confident in my abilities, and nothing in this course added to that” and “The lack of change is probably due to the fact that I have been learning about science since the age of six. I had seven science classes in high school, and once every year I’ve been at Ball State.I know my strengths and weaknesses in the area. I just don’t think it’s possible for one course to change that.”

Research question #3

How has students’ interest towards science changed in this course? Quantitative and qualitative analysis techniques were used to evaluate if the students professed any change in interest towards science. The SENCER SALG survey asked questions relating to an interest in science and the class average for all three surveys was just below 2 on a scale of 1 – 5.The words used to describe a rating of two were “a little interested. ”The statistical analysis showed no change in an interest towa-rds science during the semester for the class, which supported the findings of Gabel (1981) and Carpenter (1983).

The second quantitative method used to evaluate a change in interest was the Biology Attitude Scale. This scale assessed attitudes in general, but some questions did relate to interest. This survey demonstrated a significant increase in positive attitudes toward biology. The average score for the class went from 3.31 to 3.58 (moving towards agreement) also on a scale from 1 – 5. So why was there a difference in the two quantitative scales?

The SALG measured interest levels as it related to science. Science is a very broad term. It includes many different types of science, including life, physical, environmental, earth sciences, etc. The Biology Attitude Scale evaluated interest in biology, a more specific science.

The students in the class may have already had a preference towards biology and that was why they were taking a science requirement in the life sciences versus any other science.

In the first online reflective question, all the students expressed the SENCER course to be interesting. The more specific responses expressed that the material or topics or issues of food and nutrition, which had been covered at that point, were interesting. They did not state an interest in the broad area of science. In the last online reflective question, there was a split 50/50 of interest levels in science remaining the same and increasing. Some explanations for the student’s interest level remaining the same were ‘high interest in science already’ and ‘classifying course as science is a stretch’. A few justifycations provided for an increase in interest were specific areas of science such as health sciences, not the broad-spectrum of science. Therefore, the term science may be too wide-ranging of a term to elicit an increase in interest.

Qualitative methodology was used to build context and provide insight into why and how changes may have occurred in the situations examined. One interesting result of this study was that all four case study participants expressed that the SENCER course was not a science course in their opinion. They believed the course connected the social and science topics and had everyday applicability to life, which they did not define as science. This expression revealed that students preconceived notions about science courses, whether positive or negative, were different from the SENCER interdisciplinary science course. Collectively, the data demonstrated that the goals of the course, using the SENCER ideals, were achieved. Without the interviews to gain such insights from the subjects, the fact that this course was working on redefining what a science course is, and can be, may not have been as apparent.

Another piece of new knowledge emerged from the interviews as students grappled with the concept of confidence and how it applied to them. Chelsie, for example, explained that there is a difference in how confident you are to receive a good grade in a class versus how confident you are in being able to apply the material you have learned. Again, without the benefit of the interviews, the need to clarify the term confidence may not have been examined. The SALG asked specific questions about the students’ confidence to perform specific tasks. The online reflective questions and the interview questions could have been more specific about confidence allowing for a broader range of responses from the students.

In conclusion, the US college students, non-science majors, in this sample, do benefit from interdisciplinary SENCER styled courses but in ways not fully predicted at the outset of the course. Furthermore, there remains a tenuous relationship between the concepts of “interest”, “confidence” and “scientific literacy” that will need further examination.

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