Final Report
on Content Area 3
General Education Science & Technology
Assessment
Academic Year 2008/2009

Prepared by

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Summary

Three main tasks were addressed: a pre- and post-course assessment of student science self-efficacy, a workshop on assessment and teaching of Content Area 3 General Education Science and Technology courses, and preliminary work on evaluation of actual student learning in CA3 courses.

Late in the semester, all faculty participating in the CA3 pre- and post-course student self-efficacy assessment were asked to send results from the final exam directly pertaining to CA3 learning goals. Some faculty responded positively to the request, but no results were submitted. However, the positive reaction to the request indicates that faculty are likely to participate in a future assessment effort. Assessment of actual student learning is obviously important and should be addressed in future work.

The workshop on assessment and teaching of CA3 courses was well attended (~25 faculty and teaching assistants), indicating that the UConn teaching community is interested in workshops on teaching methods, specifically teaching methods for CA3 courses. Preliminary data from the student self-efficacy assessment was discussed during the work shop, resulting in suggestions for improvements to the self-efficacy assessment. These suggestions were coupled with further experiences from the data evaluation to modify the self-efficacy assessment.

The pre- and post-course student self-efficacy assessment was the largest single task. Faculty teaching CA3 courses with a HuskyCT site were asked to participate in the assessment. 32 faculty agreed to participate in on-line assessments, which were delivered as quizzes on the HuskyCT course sites. The pre-course assessment and post-course assessment resulted in 1375 and 1014 data points, respectively. Results indicate that students had relatively high confidence in their science abilities before taking CA3 courses and post-course improvements were small. Data on gender were added to the assessment results and hypotheses regarding differences between male and female students were evaluated. Male students had higher confidence in their science abilities than female students, both before and after CA3 courses. Encouragingly, female students increased confidence in their science abilities after taking CA3 courses and their improvement was larger than for male students.

Suggestions for future work include the modified student self-efficacy assessment, assessment of actual student learning, and further evaluation of data collected this year. Running the student self-efficacy assessment on HuskyCT worked well and this format could be used in the future. It may be useful to also run assessment of actual student learning on HuskyCT. Assessing actual student learning could focus on high-enrollment classes, which would give a high return for effort. Further evaluation of self-efficacy data collected this year could address hypotheses based on GPA, final course grade, major, and course size.

1 Workshop on assessment and teaching of CA3 courses

A workshop was arranged in collaboration with Catherine Ross from the Institute of Teaching and Learning. The main focus of the workshop was to discuss teaching methods and approaches used by UConn faculty in CA3 courses. Some of these were discovered during the assessment effort last year, and some were presented for the first time during the workshop.

The workshop started with a presentation of preliminary data (Electronic appendices 1 and 2: “Data for workshop presentation May 2009.xls” and “Workshop presentation May 2009”) from this year’s student self-efficacy assessment. The presentation resulted in a very valuable discussion of revisions to statements in the self-efficacy assessment. The suggested revisions are discussed in section 3. Hedley Freake, CA3 assessment coordinator in AY 2007-09, then moderated a session where faculty who participated in last year’s CA3 assessment effort shared their teaching approaches. A break-out session followed, where participants presented their additional approaches. The workshop wrapped up with a session, facilitated by Catherine Ross, where these new approaches were shared.

~25 faculty, teaching assistants, and graduate students participated in the workshop, and the general consensus was that the workshop was interesting and informative. This number of workshop participants is large and indicates a need for this type of workshop at UConn.

2 Assessment of actual student learning

Late in the semester, faculty participating in the CA3 pre- and post-course student self-efficacy assessment were asked to submit results from the final exam directly pertaining to CA3 learning goals. Some faculty responded positively to the request, but no results were submitted. Assessing actual student learning is obviously important and should be addressed in future work. The positive reaction to the request indicates faculty are likely to participate in a future assessment effort. Assessment of actual student learning is discussed further in section 4.2.

3 Pre- and post-course student science self-efficacy

3.1 Methods

The student self-efficacy assessment was delivered on the HuskyCT site of each course, which provided several advantages:

- Faculty did not use class time for the assessment
- Data was collected electronically and could therefore easily be transferred to Excel for evaluation
- Student identity was collected together with the responses, which makes it possible to retrieve other student data from Peoplesoft. For example, responses could be evaluated to find differences based on gender, final class grade, or GPA.

The HuskyCT course list was used to find CA3 courses with HuskyCT sites for spring semester 2009 and faculty members were contacted individually. 32 faculty committed to participating in the assessment on-line (Table 1). In addition to the faculty committing to the on-line assessment, 3 faculty members committed to carrying out the assssment on paper: Young-Chan Son (CHE1128Q, section T21), Larry Faustman and Mei-ling Siu-Caldera (NUSC1645, section 001LEC) and Boris Sinkovich (PHYS1401Q section 001LEC). Among these faculty, only Young-Chan Sun submitted complete data. Dr. Sun's data, however, is not included in this report, since it has not been entered into Excel.

