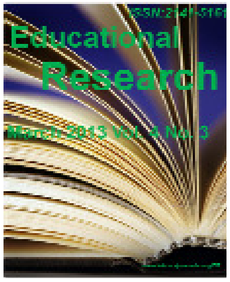

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Full Length Research Paper

Difference in American and French undergraduate students' perceptions and attitudes towards science and education

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Abstract

Attitudes toward Science survey was given to a cohort of new freshmen at The University of Akron (UA) and the Université du Maine (UM). The UA students are scholarship recipients pursing degrees in chemistry, mathematics, biology, biomedical engineering, chemical engineering, and civil engineering. The UM cohort are pursuing a degree in biology or geology. The survey was also given to the students as they entered their sophomore (UA) year or midway through their junior (UM) year to assess how science perceptions change throughout curriculum. The results were analyzed individually by university and year as well, as cross-compared between the two universities. In addition to the survey results, potential differences on student attitude based cultural education differences (grading, faculty assistance and curriculum content) will be discussed.

Keywords: Education styles, attitudes, science.

INTRODUCTION

Educational Differences

Although the subject matter of a course will be the same, there will be differences as to how it is taught depending on the individual instructors teaching style, expectations or requirements from the university. Regardless of the cause, how a subject is taught does have a relation as to how students learn (Prosser et al., 2005; Shaw and Marlow, 1999). As global business and student exchanges increases, the differences have become more pronounced (Festervand et al, 2001; Weiss 2012). In conducting personal discussions with instructors there were distinct differences found between the French and US educational style. These differences were corroborated by interviews with French graduate students pursuing masters in engineering and undergraduates completing a required internship at The University of Akron.

The largest difference was in course content and time requirements. For instance, in engineering the basic content will be the same for all accredited U.S. schools. In France, engineering students will have different degree requirement depending if they are attending a Grand Ecole or University. A Grand Ecole has restrictions on enrollment in which only those students that have passed a written exam and interview are admitted. Students that choose to attend an Ecole are those that have performed well in all of their High School courses and studied for two years after High School in preparation for the entrance exam. Students that have passed the entrance exam to a Grand Ecole are almost guaranteed a diploma (Gourves-Hayward and Morace, 2010). Conversely, a French University is open to everyone and students can enroll immediately after the end of High School. At the highly tiered Grande Ecole, students do not have to focus on science/engineering courses. Instead, they take more classes that focus on personal interactions and management (Jallade 1992). Conversely students attending a University will have course requirements similar to their U.S. counterpart, although the structure will be different. French science and engineering bachelor's degrees are typically completed in six semesters (three years); a minimum of eight semesters (four years) is required for a U.S. BS degree. In the U.S. courses are offered at a standard day and time (i.e., M-W-F from 10-11, T-Th 9-10, etc.) while in France the day and time a specific course is offered may change each week. For instance, professors with another commitment (i.e., conference) are free to cancel scheduled lectures and move it to the next available week.

According to both French instructors and students, the other two primary differences were associated with expectations and assistance. The French grading system is based on 20 points (14-20 for A, 11-13.9 B, 8-10.9 C, 4-7.9 D and 0-3.9 F) (Festervand et al., 2001). However, it is impossible for a French student to earn a perfect score. For example, with a 20-point exam, the highest grade that can be obtained is 17. When completing an evaluation for an intern from France the rating of excellent was 16-18 even though the total points possible were 20. However, if a French student performs extremely bad on an exam, he/she can be scored with a zero. A zero can also be assigned as a penalty for handing in written assignments late or for unexcused absences at required practical laboratories. Conversely, the U.S. grading scale is 90-100 A, 80-89 B, 70-79 C, 60-69 and 0-50 F. If a student works hard, it is possible to earn 100 points. Similarly, U.S. faculty interact more one-on-one interaction with students than their French counterparts. The U.S. faculty interaction spans individual meetings during office hours, impromptu questions in hallways to facilitating discussion questions during the lecture. While U.S. students can be categorized as more extroverted, French students do not actively participate in class nor approach the professor outside of class (Festervand et al., 2001). How do these differences impact the students' attitudes toward science? To investigate this question, incoming freshmen at The University of Akron and Université du Maine were given Attitudes toward Science survey. The students were reassessed to see if their attitudes change as they progressed toward matriculation.

Cohorts and Assessment

Two different cohorts, S-STEM and biology, were given an Attitudes Toward Science survey. There are different surveys available to assess student attitudes. The survey used for this paper was obtained from the Institute of Teaching and Learning at The University of Akron. Please refer to the article by Blalock et al. (2010) for a comprehensive review of instruments/surveys to assess student attitudes. The S-STEM cohort at University of Akron (UA) was comprised of students that were selected for a National Science Foundation (NSF) scholarship for students pursing STEM (science, technology, engineering or mathematics) degree. The UA cohort has 16 freshmen students from engineering (11), biology (4), and chemistry (1) disciplines. The Université du Maine (UM) in France cohort was comprised of first semester freshmen biology class of 22 students pursuing a degree in geology or biology.

The cohorts had changed by the time the second survey was given. The UA cohort was still comprised of students who were selected for the NSF scholarship. However some of the individual participants had changed based on students leaving the program to pursue a non-STEM degree. The UA cohort, now also includes two students pursuing a mathematics degree, was given the survey again after completing four semesters (end of the sophomore year). The second UM cohort was a new set of third year chemistry students that had completed the fifth semester of courses.

The individual statements were grouped to assess seven different areas ranging from their attitude towards the need for science to their confidence in solving science problems. Results will be reported in terms of average and standard deviation for overall student responses, male responses, and female response for U.S. and French students. It is important to remember the scale that the students used in completing the assessment: 6 strongly agree, 5 moderately agree, 4 weakly agree, 3 weakly disagree, 2 moderately disagree and 1 strongly disagrees.

