

Does Active Learning Improve Students' Knowledge of and Attitudes Toward Research Methods?

By Jay Campisi and Kevin E. Finn

We incorporated an active, collaborative-based research project in our undergraduate Research Methods course for first-year sports medicine majors. Working in small groups, students identified a research question, generated a hypothesis to be tested, designed an experiment, implemented the experiment, analyzed the data, and presented their findings to the college community. We used a survey to assess students' perception of and attitudes about research and research methods before and after the semester. In addition, students reflected on the research experiment through a weekly discussion and dialogue on Blackboard. Students were responsible for a final oral presentation and a poster presentation. Incorporating a participatory, collaborative, and active learning component to this course allowed students to grasp relevant research methodology theories and principles, acquire competency in research methodology techniques, develop interpersonal and professional skills, and improve their attitude regarding science and the research process. The results suggest participation in a research project can be an effective way to enhance first-year student learning and attitudes regarding research methodology.



The lecture format has historically been the most popular teaching pedagogy utilized by collegiate faculty members in the United States. However, lecturing alone is not always the most successful approach to promote learning (Handelsman et al. 2004; Knight and Wood 2005). Encouraging students to formulate their own ideas, interpret data, generate conclusions from experimental evidence, and participate in other “hands-on” activities can be more effective than the passive learning that typically occurs during lecturing. In fact, many national organizations (American Association for the Advancement of Science 1993; Association of American Colleges and Universities 2007; NRC 1999, 2003a, 2003b; National Science Foundation 1996) encourage the use of active learning in the college science classroom.

The increased recognition of the value of active learning is supported by a growing body of evidence demonstrating the effectiveness of incorporating active learning techniques in the undergraduate classroom. Studies have found increased learning when active learning strategies were used in a wide range of science disciplines including physics (Hake 1998), chemistry (Niaz et al. 2002; Towns and Grant 1997), biology (Burrowes 2003), nursing (Clark et al. 2008), and physiology (Miersson 1998) and through the use of a number of different active learning activities (Prince 2004). For example, collaborative learning has been found to enhance academic achievement (Johnson, Johnson, and Smith 1998a, 1998b; Springer, Stanne, and Donovan 1999), student attitudes (Springer, Stanne, and Donovan 1999), and student retention (Berry 1991; Fredericksen 1998).

Many undergraduate programs include a one-semester research methods course in the curriculum. The research methods course is usually offered to upperclass students and is a course that students do not eagerly anticipate. One potential reason for the lack of interest is students' inability to perceive themselves as engaged in meaningful research activities (Rash 2005). Thus, we redesigned our research methods course to incorporate participation in a research project. We hoped that stimulating interest in research at the beginner baccalaureate level through active and collaborative learning would allow students to build on their knowledge base in subsequent courses and potentially encourage their participation in research projects. Therefore, we offered our research methods course to first-year students.

Despite the fact that the research process is inherently an active and collaborative process, there are few studies that have examined the efficacy of active learning in teaching scientific research methodology. Moreover, we are unaware of any studies that have examined how first-year students respond to an active learning project involving research methods. Therefore, the purpose of the present study was to evaluate the effectiveness of incorporating active learning teaching techniques in a first-year undergraduate research methods course.

Materials and methods

Course and student details

This study included 54 first-year students majoring in sports medicine enrolled in a required undergraduate research methods course dur-