Table 1. Courses participating in the on-line version of the student self-efficacy assessment.

Class	**Section**	**Instructor**
BIOL1102	001LEC	David Wagner, Richard King
BIOL1102	N68LEC	Christine Giambartolomei-Green
BIOL1102	N69LEC	Dana Frank
BIOL1102	Z82	Claudia Kraemer
BIOL1107	N60, APt	Evan Ward
BIOL1107	N68, Apt	Christine Green
BIOL1108	001LEC	Charles Smith, Louise Lewis
CHEM1101	001LEC	Brenda Shaw
CHEM1122	All	Carl David
CHEM1127Q	001LEC	Brenda Shaw
CHEM1128Q	001LEC	Brenda Shaw
CHEM1128Q	003LEC, 005LEC	Fatma Selampinar-Sotzing
CHEM1128Q	N60	Rob Mason
COGS2201	001LEC	Thomas Bontly, Whitney Tabor
GEOG1304	N60LEC	Nathaniel Trumbull
GEOG2300	001LEC	John-Andrew Ballantine
GEOL1050	002LEC	Christophe Dupraz
GEOL1051	002LEC	Christophe Dupraz
MATH1050Q	N60, Apt	Dmitriy Leykekhman
MCB1401	001-LEC	Craig Nelson, Ion Mandoiu
MCB1405	SEC001	Michael O'Neill, Rachel O'Neill
NUSC1030	001LEC	Nancy Rodriguez, Valerie Duffy
PHAR1001	001LEC	John Morris
PHYS1010Q	Z81LEC	Mark Swanson
PHYS1201Q	001LEC	David Perry
PHYS1201Q	H71	Timothy Bragdon
PHYS1402Q	006LEC	Peter Schweitzer
PHYS1402Q	N60	Jim Edson
PHYS1501Q	005LEC	Richard Jones
PHYS1502Q	006LEC	Menka Jain
PSYC1100	001LEC, 002LEC	David Miller

The assessment was translated into A HuskyCT quiz, which was imported to the HuskyCT sites by Kim Chambers from the Instructional Resource Center. Faculty were asked to ensure that students do the pre-course assessment only during the first or second week of the semester, after which the assessment was made unavailable. In order to increase student participation, it was suggested that participating students would receive extra credit, and most faculty seem to have used this approach. Kim Chambers loaded post-course assessments onto the HuskyCT sites three weeks before end of the semester. Faculty were sent instructions on how to retrieve the assessment data and submit them. However, Kim Chambers had to retrieve data from a large number of HuskyCT sites.

Table 2. Statements used in the pre and post-course assessments spring 2009. Statements 11 and 13 were the same in the pre- and post-course assessment.

Pre-course: I am confident that I can answer questions on: Post-course: After taking a CA3 Course, I am confident that I can answer questions on:
1. Basic concepts and vocabulary taught in the course
2. The methods and technologies utilized by scientists in the discipline
3. The application of the Scientific Method
4. The difference between science and pseudoscience
5. The conduct of a scientific experiment I am familiar with
6. The identity of unresolved questions in the field of science
7. How science impacts society
8. Pre-course: I am confident that I can apply my science knowledge to events in everyday life Post-course: After taking a CA3 Course, I am confident that I can apply my science knowledge to events in everyday life
9. Pre-course: By taking a lab course, I will improve my practical science skills Post-course: By taking a lab course, I improved my practical science skills
10. Pre-course: I like science Post-course: I like science more after taking a CA3 Course
11. I find it difficult to understand current scientific events in the news
12. Pre-course: I am interested in science Post-course: After taking this CA3 Course, I am more interested in science
13. I will likely seek out more information about science through (check all that apply) _ Another course_ Internet_ News/ Media_Other: __ I will not seek out more information

The self-efficacy assessment was written by Liz Kloeblen, graduate assistant, and modified by Hedley Freake, Nutritional Science in the College of Agriculture and Natural Resources, and Scott Brown, Educational Psychology in the Neag School of Education. This year, Scott Brown modified the assessment to a pre- and post-course assessment (Table 2). In the assessments, students rated 13 statements about their abilities and interest in science from “1. Strongly disagree” to “5. Strongly agree”. Raw data from HuskyCT were collected in comma separated files (.csv file extension), which were imported into Excel. The data were arranged in a table, where each row contained responses from, and information about, one student. Student responses were transformed to numerical values using a nested if-then function. The following was entered into a cell to retrieve the numerical response: =IF (F3= "5. Strongly agree", 5, IF (F3="4.Agree", 4, IF (F3="3.Neither", 3,IF (F3="2.Disagree", 2, IF (F3="1.Strongly disagree", 1))))).