Assessment Results for First Year Students

Need For Science

As shown in Table 1, the survey contained eight positive statements to assess the belief that there is a need for science and three negative statements. It was good to find out that all of the students strongly to moderately disagree with statements that alluded to 'science was not good for society.' Although the students felt had a strong to moderate (2.81±0.91) disagreement with the statement that you can 'get a long in life without science,' the female students (3.33) did not have as strong of a conviction as their male counterparts (2.5). Surprisingly, the UM students had weak agreement with the statement (4.14±1.52 overall). In general, both the UA and UM the cohort all depicted a moderate to strong agreement with the need for science. The strongest conviction for UA students (5.81±0.40) was for the belief that science is in fact useful for everyday life. For UM students, the strongest overall conviction (5.23) was for being curious and science being helpful for understanding the world. The need for science, curiosity about science activities and its beneficial uses to society is the key factors that drew the students to pursue a STEM discipline (Chelser et al., 2010; Feist 2012; Ryder et al., 1999).

Personal Interest and Connection to Science

The fact that the students believe there is a need for

Table 1. Averages of the freshmen students view on the need for science

	American students			French Students		
Abbreviated statement	**Overall (n=16)**	**Male (n=10)**	**Female (n=6)**	**Overall (n=22)**	**Male (n=13)**	**Female (n=9)**
1. $ spent on science, well worth	5.50± 0.89	5.50±0.71	5.50±1.22	5.5± 0.67	5.62± 0.65	5.44± 0.73
2. Science useful everyday life.	5.81±0.40	5.90±0.32	5.67±0.52	5.09±1.06	4.85±1.14	5.44±0.88
13. Most should study science	5.19±0.75	5.10±0.74	5.33±0.82	4.59±1.30	4.77±1.36	4.33±1.22
18. curious about the world	5.63±0.62	5.60±0.70	5.67±0.52	5.23±0.81	5.15±0.80	5.33±0.87
19. Science helpful understand world	5.63±0.72	5.50±0.85	5.83±0.41	5.23±0.75	5.08±0.64	5.44±0.88
26. important know sci to get job	4.75±1.00	5.00±0.82	4.33±1.21	3.27±1.52	3.15±1.72	3.44±1.24
29. govt spend more $ sci res	5.06±0.77	5.10±0.88	5.00±0.63	4.64±1.09	4.77±1.09	4.44±1.13
56. Knowledge of sci, important	5.19±1.05	5.60±0.52	4.50±1.38	4.91±0.92	5.00±1.00	4.78±0.83
7. little need for sci in most jobs.	1.56±0.89	1.60±0.97	1.50±0.84	2.86±1.58	3.38±1.61	2.78±1.09
22. Sc discoveries do more harm	1.81±1.05	1.90±1.20	1.67±0.82	2.55±1.22	2.85±1.28	2.11±1.05
33. along well in life without sci	2.81±0.91	2.50±0.71	3.33±1.03	4.14±1.52	4.54±1.61	3.56±1.24

Table 2. Assessment results of freshmen students' personal interest in and connection to science

	American students			French Students		
Abbreviated statement	**Overall (n=16)**	**Male (n=10)**	**Female (n=6)**	**Overall (n=22)**	**Male (n=13)**	**Female (n=9)**
2. Sci useful everyday life.	5.81±0.40	5.90±0.32	5.67±0.52	5.09±1.06	4.85±1.14	5.44±0.88
4. Sci. something I enjoy	5.60±0.60	5.70±0.48	5.67±0.82	5.23±0.61	5.38±0.51	5.00±0.71
18. curious about the world	5.63±0.62	5.60±0.70	5.67±0.52	5.23±0.81	5.15±0.80	5.33±0.87
19. Sci helpful understand world	5.63±0.72	5.50±0.85	5.83±0.41	5.23±0.75	5.08±0.64	5.44±0.88
26. important know sci to get job	4.75±1.00	5.00±0.82	4.33±1.21	3.27±1.52	3.15±1.72	3.44±1.24
30. excited to take sci class	5.75±1.18	4.70±1.06	4.83±1.47	4.09±1.57	4.15±1.57	4.00±1.66
41.like teach sci after school	2.50±1.26	2.50±1.27	2.50±1.38	2.59±1.89	2.38±2.02	2.89±1.76
54. enjoy talking sci to others	4.75±1.24	4.90±1.20	4.50±1.20	4.18±1.18	4.23±1.17	4.11±1.27
14. like spend less time studying	1.63±0.62	1.60±0.52	1.67±0.82	2.91±1.38	3.08±1.38	2.67±1.41
21 don't like anything about studying sci	1.31±0.60	1.30±0.48	1.33±0.82	1.59±1.10	1.69±1.18	1.44±1.01
27 prefer job doesn't use sci	1.69±0.95	1.40±0.70	2.17±1.17	2.27±1.52	2.62±1.61	1.78±1.30
33. along well in life without sci	2.81±0.91	2.50±0.71	3.33±1.03	4.14±1.52	4.54±1.61	3.56±1.24
50 dislike reading news re sci	2.56±1.31	2.60±1.51	2.50±1.05	2.59±1.33	2.77±1.17	2.33±1.58

science indicates that they may have made the correct choice in pursuing a STEM degree. An indicator that a student will persist in a chosen field is if they have a personal connection/strong interest in the specific area. As with the need for science criteria, the students indicated moderate to strong disagreement with the statements that could be viewed as negative. For instance, students reported an average 1.31±0.60 UA and 1.59±1.10 UM for "I do not like anything about studying science" (Table 2). Most of the students expressed moderate to strong agreement for science being something they enjoy (5.60±0.60 overall UA and 5.23±0.61 UM), its useful for everyday life (5.81±0.40 all UA students, 5.09±1.06 UM), and is helpful for understanding how things work in the world around them (5.63±0.72 UA, 5.23±0.75 UM). There was a weak to moderate agreement in the excitement (4.75±1.18 UA and 4.09±1.57 UM) associated with taking a science class or enjoyment in talking about science with others (4.75±1.24 UA, 4.18±1.18 UM). It will be interesting if these change as they successfully take science courses.