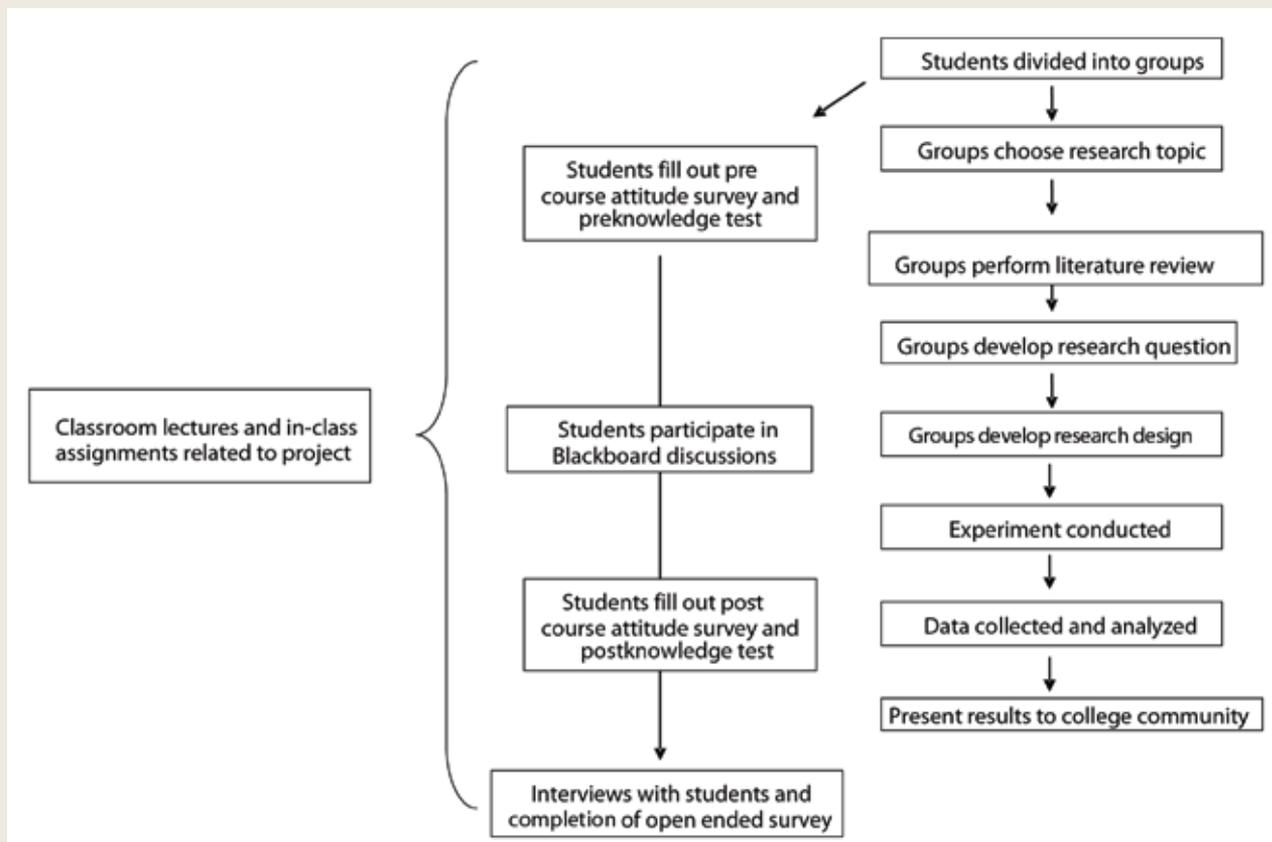
ing the spring 2009 semester. The course was taught in two separate sections with 27 students in each section, each meeting on a MWF, 50-minute class schedule. The sample was 70% female and 30% male. Institutional Review Board approval allowed us to examine student attitudes and content knowledge for research purposes.

General procedures

Previously, this course was taught in a lecture-based pedagogical approach. Students were required to read peer-reviewed journals and understand the major concepts of research methodology. The active, collaborative learning project was created to assist students to become more familiar with research methodology typically used in the sports medicine field and to work

FIGURE 1

Flow diagram of course procedures.



together as part of a team. The project required active participation in a research project conducted throughout the academic semester and involved continual feedback from the instructors (see Figure 1). Class time was used to provide information regarding the theories and practices of research methodology in the form of lectures and group activities. The research project occurred mainly outside of the classroom on students' own time.

Students were randomly assigned to a group of three or four and were introduced to the research project orally in class and through written handouts during the first class meeting. Student groups initially chose a topic from an instructor-generated list of feasible research ideas. Once members of the group settled on a

topic, they conducted a literature review to further their knowledge and understanding of their selected topic. Next, students developed a specific research question and hypothesis that they planned to investigate during the semester. Working with the course instructors, student groups refined their research questions and created their study design. For example, one group examined "the effects of body composition on running speed" by measuring the body composition and 100-yard dash time of subjects and conducting correlation analysis. Another group studied "the influences of caffeine on blood pressure in female athletes and nonathletes" by measuring blood pressure and tracking caffeine intake in groups of women. We placed few restrictions on students in terms of designing

their project, provided that the project was logistically feasible.