However, the data did not translate cleanly into Excel, so data from each course was proofread and corrected before use. The gender of each student was entered, using either conclusions from clearly gender-specific names or information on gender from Peoplesoft.

A large number of data points were collected, and it is likely that a smaller number would be sufficient, since there was no statistical difference in the results between paired (1395 data points) and un-paired (2435 data points) samples.

3.2 Proposed modification of assessment statements

During preliminary data evaluation, the workshop, and final data evaluation, it was discovered that some assessment statements were unclear, which has to be addressed before future use of the assessment. Suggestions for rewording assessment statements were collected from the workshop and during further data evaluation (Table 3).

Note that statement 13 has been excluded (Table 2 and 3). This statement was difficult to evaluate using Excel, since there are 5! permutations of the 5 answers. Responses to this statement, therefore, have to be evaluated manually, which is a large undertaking and was not done for this report. Unless this information is considered crucial, it is suggested that this statement is omitted from future assessments.

Table 3. Statements to be used in future pre and post-course assessments.

Pre-course: Before the course, I am confident I already know: Post-course: This CA3 course improved my ability to answer questions about:
1. Basic concepts and vocabulary taught in the course
2. Methods and technologies used by scientists in the discipline
3. The scientific method
4. How to discern between scientifically supported and non-scientific data (pseudoscience).
5. How to describe and conduct a scientific experiment with which I am familiar
6. Unresolved questions in this field of science
7. How science impacts society
8. Pre-course: I am confident that I can apply my science knowledge to events in everyday life Post-course: This CA3 course increased my ability to apply science knowledge to events in everyday life.
9. Pre-course: By taking the lab section of this course, I expect I will increase my knowledge of the course material Post-course: By taking the lab section of this course, I increased my knowledge of the course material. NOTE: It is important that this question is only posed to students taking a course with a laboratory component.
10. Pre-course: I like science Post-course: I like science more after taking this CA3 Course
11. Pre-course: I understand current scientific events in the news Post-course: This course increased my understanding of current scientific events in the news.

12. Pre-course: I am interested in the area of science covered by this course.
Post-course: This CA3 course increased my interest in this area of science.

3.3 Results and discussion

3.3.1 General trends

This analysis was carried out both using un-paired data and paired data, and the results were the same. Interestingly, students were fairly confident about their science skills even before taking courses (Fig. 1). This is evident in the large number of responses with averages close to 4, that is, a verbal response of “agree”. The small improvement in the students’ perceived post-course understanding was also striking.

Note that statement 11 addressed whether students find it difficult to understand science news, so we expect them to disagree if they are confident they understand, resulting in an average close to 2.

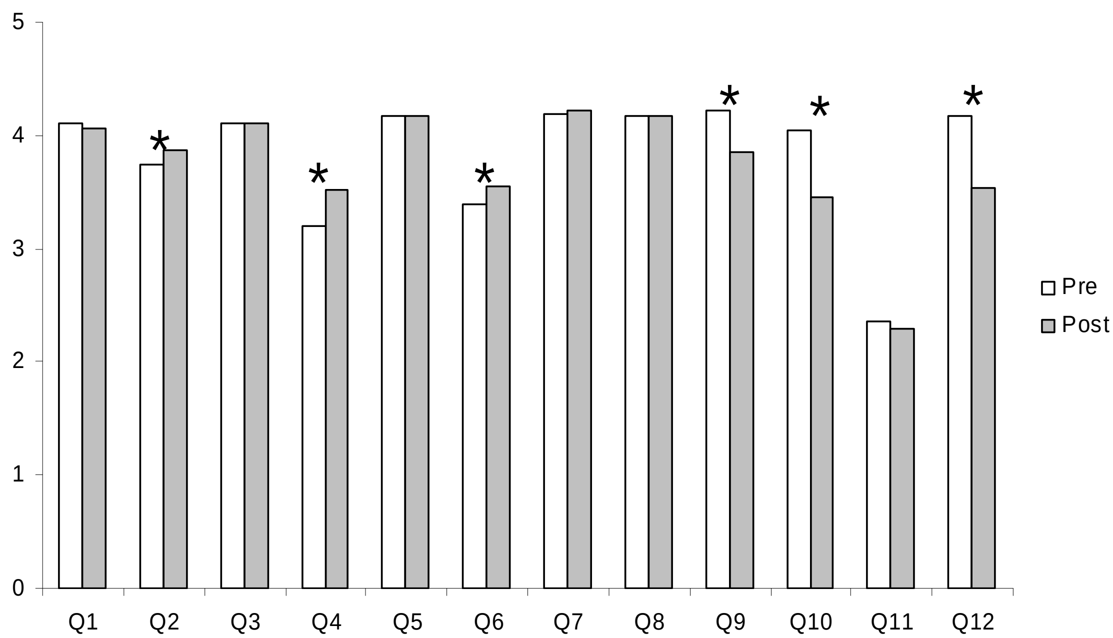

Figure 1. Averages of all data from the pre and post-course assessments. Q1 to Q12 refer to statements 1-12. Asterisks denote statistically significant (p<0.05, two-tailed t-test) differences between pre and post-course results. N is 1373 and 1014 for the pre- and post-course assessment, respectively.