Real world Connection to Science

Table 3 contains the averages for the cohorts view on the real-world connection to science. Overall, the students strongly disagreed with the statement that science discoveries do more harm than good. It was not surprising that the individual students that selected the 'strongly disagree' corresponded to those that had already completed a research project of some form. The highest positive correlation was for 'science is useful for everyday life' (5.81±0.40) for U.S students. For French students the highest correlation (5.55±0.67) was that money spent on science was well worth the expense.

Table 3. Freshmen students' perception of a real-world connection to science

	American students			French Students		
Abbreviated statement	**Overall (n=16)**	**Male (n=10)**	**Female (n=6)**	**Overall (n=22)**	**Male (n=13)**	**Female (n=9)**
1. $ spent on science, well worth	5.50± 0.89	5.50±0.71	5.50±1.22	5.55± 0.67	5.62± 0.65	5.44± 0.73
2. Sci useful everyday life	5.81±0.40	5.90±0.32	5.67±0.52	5.09±1.06	4.85±1.14	5.44±0.88
7. little need for sci in most jobs.	1.56±0.89	1.60±0.97	1.50±0.84	2.86±1.58	3.38±1.61	2.78±1.09
19. Sci helpful understand world	5.63±0.72	5.50±0.85	5.83±0.41	5.23±0.75	5.08±0.64	5.44±0.88
22. Sc discoveries do more harm	1.81±1.05	1.90±1.20	1.67±0.82	2.55±1.22	2.85±1.28	2.11±1.05
26. important know sci to get job	4.75±1.00	5.00±0.82	4.33±1.21	3.27±1.52	3.15±1.72	3.44±1.24
33. along well in life without sci	2.81±0.91	2.50±0.71	3.33±1.03	4.14±1.52	4.54±1.61	3.56±1.24
56. Knowledge of sci, important	5.19±1.05	5.60±0.52	4.50±1.38	4.91±0.92	5.00±1.00	4.78±0.83

This was not surprising as French universities are often viewed as preparing individuals for civic duty (Meuret 2005). The students also had a moderate to strong agreement for science being helpful to understanding the world (5.63±0.72 UA, 5.23±0.75 UM) and that knowledge of science and how it works is important (5.19±1.05 UA, 4.91±0.92 UM). Although there was no statistical difference in responses for UA male and female students, there was a slightly lower value for UM's female responses.

Confidence in Problem Solving

The attitudes toward science survey also assessed the students' ability, confidence and sophistication in problem solving. Table 4 contains the average for their confidence in solving science/math problems. Although all students enjoy science (5.60±0.6 UA, 5.23±0.61 UM) and feel comfortable in a science class (5.44±0.89 UA, 4.86±0.77 UM), the women do not believe science is easy (3.83±1.17 UA, 2.78±0.97 UM) whereas the males do (5.10±0.48 UA, 3.69±0.85 UM). As shown, the belief that science was hard is more significant for French students. While the median average indicated that males were less tense (2.30±1.25 UA, 2.54±1.39 UM) when they thought about doing science than their female (3.00±1.67 UA, 1.89±1.17 UM) counterparts, the standard deviations were too large to yield a definitive difference. The overall trend was not surprising, as previous literature has identified that male students tend to be more confident in their science and mathematics abilities than female freshmen (Lee 2003). The large standard deviation was attributed to the fact that the all of the students had done very well in their high school curriculum. A few had even completed post-secondary courses. In general, French students (UM) were less confident in their abilities than their US (UA) counterparts. Interestingly, females were less confident regardless of their nationality. This is important as a student's self-efficacy key aspect for their persistence in a STEM discipline (Scott and Mallinckrodt, 2005). However, perception of abilities can change even after one year (Hartman and Hartman, 2008), especially if provided positive reinforcement via grades and exposure to strong role models.

Sophistication in Problem Solving

Table 5 contains the responses for the statements used to assess potential sophistication in problem solving skills. The average male and female responses were similar for most of the statements. The exception was for 'dislike repeating experiments to find an answer' where the females reported a moderate to strong disagreement (1.5±0.84 UA, 2.44±1.24 UM) and the males weakly disagreed (3.40±1.70 UA, 4.23±159 UM). Ryder et al. (1999) also found that female undergraduates understood the need of meticulous experiments and data more frequently than their male colleagues. It was good to see that students were already aware of the importance of reporting unexpected results during an experiment (5.31±0.60 UA, 4.95±0.97 UM). Students were confident that they could obtain scientific data in either a laboratory or field setting (4.94±0.57 UA, 4.32±1.04 UM).

Assessment Results for Second (UA) and Third (UM) Year Students

Need for Science after completing 4 or 5 semesters

The results in Table 6 are in agreement with the analogous statements in Table 1. As expected, there were some changes as both sets of cohorts had gained experience. For instance, although both French and UA freshmen seemed to agree that it is worthwhile to spend money on science, the more experienced UA student seem to have reinforced their belief (5.71±0.47 by year two versus 5.50±0.89 as freshmen) while French students seem to have lost enthusiasm. After five

Table 4. Assessment of freshmen students' confidence in problem solving.