Students were required to recruit and collect data on at least 40 college-age subjects over a four-week period. Students worked collaboratively out of class to input the raw data into an Excel spreadsheet, perform basic statistical analysis (i.e., calculating the mean and standard deviation for a particular variable), and generate figures. At the end of the semester, students collaboratively generated posters and presented the results of this project during a campuswide, student-research colloquium.

Reflection techniques

In addition to the poster and oral presentations, students were encouraged to reflect on their experiences throughout the project in a number of ways. Students completed a survey addressing their attitudes and perceptions related to research methodology at the beginning and end of the semester. Throughout the semester, students participated in biweekly Blackboard discussions to reflect on the research topics and assignments of the week and discuss their experiences during their research project.

Measurements and statistical analyses

We administered a 25-question multiple-choice exam on the first and last day of the course to examine content knowledge gain (see Table 1). Students were told that the exam would not count toward their grade but were instructed to answer the questions to the best of their ability. The purpose of the pretest–posttest comparison was to detect differences in learning out-

TABLE 1

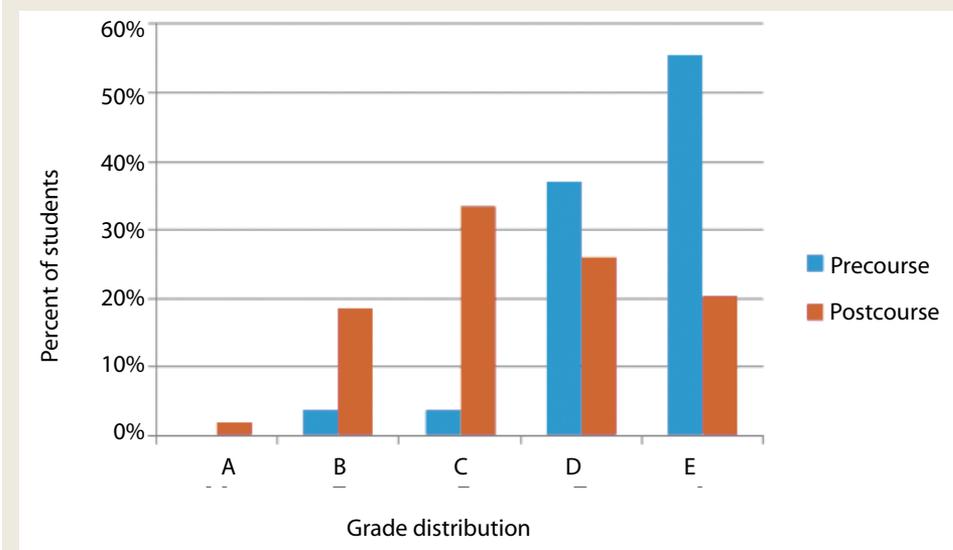
Students' knowledge about research methodology before and after completion of the course.

	Precourse (Mean ± SD)	Postcourse (Mean ± SD)	Change (Mean ± SD)	Individual difference (Mean ± SD)
Correct answers	14.0 ± 2.7	17.3 ± 3.3*	3.3 ± 2.9	26.2 ± 0.3
Percentage correct	56.1 ± 0.1	69.3 ± 0.1*	13.2 ± 0.1	26.2 ± 0.3

* $p < 0.05$

FIGURE 2

Grade distribution for content knowledge exam.



comes relative to student content knowledge of research methodology. The 25 questions were directly related to the learning objectives and the content areas covered in the course. For example, questions examined if students could differentiate between a dependent and independent variable, recognize a quantitative versus a qualitative measurement, and describe a double-blind experiment.