Male students were slightly more confident than female students in their pre-course science ability (Fig. 2) in 6 out of 12 areas, but this difference decreased post-course (Fig. 3); post-course, male students were more confident than female students in only 2 out of 12 areas.

Female students had a larger number of post-course improvements in their self-perceived science ability and interest (5 out of 12, Fig. 4), than male students (1 out of 12, Fig. 5).

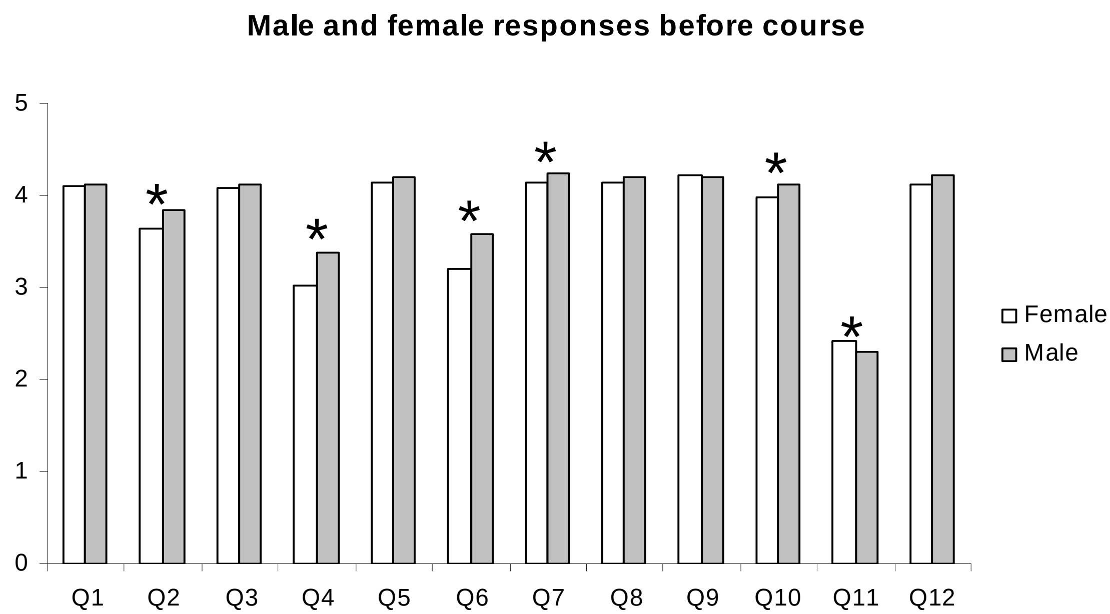

Figure 2. Averages of data from the pre-course assessment. Q1 to Q12 refer to statements 1-12. Asterisks denote statistically significant (p<0.05, two-tailed t-test) differences between female and male students in the pre-course results. N is 668 and 702 for the female and male students, respectively.