	American students			French Students		
Abbreviated statement	**Overall (n=16)**	**Male (n=10)**	**Female (n=6)**	**Overall (n=22)**	**Male (n=13)**	**Female (n=9)**
4. Sci. something I enjoy	5.60±0.60	5.70±0.48	5.67±0.82	5.23±0.61	5.38±0.51	5.00±0.71
5. don't do well in sci	2.00±1.21	2.00±1.49	2.00±0.63	3.68±1.36	3.46±1.39	4.00±1.32
6. feel comfortable in science class	5.44±0.89	5.70±0.48	5.00±1.26	4.86±0.77	4.92±0.76	4.78±0.83
9. Science is easy for me	4.63±1.02	5.10±0.57	3.83±1.17	3.32±0.99	3.69±0.85	2.78±0.97
12. hear "science," feel confident	4.94±0.85	5.10±0.74	4.67±0.30	4.27±1.24	4.69±1.18	3.67±1.12
15. confid make argument w/scientific evidence.	4.56±1.03	4.80±0.63	4.17±1.47	4.36±1.22	4.69±1.25	3.89±1.05
16. confident interpret tables/graphs	5.19±0.66	5.40±0.70	4.83±0.41	4.77±1.38	5.15±1.46	4.22±1.09
20.understand what discussing in sci	5.13±0.62	5.40±0.52	4.67±0.52	4.45±1.18	4.85±0.80	3.89±1.45
23. No matter how hard try, can't understand sci.	1.69±1.20	1.20±0.42	2.50±1.64	1.77±0.92	1.69±0.85	1.89±1.05
24. nervous when someone talks about sci	2.06±1.48	1.80±1.55	2.50±1.38	1.82±1.10	1.62±0.77	2.11±1.45
25. "cannot do this," when assignment difficult	2.00±1.21	1.50±0.71	2.83±1.47	3.50±1.19	3.69±1.03	3.22±1.39
31. good at science labs and hands-on activities	5.06±0.57	5.10±0.57	5.00±0.63	4.45±1.10	5.00±0.71	3.67±1.12
32. conf can find sci journal articles	4.31±0.37	4.40±0.70	4.17±0.75	4.45±1.01	4.69±0.85	4.11±1.17
34. comfortable studying science.	5.31±0.79	5.40±0.52	5.17±1.17	4.41±0.96	4.54±0.88	4.22±1.09
37. get tense thinking about doing sci	2.56±1.41	2.30±1.25	3.00±1.67	2.27±1.32	2.54±1.39	1.89±1.17
40. confident can obtain sci data in lab/field	4.94±0.57	4.80±0.42	5.17±0.75	4.32±1.04	4.77±0.83	3.67±1.00
42. confident extract main pt from sci article	4.38±1.15	4.20±1.23	4.67±1.03	3.82±1.47	3.77±1.59	3.89±1.36
44. conf can understand how sci research done	4.94±0.93	5.00±0.82	4.83±1.17	4.45±1.10	4.69±1.03	4.11±1.17
53. conf can give ptt about science	4.69±1.01	4.80±0.92	4.50±1.22	3.62±1.43	3.92±1.68	3.22±0.97
57. conf think critically about sci	4.69±0.70	4.80±0.42	4.50±1.05	3.86±0.89	4.15±0.90	3.44±0.73
60. conf think critically about things read	4.94±0.77	5.10±0.57	4.67±1.03	4.50±0.86	4.69±0.85	4.22±0.83

Table 5. Average responses for assessment of freshmen's problem solving sophistication

	American students			French Students		
Abbreviated statement	**Overall (n=16)**	**Male (n=10)**	**Female (n=6)**	**Overall (n=22)**	**Male (n=13)**	**Female (n=9)**
3. prefer find out by an expt	5.31±0.70	5.10±0.74	5.67±0.52	4.73± 1.03	4.85± 1.14	4.56± 0.88
8. conf determine valid sci evidence	4.81±0.54	4.80±0.42	4.83±0.75	3.38±1.32	3.83±1.34	2.78±1.09
10. expts not as good as info from prof	1.63±1.50	3.00±1.70	2.00±0.89	2.41±1.33	2.69±1.44	2.00±1.12
11. dislike repeating exp to find ans	2.69±1.40	3.40±1.17	1.50±0.84	3.50±1.68	4.23±1.59	2.44±1.24
15. conf make argument w/sci evidence	4.56±1.03	4.80±0.63	4.17±1.47	4.36±1.22	4.69±1.25	3.89±1.05
16. confident interpret tables/graphs	5.19±0.66	5.40±0.70	4.83±0.41	4.77±1.38	5.15±1.46	4.22±1.09
17. prefer to do experiments	5.31±0.60	5.10±0.57	5.67±0.52	4.73±0.94	4.77±0.93	4.67±1.00
32. conf can find sci journal articles	4.31±0.37	4.40±0.70	4.17±0.75	4.45±1.01	4.69±0.85	4.11±1.17
35. remember things learn in sci	5.06±1.00	5.30±0.48	4.67±1.51	4.09±0.92	4.23±0.93	3.89±0.93
40. conf can obtain sci data lab/field	4.94±0.57	4.80±0.42	5.17±0.75	4.32±1.04	4.77±0.83	3.67±1.00
47. when doing expt, report unexpected results	5.31±0.60	5.20±0.63	5.50±0.55	4.95±0.97	4.62±0.98	5.50±0.76
51. understand how sci res is done	4.81±0.83	4.80±0.79	4.83±0.98	4.05±1.00	4.08±1.12	4.00±0.87

Table 6. Averages of the students view on the need for science after 4 (US) or 5 (France) semesters of study

	American students			French Students		
Abbreviated statement	**Overall (n=14)**	**Male (n=8)**	**Female (n=6)**	**Overall (n=15)**	**Male (n=9)**	**Female (n=6)**
1. $ spent on science, well worth	5.71± 0.47	5.73±0.47	5.67±0.52	4.93± 1.44	5.78± 0.44	3.67± 1.51
2. Sci useful everyday life.	5.76±0.56	5.73±0.65	5.83±0.42	5.73±0.59	5.78±0.67	5.67±0.52
13. Most should study sci.	5.24±0.56	5.27±0.47	5.17±0.75	5.20±0.77	5.22±0.97	5.17±0.41
18. curious about the world	5.47±0.80	5.45±0.93	5.50±0.55	5.13±1.13	5.11±1.36	5.17±0.75
19. Sci helpful understand world	5.65±0.61	5.50±0.85	5.83±0.41	5.47±0.45	5.56±0.73	5.33±0.82
26. important know sci to get job	4.06±1.52	3.82±1.60	4.50±1.38	3.33±1.18	3.11±1.27	3.67±1.03
29. govt spend more $ sci res	5.00±0.94	4.73±1.01	5.50±0.55	5.27±0.80	5.56±0.73	4.83±0.75
56. Knowledge of sci, important	5.24±0.09	5.18±1.08	5.33±0.52	4.87±0.92	4.33±1.12	4.67±0.52
7. little need for sci in most jobs.	1.41±0.71	1.55±0.82	1.17±0.41	3.07±1.67	3.11±1.76	3.00±1.67
22. Sc discoveries do more harm	2.12±1.36	2.64±1.43	1.17±0.41	1.60±0.99	1.67±0.87	1.50±1.22
33. along well in life without sci	3.00±1.54	3.27±1.74	2.50±1.05	2.93±1.33	3.38±1.41	2.33±1.03

Table 7. Assessment of the students' personal interest in and connection to science after 4 or 5 semesters of course

	American students			French Students		
Abbreviated statement	**Overall (n=14)**	**Male (n=8)**	**Female (n=6)**	**Overall (n=15)**	**Male (n=9)**	**Female (n=6)**
2. Sci useful everyday life.	5.76±0.56	5.73±0.65	5.83±0.42	5.73±0.59	5.78±0.67	5.67±0.52
4. Sci. something I enjoy	5.00±0.69	5.00±0.82	5.00±0.53	5.20±0.86	5.11±0.93	5.33±0.82
18. curious about the world	5.47±0.80	5.45±0.93	5.50±0.55	5.13±1.13	5.11±1.36	5.17±0.75
19. Sci helpful understand world	5.65±0.61	5.50±0.85	5.83±0.41	5.47±0.45	5.56±0.73	5.33±0.82
26. important know sci to get job	4.50±1.20	4.30±1.34	4.75±1.04	3.33±1.18	3.11±1.27	3.67±1.03
30. excited to take sci class	4.94±1.16	5.00±1.25	4.88±1.13	4.67±1.18	4.44±1.33	5.00±0.89
41.like teach sci after school	2.00±1.19	2.30±1.49	1.63±0.52	3.53±1.88	3.11±2.20	4.17±1.17
54. enjoy talking sci to others	4.72±0.96	4.60±1.07	4.88±0.33	4.93±0.96	5.33±1.00	4.33±0.52
14. like spend less time studying	1.89±0.96	2.20±1.14	1.50±0.53	3.07±1.83	3.11±1.76	3.00±2.10
21 don't like anything about studying sci	1.83±1.15	2.00±0.94	1.63±1.41	1.47±0.64	1.44±0.73	1.50±0.55
27 prefer job doesn't use sci	1.78±0.81	1.80±0.63	1.75±1.04	2.00±1.20	2.22±1.48	1.67±0.52
33. along well in life without sci	2.50±1.38	2.70±1.64	2.25±1.04	2.93±1.33	3.38±1.41	2.33±1.03
50 dislike reading news re sci	1.94±1.00	2.00±1.25	1.88±0.64	2.20±1.21	2.22±1.48	2.17±0.75

semesters, the French response had dropped to weak agreement (4.93±1.44) from the moderate agreement (5.5±0.67) expressed as freshmen. French female students reported the weakest conviction (3.67±1.51). The attitude and overall trend was confirmed by the other responses. UA students still believe that it is important to know science to get a job (4.06±1.52 UA, 3.33±1.18) and that most people should study science (5.24±0.56 UA, 5.20±0.77 UM). UA students depicted a stronger disagreement that there is little need for science in most jobs (1.41±0.71) than their French counterparts (3.07±1.67). Conversely, the French disagreement that science does more harm than good was more pronounced after five semesters (1.66±0.99) than two (2.55±1.22).

Personal Interest and Connection to Science

One could expect that the personal interest/connection to science would increase after completing the basic courses in freshmen year, when the student is more into the subject that he/she has chosen. Thus in comparing tables 2 and 7 we could expect a stronger disagreement with statements like "I prefer jobs that do not use science" or "we can get along well without science." While American students were still excited to take a science class (5.75±1.18), the French were somewhat less excited (4.09±1.57). French student would still like to spend less time studying science (3.07±1.83) with the largest standard deviation for the women (3.00±2.10). Both student cohorts had depicted less interest at the

Table 8. Students' perception of a real-world connection to science after 4 or 5 semesters of classes