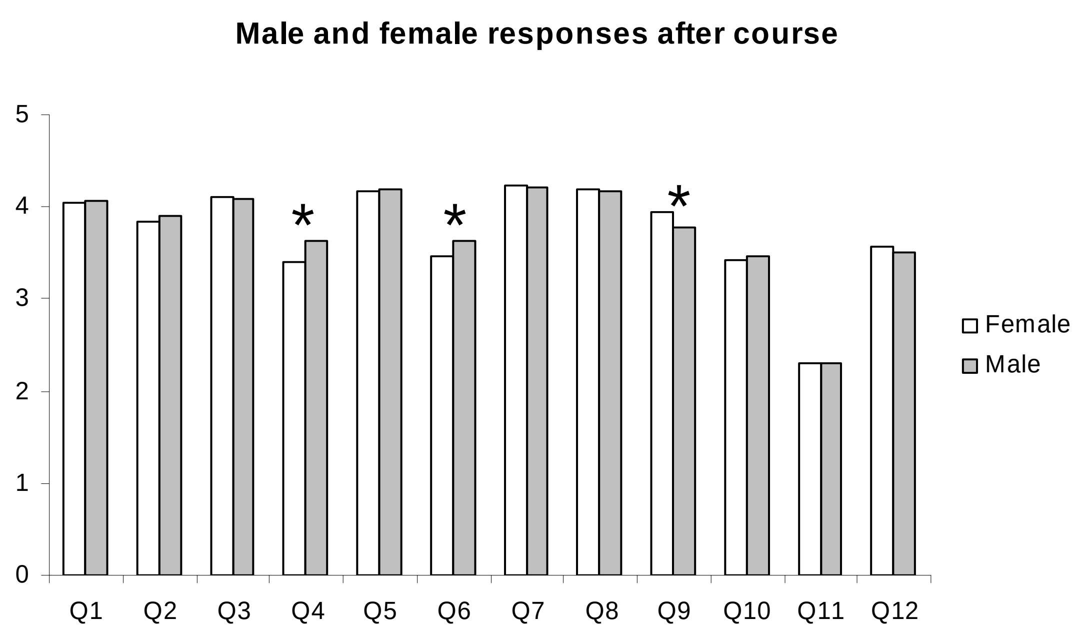

Figure 3. Averages of data from the post-course assessment. Q1 to Q12 refers to statements 1-12. Asterisks denote statistically significant (p<0.05, two-tailed t-test) differences between female and male students in the post-course results. N is 494 and 520 for the female and male students, respectively.

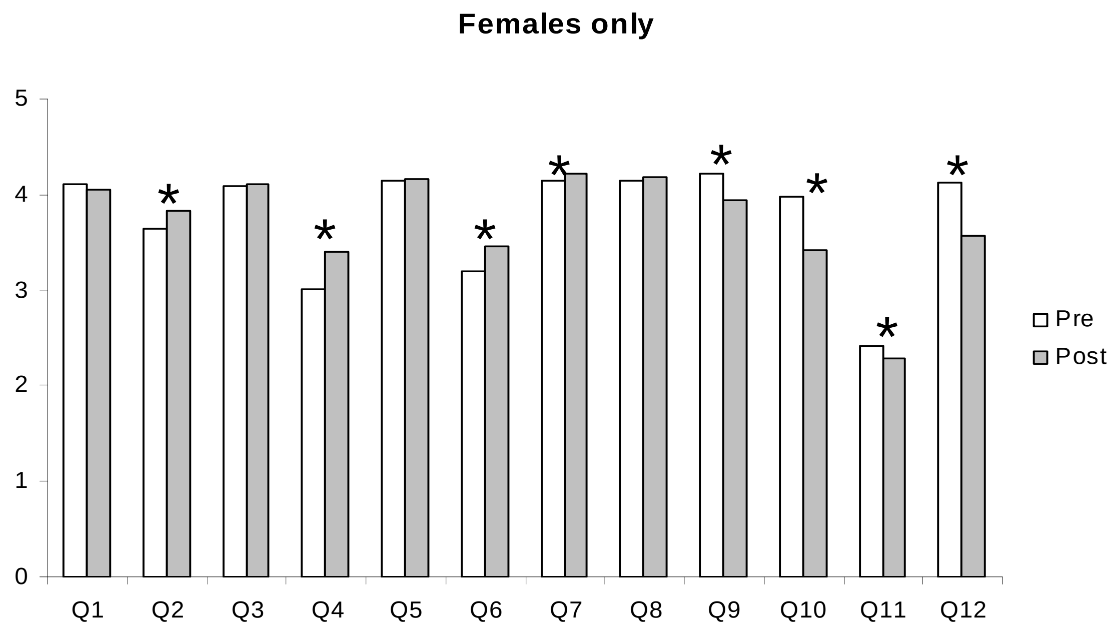

Figure 4. Averages of all data from the pre and post-course assessments for females only. Q1 to Q12 refers to statements 1-12. Asterisks denote statistically significant (p<0.05, two-tailed t-test) differences between pre and post-course results. N is 706 and 520 for the pre- and post-course assessment, respectively.