	American students			French Students		
Abbreviated statement	**Overall (n=14)**	**Male (n=8)**	**Female (n=6)**	**Overall (n=15)**	**Male (n=9)**	**Female (n=6)**
1. $ spent on science, well worth	5.50± 0.89	5.50±0.71	5.50±1.22	5.55± 0.67	5.62± 0.65	5.44± 0.73
2. Sci useful everyday life	5.81±0.40	5.90±0.32	5.67±0.52	5.09±1.06	4.85±1.14	5.44±0.88
7. little need for sci in most jobs.	1.44±0.70	1.60±0.97	1.70±0.82	3.07±1.67	3.11±1.76	3.00±1.67
19. Sci helpful understand world	5.50±0.71	5.30±0.82	5.75±0.46	5.47±0.74	5.56±0.73	5.33±0.82
22. Sc discoveries do more harm	1.89±1.28	2.50±1.43	1.13±0.35	1.60±0.99	1.67±0.87	1.50±1.22
26. important know sci to get job	4.50±1.20	4.30±1.34	4.75±1.04	3.33±1.18	3.11±1.27	3.67±1.04
33. along well in life without sci	2.50±1.38	2.70±1.64	2.25±1.04	2.93±1.33	3.38±1.41	2.33±1.03
56. Knowledge of sci, important	5.24±0.09	5.18±1.08	5.33±0.52	4.87±0.92	4.33±1.12	4.67±0.52

Table 9. Assessment of students' confidence in problem solving after 4 or 5 semesters of classes

	American students			French Students		
Abbreviated statement	**Overall (n=14)**	**Male (n=8)**	**Female (n=6)**	**Overall (n=15)**	**Male (n=9)**	**Female (n=6)**
4. Sci. something I enjoy	5.00±0.69	5.00±0.82	5.00±0.53	5.20±0.86	5.11±0.93	5.33±0.82
5. don't do well in sci	2.61±1.20	2.60±1.35	2.63±1.06	3.47±1.30	3.00±1.32	4.17±0.98
6. feel comfortable in science class	4.89±0.90	4.70±1.06	5.13±0.64	4.47±1.25	4.44±1.42	4.50±1.05
9. Science is easy for me	4.28±1.18	4.20±1.03	4.38±1.41	3.73±1.10	3.78±0.97	3.67±1.37
12. hear "science," feel confident	4.67±0.91	4.80±0.79	4.50±1.07	4.60±0.83	4.33±0.87	5.00±0.63
15. confid make argument w/scientific evidence.	4.83±0.86	4.90±0.99	4.75±0.71	4.73±1.10	4.67±1.22	4.83±0.98
16. confident interpret tables/graphs	5.39±0.70	5.40±0.70	5.38±0.74	4.47±0.99	4.44±0.73	4.50±1.38
20.understand what discussing in sci	4.56±1.15	4.80±0.92	4.25±1.39	4.73±0.80	4.78±0.83	4.67±0.82
23. No matter how hard try, can't understand sci.	1.72±1.07	1.60±0.70	1.88±1.46	2.00±1.13	1.44±0.73	2.83±1.17
24. nervous when someone talks about sci	2.22±1.11	2.30±0.95	2.13±1.36	2.00±1.31	1.67±1.12	2.50±1.52
25. "cannot do this," when assignment difficult	2.39±1.50	2.10±1.20	2.75±1.83	3.14±1.35	3.11±1.36	3.20±1.48
31. good at science labs and hands-on activities	4.94±0.87	5.20±0.79	4.63±0.92	4.40±1.35	4.78±1.64	3.38±0.41
32. conf can find sci journal articles	5.00±0.77	5.00±0.82	5.00±0.76	4.53±1.06	4.89±1.17	4.00±0.63
34. comfortable studying science.	4.94±1.00	4.70±0.95	5.25±1.04	4.29±1.49	4.38±1.77	4.17±1.17
37. get tense thinking about doing sci	2.33±1.19	2.30±0.95	2.38±1.51	2.43±1.65	1.88±1.46	3.17±1.72
40. confident can obtain sci data in lab/field	4.72±0.67	4.50±0.71	5.00±0.53	4.53±0.83	4.56±1.01	4.50±0.55
42. confident extract main pt from sci article	4.61±1.04	4.70±0.95	4.50±1.20	4.40±0.99	4.33±1.22	4.50±0.55
44. conf can understand how sci research done	4.72±0.89	4.70±0.82	4.75±1.04	4.79±0.70	5.00±0.76	4.50±0.55
53. conf can give ptt about science	4.61±0.98	4.70±1.16	4.50±0.76	4.67±1.05	5.00±1.12	4.17±0.75
57. conf think critically about sci	4.89±0.76	4.90±0.88	4.88±0.64	4.47±0.83	4.56±0.88	4.33±0823
60. conf think critically about things read	4.94±0.77	4.80±0.92	5.13±0.35	4.47±0.92	4.33±1.12	4.67±0.52

Table 10. Average responses for assessment of problem solving sophistication after 4 and 5 semesters

	American students			French Students		
Abbreviated statement	**Overall (n=14)**	**Male (n=8)**	**Female (n=6)**	**Overall (n=15)**	**Male (n=9)**	**Female (n=6)**
3. prefer find out by an expt	5.00±0.84	4.70±0.82	5.38±0.74	5.00±1.00	5.00±1.12	5.00±0.89
8. conf determine valid sci evidence	4.39±1.04	4.60±0.70	4.13±1.36	4.07±1.16	3.78±1.30	4.50±0.84
10. expts not as good as info from prof	2.39±0.85	2.70±0.82	2.00±0.76	2.53±0.83	2.33±0.87	2.83±0.75
11. dislike repeating exp to find ans	2.94±1.43	3.50±1.35	2.25±1.28	2.80±1.08	3.22±0.97	2.17±0.98
15. conf make argument w/sci evidence	4.83±0.86	4.90±0.99	4.75±0.71	4.73±1.10	4.67±1.22	4.83±0.98
16. confident interpret tables/graphs	5.39±0.70	5.40±0.70	5.38±0.74	4.47±0.99	4.44±0.73	4.50±1.38
17. prefer to do experiments	4.94±1.26	4.90±0.99	5.00±1.60	4.73±1.39	4.56±1.67	5.00±0.89
32. conf can find sci journal articles	5.00±0.77	5.00±0.82	5.00±0.76	4.53±1.06	4.89±1.17	4.00±0.63
35. remember things learn in sci	4.33±1.33	4.50±0.97	4.13±1.73	4.07±1.22	3.78±1.39	4.50±0.84
40. conf can obtain sci data lab/field	4.72±0.67	4.50±0.71	5.00±0.53	4.53±0.83	4.56±1.01	4.50±0.55
47. when doing expt, report unexpected results	5.28±0.89	5.20±1.03	5.38±0.74	4.20±1.57	4.44±1.67	3.83±1.47
51. understand how sci res is done	4.50±0.86	4.50±0.85	4.50±0.93	4.40±0.99	4.56±1.13	4.17±0.75

beginning regarding the possibility of becoming a science teacher (2.50±1.26 UA, 2.59±1.89 UM). However this had changed for the French students by the third year (2.00±1.19 UA, 3.53±1.88) with the strongest agreement being expressed by the female students (4.17±1.17 UM). It would be interesting to know why teaching is not appealing, especially for the US students. Is it attributable to difficulty entering the academic world (requirement of a PhD for college level), a matter of a lower salary (college and secondary education) or is it simply less interest in becoming a specialist in field that transfers knowledge to younger generations?

Real world Connection to Science

The perception the knowledge of science matters to everyday life as well as in understanding what is around us was reconfirmed. Statement 2 and 19 were had the overall strongest agreement for both nationalities. The exception was with the male responses to statement 2. American males had a stronger agreement (5.90±0.32) than their French counterparts (4.85±1.14). All students had a moderate disagreement with the statement, can get along well in life without science.

Confidence in Problem Solving

As the students progress in their studies, they still enjoy science but yet are not completely comfortable in a science class. The discomfort in a science class was more pronounced for French students (3.73±1.10) than the UA students (4.28±1.18). Furthermore, French students (3.47±1.30 overall) do not believe they do well in science. This was especially true for the French women (4.17±0.98).

Statements 9, 16, 31 and 41 dealt with the students' ability to complete lab/experimental work and in the interpretation of the results. They generally felt confident with the ability to conduct experiments and discuss the data. It was interesting that for both nationalities, male students confidence regarding hands' on science activities had increased while the female students confidence had decreased slightly. For instance US male confidence for hands on activities had gone from 5.10±0.57 as freshmen to 5.20±0.79 by the end of the second year while that of French female students had was still low after three years (3.38±0.41). The persistence of the women's lack of self-confidence, although a concern, was not surprising. A six-year study of engineering and science students reported that the proportion of women reporting a lack of self-confidence was roughly double by senior year (Brainard and Carlin, 1998).

Both cohorts show they feel at ease in their environment and are able to defend their conclusions with scientific evidence and critical attitude (statements 53 and 57). However when asked about understanding how research is done, both UA and UM cohorts maintained a weak agreement (~4.5) even after one to two years of instruction. French students generally fill this gap when they perform their first compulsory 2-months internships in a laboratory or in industry during the first year their masters. The internship is when they start to work full-time on a project. They are supervised by a PhD student and an assistant professor and have meetings where they have to learn how to present their results. American students can complete a similar program earlier in their undergraduate career. For the engineering students, they will begin their co-operative (co-op) education (alternating semesters working for a company in their discipline) during the sixth semester. Biology, chemistry and mathematics majors can complete a summer internship after completing their sophomore year (four semesters). Although the UA cohort had not yet been eligible for a co-op or internship, two of the students were working as an undergraduate research assistant for faculty members.

Sophistication in Problem Solving after two or three years of coursework

Overall, the students still seem to prefer carrying out experiments rather than listening to the theoretical lecture. After three years, French students to questions 3 and 17 remained the same. Both cohorts were not completely positive about their ability to remember things learned in class (4.33±1.33 UA, 4.07±1.22 UM). All students were willing to repeat experiments (statement 11). Interestingly the trend that females are more meticulous was confirmed (UA females 2.25±1.28 UA males 3.50±1.35, UM females 2.17±0.98 UM males 3.22±0.97). All students agreed with the need of reporting unexpected results, and they were confident in interpreting tables and graphs. These responses indicated that their sophistication in problem solving and self-efficacy had improved.

As shown in the student surveys, French students were less confident in their abilities than American students. This in part could be attributed to the inability to achieve high marks, regardless of how diligently they work. Females were less confident in comparison to male students regardless of nationality. A 2001 statistical study conducted in France indicated that women comprised only 25% of the >180,000 researchers employed in France (Bonneau and Gordon, 2002). Most of the women were in public sector in the areas of humanities and life sciences. According to a survey of over 200 of the top US research universities, although 93% of the female undergraduates were more prepared for their STEM career than the male students (Bayer 2012), men still outnumber women in graduation rates. For some science fields such as engineering and computer science, women receive only 20% of the bachelor degrees (Hill et al., 2010). The lack of female role models becomes more pronounced for post-secondary degrees. As with France, in the U.S. women are still underrepresented as faculty members in STEM fields (Chelser et al., 2010; Fox 2010; Glass and Minnotte, 2010; Hartman and Hartman, 2008). Lack of confidence in their abilities, too few role models, feelings of isolation and discouragement from a counselor/teacher were listed as the most common reasons for not matriculating (Bayer 2012, Chelser et al., 2010; Scott and Mallinckrodt, 2005; Sonnert and Fox 2012).

CONCLUSIONS

As expected, there were cultural differences in the teaching style and expectations for both instructor and students. These differences ranged from instructor-student interactions, to course offerings, to grading. All of which impact the students' perceptions of their own capability. These perceptions can have a significant impact on academic performance and persistence in STEM fields.