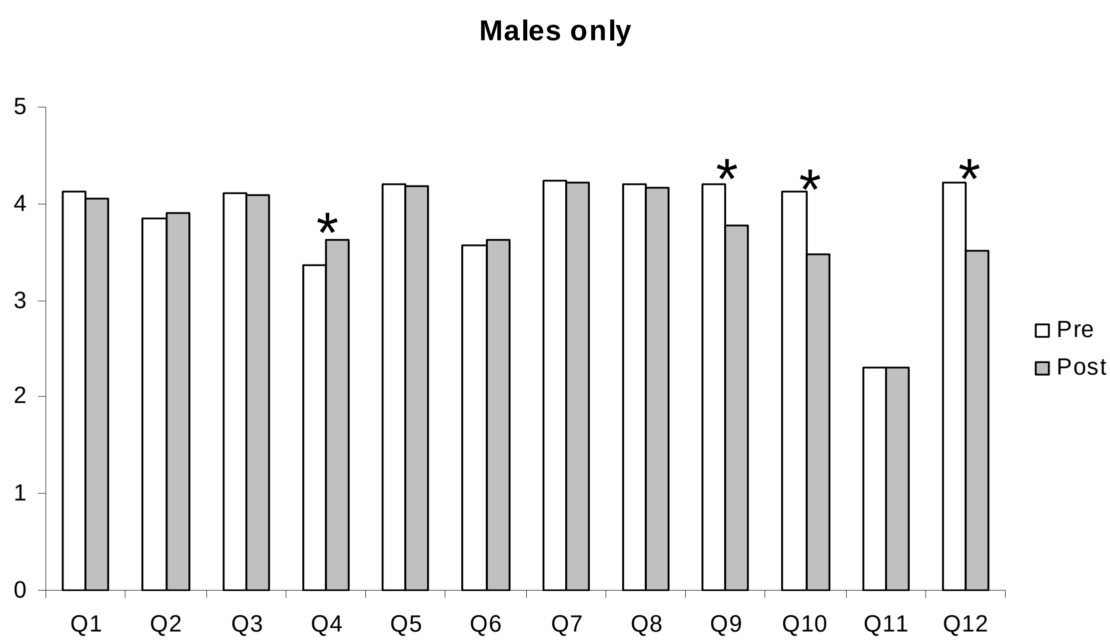

Figure 5. Averages of all data from the pre and post-course assessments for males only. Q1 to Q12 refers to statements 1-12. Asterisks denote statistically significant (p<0.05, two-tailed t-test) differences between pre and post-course results. N is 706 and 520 for the pre- and post-course assessment, respectively.

3.3.2 Statements 1, 2, and 6 – basic knowledge conveyed in the course

These statements addressed basic course content. Statement 1 included concepts and vocabulary, statement 2 included methods and technologies used by scientists in the field, and statement 6 included the identity of unresolved questions in the field. Responses to statement 1 showed no difference pre- and post-course for the general student group (Fig. 1), or for female versus male students (Figure 2). The absolute value of the average responses was ~4, i.e. the students agreed they know basic concepts and vocabulary taught in the course.

The responses to statement 2 were more interesting. Both male and female students were fairly confident they knew methods and technologies of the field even pre-course (average 3.8). The male students, however, were slightly more ($p<0.05$) confident (average 3.9) than the female students (average 3.7). There was a small but significant ($p<0.05$, t-test) post-course increase for all students (Fig. 1). Interestingly, this increase was a result of the female students upgrading their knowledge of methods and technologies ($p<0.05$), while the male students perceived no increase in post-course knowledge (Fig. 2 and 3).

The responses to statement 6 were also interesting. This statement had one of the lowest averages; the difference between science and pseudoscience had the only lower average. I.e., the students were not certain about unresolved scientific questions in the field. There was significant post-course improvement for the general student group (Fig. 1) and both females and males perceived an improvement. However, before the course, males were more certain than females they know unresolved questions (Fig. 2 and 3) and the perceived post-course improvement was larger among females than among males (Fig. 4 and 5).

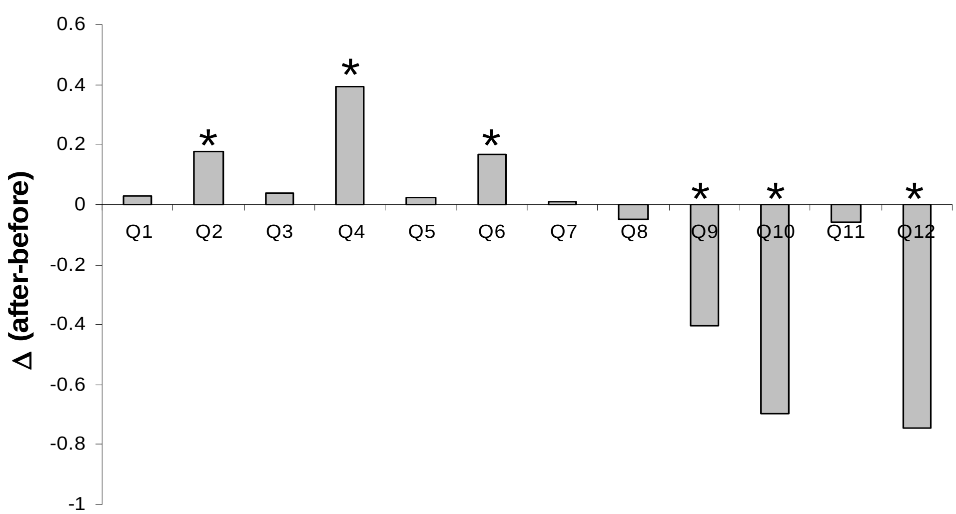

Figure 6. The average of differences in responses pre- and post-course, calculated by subtracting the post-course value from the pre-course value for paired data points, i.e. responses from the same students doing the assessment pre- and post-course (n = 618). Q1 to Q12 refers to statements 1-12. Asterisks denote statistically significant ($p<0.05$, two-tailed, paired t-test) differences between pre and post-course results. With the exception of statement 11, a positive value indicates a perceived improvement in knowledge or attitude.