Overall female students, regardless of nationality were less confident of their capabilities. The lack of confidence occurred even for women who earned higher grades than their male colleagues. A students lack in confidence, regardless of gender or nationality, was the primary reason for leaving STEM fields by the mid or end of the freshmen year.

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APPENDIX

Attitudes Toward Science Assessment

Directions:

1. This test contains a number of statements about science. You will be asked what you think about these statements. There are no “right” or “wrong” answers. Your opinion is what is wanted.
2. For each statement, draw a circle around the specific numeric value corresponding to how you feel about each statement. **Please circle only ONE value per statement.**

6 = Strongly Agree (SA)
5 = Moderately Agree (A)
4 = Weakly Agree (WA)
3 = Weakly Disagree (WD)
2 = Moderately Disagree (D)
1 = Strongly Disagree (SD)

Statement	SA	MA	WA	WD	MD	SD
1. Money spent on science is well worth spending.	6	5	4	3	2	1
2. Science is useful for the problems of everyday life.	6	5	4	3	2	1
3. I would prefer to find out why something happens by doing an experiment rather than by being told.	6	5	4	3	2	1
4. Science is something that I enjoy very much.	6	5	4	3	2	1
5. I do not do very well in science.	6	5	4	3	2	1
6. I feel comfortable in a science class.	6	5	4	3	2	1
7. There is little need for science in most of today’s jobs.	6	5	4	3	2	1
8. I am confident I can determine what is – and what is not – valid scientific evidence.	6	5	4	3	2	1
9. Science is easy for me.	6	5	4	3	2	1
10. Doing experiments is not as good as finding out information from teachers.	6	5	4	3	2	1
11. I dislike repeating experiments to check that I get the same results.	6	5	4	3	2	1
12. When I hear the word “science,” I have a confident feeling.	6	5	4	3	2	1
13. Most people should study some science.	6	5	4	3	2	1
14. I would like to spend less time in school studying science.	6	5	4	3	2	1
15. I am confident I can make an argument using scientific evidence.	6	5	4	3	2	1
16. I am confident I can interpret tables and graphs.	6	5	4	3	2	1
17. I would prefer to do experiments rather than to read about them.	6	5	4	3	2	1
18. I am curious about the world in which we live.	6	5	4	3	2	1
19. Science is helpful in understanding today’s world.	6	5	4	3	2	1
20. I usually understand what we are discussing in science.	6	5	4	3	2	1
21. I do not like anything about studying science.	6	5	4	3	2	1
22. Scientific discoveries are doing more harm than good.	6	5	4	3	2	1
23. No matter how hard I try, I cannot understand science.	6	5	4	3	2	1
24. I feel nervous when someone talks to me about science.	6	5	4	3	2	1

Statement	SA	MA	WA	WD	MD	SD
25. I often think, “I cannot do this,” when a science assignment seems difficult.	6	5	4	3	2	1
26. It is important to know science to get a good job.	6	5	4	3	2	1
27. I would prefer a job that does not use any science.	6	5	4	3	2	1
28. Anything done scientifically is always accurate and reliable.	6	5	4	3	2	1
29. The government should spend more money on scientific research.	6	5	4	3	2	1
30. I enjoy watching science programs on television.	6	5	4	3	2	1
31. I am good at science labs and hands-on activities.	6	5	4	3	2	1
32. I am confident I can find scientific journal articles using library/internet databases.	6	5	4	3	2	1
33. You can get along perfectly well in everyday life without knowing science.	6	5	4	3	2	1
34. I am comfortable studying science.	6	5	4	3	2	1
35. I remember most of the things I learn in science class.	6	5	4	3	2	1
36. Science is mostly concerned with collecting facts.	6	5	4	3	2	1
37. I get tense when thinking about doing science.	6	5	4	3	2	1
38. Most of the ideas in science are not very useful.	6	5	4	3	2	1
39. I am excited when I have to take a science class.	6	5	4	3	2	1
40. I am confident I can obtain scientific data in a laboratory or field setting.	6	5	4	3	2	1
41. I would like to teach science when I leave school.	6	5	4	3	2	1
42. I am confident I can extract main points from a scientific article and develop a coherent summary.	6	5	4	3	2	1
43. Science is one of my favorite subjects.	6	5	4	3	2	1
44. I am confident I can understand how scientific research is carried out.	6	5	4	3	2	1
45. I have a good feeling towards science.	6	5	4	3	2	1
46. A scientific fact is absolute and fixed.	6	5	4	3	2	1
47. In science experiments, I report unexpected results as well as expected ones.	6	5	4	3	2	1
48. I would dislike becoming a scientist because it needs too much education.	6	5	4	3	2	1
49. I would enjoy school more if there were no science lessons.	6	5	4	3	2	1
50. I dislike reading newspaper/magazine articles about science.	6	5	4	3	2	1
51. I understand how science research is carried out.	6	5	4	3	2	1
52. It scares me to have to take a science class.	6	5	4	3	2	1
53. I am confident I can give a presentation about a science topic to my class.	6	5	4	3	2	1
54. I enjoy talking to other people about science.	6	5	4	3	2	1
55. Most engineers and medical doctors are actually scientists.	6	5	4	3	2	1

Statement	SA	MA	WA	WD	MD	SD
56. Knowledge of what science is, what it can and cannot do, and how it works, is important for all educated people.	6	5	4	3	2	1
57. I am confident I can think critically about scientific findings I read about in the media.	6	5	4	3	2	1
58. If a scientific finding is reported in the media, I can be confident that it is right.	6	5	4	3	2	1
59. Scientists often try to test or disprove possible explanations.	6	5	4	3	2	1
60. I am confident I can think critically about things I read.	6	5	4	3	2	1