3.3.3 Statements 3 and 4 – the scientific method

These statements addressed the scientific method (statement 3) and applying the scientific method to understand the difference between science and pseudoscience (statement 4). The students thought they knew, pre-course, what the scientific method is (average value 4.1) and there was no post-course improvement. The students were, however, much less certain of the difference between science and pseudoscience pre-course (average 3.2, median 3), and there was significant post-course improvement (average 3.5, median 4; Fig. 1) for both females (Fig. 2) and males (Fig. 3). The male students were more certain (Fig. 3) than the females that they knew the difference between science and pseudoscience both pre- and post-course. The improvement in the perceived knowledge of the difference between science and pseudoscience had the largest absolute value among all statements (fig. 6).

The students seemed to think they know the scientific method, but failed to realize its application to discern between science and pseudoscience. The scientific method is taught in high school, and the students may therefore feel they know it. The failure to discern between science and pseudoscience may be real, i.e., imply a real lack of understanding of the application of the scientific method or this failure may have more to do with the term “pseudoscience”. In order to find out which is true, statement 4 could be reworded in future assessments to include a definition of pseudoscience as being non-scientific.

3.3.4 Statements 5, 8, and 9 – practical applications of science

These statements addressed the perceived capability of applying science - statement 5 concerned a scientific experiment, statement 8 concerned applying science to everyday life, and statement 9 concerned laboratory skills. The perceived capability was high for statements 5 and 8 (pre-course averages of 4.17 for both) and there was no perceived post-course improvement (average 4.18 and 4.17, respectively, Fig. 1). There were no differences between male and female students in these areas.

Strikingly, students perceived no post-course improvement in their laboratory skills (statement 9, Fig. 1) and this was true for both female (Fig. 4) and male students (Fig. 5). This could be a result of skewed data – not all CA3 courses have a laboratory component, but all students taking a CA3 course were asked to rate this statement. The alternative is that our laboratory courses are ineffective, so this is an important topic that should be further addressed. A first step would be to make sure that the right group of students is asked to rate the statement – i.e. this statement should only be posed to students taking a class with a laboratory component. Further, the statement should probably address whether the laboratory component improved understanding of course content, not whether it improved laboratory skills. When these changes have been affected, further evaluation will show whether laboratory courses also need changes.

The students’ perception of their understanding of application of science was a little surprising (statements 5 and 8). The application of a general concept to a new problem or situation falls under the umbrella of “critical thinking”, which is generally difficult for students. It would be interesting to further probe the probable discrepancy between the actual abilities of the students and their perceived abilities in applying science. This could be included in future assessment efforts of actual student knowledge (see also section 4.2).

3.3.5 Statements 7 and 11 – science and society

These statements addressed connections between science and society – statement 7 directly addressed the students' perceived understanding of how science impacts society, while statement 11 addressed understanding of current scientific events in the news. Statement 7 had the highest overall post-course average (4.22) among all statements and there was no significant post-course improvement (pre-course average 4.20). Statement 11 showed no significant post-course improvement for the general student group (Fig. 1). However, pre-course, female students were less sure than male students that they understand scientific news (Fig. 2) and female students also perceived an improved post-course understanding (Fig. 4).

Statement 11 was the only one where the value should become more negative if there was an increase in understanding. The negative value is unfortunate and the statement should be rephrased for future assessments (see Table 2). However, the new statements should be carefully worded, such that the pre-course and post-course statements address the same thing and can be compared.

3.3.6 Statements 10 and 12 – attitude towards science

These statements addressed the students' attitude towards science – statement 10 addressed whether the students like science, while statement 12 addressed science interest. Pre-course, responses to both statements had averages close to 4 (Fig. 1), that is, the students liked science and found it interesting. However, both of these statements had significantly lower averages post-course than pre-course (Fig. 1), both for female and male students (Figs. 4 and 5), and the decrease was the largest among all statements (Fig. 6). The decrease may be a result of wording of the post-course statements – these statements ask whether students are <u>more</u> interested after taking a CA3 course. If the students responded no, it may mean that they are equally interested/like science equally much as before the course, or that their interest and liking has decreased. Hence, the only conclusion we can firmly draw is that CA3 courses did not make students like science more or become more interested in science, which is disappointing.

3.4 Conclusions from the student self-efficacy assessment

- There was no difference in averages derived from paired and un-paired data points. This indicates that a total of 1392 data points, or ~700 data points pre-course and ~700 data points post-course, is enough to ensure statistical significance and unbiased sampling of the underlying population.
- Students were confident in their science abilities even pre-course, and the perceived post-course improvement in their knowledge was generally small.
- Male students were more confident in their science ability than female students pre-course, but this gender difference decreased post-course.
- Female students had a larger number of improvements in their self-perceived science ability and interest than male students.
- There was no improvement in the perceived knowledge of basic concepts and vocabulary of the science. However, knowledge of methods and technologies, as well as understanding of unresolved questions, increased for the student population as a whole. Female students had a larger improvement than male students in both of these areas.

- Students were confident they knew what the scientific method is, and there was no improvement post-course. However, students were less certain about the difference between science and pseudoscience, i.e. the importance of the application of the scientific method. There was significant post-course improvement in discerning between science and pseudoscience.
- Student confidence in their ability to describe a scientific experiment and apply science to everyday life was high pre- and post-course, and there were no differences between male and female students in these areas.
- Strikingly, neither male nor female students perceived a post-course improvement in their laboratory skills. This could be a result of biased data – not all CA3 courses have a laboratory component, but all students were asked to rate this statement. The alternative is that our laboratory courses are ineffective. This is an important topic that should be further addressed.
- On average, students were also confident in their ability to understand impacts of science on society and science in the news and there was no perceived post-course improvement. However, pre-course, female students were less sure than male students that they understand scientific news and female students also felt an improved understanding post-course.
- CA3 courses do not increase interest or liking of science.

4 Future work

4.1 Carrying out a revised student self-efficacy assessment

It was efficient to deliver the assessment on-line, so this format could be used in future assessments. However, many of the responses were difficult to evaluate. This was a result of unclear statements. Suggestions for revised statements can be found in Table 2.

4.2 Assessing actual student learning

As mentioned above, it worked well to use HuskyCT to deliver the self-efficacy assessment and this method could potentially be used to assess actual student learning as well. This assessment could be done using a quiz, where some questions are the same between courses, while other questions are course-specific. Course-specific questions should be written by the course instructor. In order to maximize return per effort, the effort should focus on high-enrollment courses. The results from this year’s self-efficacy assessment could be used to specifically probe areas of perceived high self-efficacy.

During this year’s self-efficacy assessment, there was no difference between averages of data from sample sizes of ~1200 students versus ~700, indicating that a sample size <= 700 students is sufficient. Examples of potential courses for assessment of actual student learning include: BIOL 1108 section 001 (169 data points post-course), CHEM1128Q sections 001-013 (352 data points pre-course), GEOG 2300 section 001 (112 data points pre-course), PHYS1501Q section 001 (89 data points pre-course), and PSYC1100 section 001-013 (234 data points pre-course).

4.3 Further analysis of collected data

Without collecting additional data, the effect of course size could be evaluated. Data from the preliminary evaluation (Electronic appendices 1 and 2), indicated a larger number of improvements in low-enrollment courses, which would be interesting to evaluate further. By importing data from Peoplesoft, hypotheses based on GPA, final course grade, and major could also be addressed. Proposed hypotheses include:

- Low-enrollment courses give larger improvements in average science self-efficacy than high-enrollment courses.
- Female students in low-enrollment courses have larger improvement in average self-efficacy results than male students in low-enrollment courses.
- Students with high GPA have higher average self-efficacy results than students with low GPA.
- Students with low GPA have a larger improvement in average self-efficacy results than students with high GPA.
- Students with low GPA in a low-enrollment course have a larger improvement in average self-efficacy results than students with low GPA in a high-enrollment course.
- Science majors have higher average self-efficacy results than non-science majors.
- Non-science majors have larger improvements in science self-efficacy than science majors after taking a CA3 course.

5 Electronic appendices (omitted from posted report)

1. **Data for workshop presentation May 2009.xls**

   This file contains data used for evaluation of preliminary results. The data comprises a subset of all collected data. The results were presented during the workshop in May 2009.

2. **Workshop presentation May 2009.ppt**

   Presentation from workshop May 2009 including evaluation of "Data for workshop presentation May 2009.xls".

3. **Data by course, pre and post.xls**

   This file contains all raw data, except gender. Each course has one spread sheet for the pre-course evaluation and one spread sheet for the post-course evaluation. This file was used to translate word responses to numbers and, hence, contains the nested if-then function used for this purpose.

4. **All data.xls**

   This file contains answers translated to a numerical value and gender. The data is organized in two spread sheets: one with all data (including paired data), the second with paired data only. Both spreadsheets contain information on gender. Gender was added manually, either based on a gender-specific name or on information from Peoplesoft. Paired data is data from students taking both the pre- and the post-course assessment. Paired data was extracted by sorting all data and manually deleting non-paired data.

5. **Hypothesis testing.xls**

   This data contains statistical evaluations of all hypotheses presented in this report, organized with one hypothesis per spreadsheet. The data for the hypothesis testing is derived from "All data.xls".