In order to assess student attitudes and perceptions about research methodology, we distributed an attitudinal survey (adapted from Vodopivec et al. 2002) on the first and last day of class (see Table 2). The validity and reliability of this test have been reported previously (Vodopivec et al. 2002). Briefly, the test was first created by a team of experienced researchers. Next, to ensure the validity, eight independent observers were asked to select 60 (30

positive and 30 negative) of the most relevant statements out of the initial 199 developed. The items chosen by at least four observers were included in the questionnaire. Reliability analysis was conducted and the final questionnaire was formed by selecting a subset of questions on the basis of item discrimination and item-total correlation. We adopted the questionnaire by changing some of the wording slightly to make it more relevant to our course without compromising the reliability or validity of the instrument. For example, we replaced “medicine” with “sports medicine” in the item “scientific research accounts for progress in sports medicine.” The survey asked students to rate 45 statements using a standard Likert scale (ranging from 1 = *strongly disagree* to 5 = *strongly agree*).

At the end of the semester, students were given instructions to

complete the Student Assessment of Their Learning Gains (SALGains), a web-based instrument that includes several items specifically related to various aspects of the research project (Seymour et al. 2000; Student Assessment of Their Learning Gains 2009). For example, Tables 3–5 describe items examining students’ perceptions of class impact on gains in content knowledge (see Table 3), skill acquisition (see Table 4), and interest, confidence, and comfort in research methods (see Table 5).

Analysis of pre–post attitudinal survey and content knowledge was completed using ANOVA in Stat-View; α was set at 0.05. In all of the figures, the values are shown as group means \pm standard deviation.

Results

Content knowledge

Results of the precourse content knowledge assessment exam reveal

TABLE 2

Significant changes in students’ attitudes pre- and postcourse.

Question		Strongly agree (%)		Agree (%)		Undecided (%)		Disagree (%)		Strongly disagree (%)	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	Science has too rigid view about the world.	1.9	3.8	31.5	11.3	42.6	49.1	24.1	35.8	0.0	0.0
9	Research made the greatest contribution for development of sports medicine.	7.4	17.0	44.4	49.1	33.3	24.5	14.8	7.5	0.0	1.9
11	The only data that we can be sure of are those obtained by scientific methods.	1.9	13.2	24.1	32.1	20.4	28.3	48.1	26.4	5.6	0.0
15	Only the scientific kind of research makes progress in sports medicine possible.	1.9	1.9	9.4	28.3	24.5	18.9	58.5	47.2	5.7	3.8
16	Scientists often use unethical methods in their research.	3.8	1.9	24.5	18.9	18.9	17.0	50.9	50.9	1.9	11.3
17	Only by scientific approach can one obtain objectively measurable and precise data.	3.8	13.5	40.4	51.9	30.8	21.2	25.0	11.5	0.0	1.9
21	Use of research methodology is basic for progress in sports medicine.	1.9	11.5	53.8	65.4	36.5	17.3	7.7	5.8	0.0	0.0
32	Facts can be established only through scientific research.	7.5	5.7	22.6	41.5	17.0	18.9	49.1	34.0	3.8	0.0
41	There would be no progress without scientific progress.	1.9	2.2	32.1	39.1	22.6	26.1	30.2	32.6	13.2	0.0

Note: Mean Likert score significantly different from pre- to postcourse on all questions at $P \leq 0.05$.

that students lacked a strong understanding of many of the concepts and theories regarding research methods prior to taking the course (see Table 1 and Figure 2). Ninety-three percent of the class scored a 60%–69% (“D”) or <60% (“F”) on the pretest exam and the mean precourse average was 14 correct answers out of 25 possible questions (56.1% ± 0.1). Differences in performance on the content knowledge exam were observed at the end of the semester. The majority (54%) of students scored a 70% (“C”) or higher (B = 80%–89% and A = 90%–100%) on the postcourse exam, and average scores on the exam increased by 13.2% (56.1%–69.3%); $p < .05$ from pre- to postcourse (see Table 1 and Figure 2). Additionally, when percentage of improvement was calculated, the results indicated posttest scores improved on average by 26.2% (e.g., a student who went from 48% to

60% demonstrated a 25% improvement from their precourse score; see Table 1). Item analysis revealed that students improved dramatically in areas that they played an active role in throughout the semester, such as research design and institutional review board procedures. On the other hand, students demonstrated the least amount of gains in content area that they had little exposure to during the research process (e.g., statistical analysis) or in class.

Student attitudes

The significant results of the pre- and postcourse attitudinal survey are displayed in Table 2 following statistical analysis based on previous results (Vodopivec et al. 2002). Students’ initial (precourse) views regarding research were generally positive, although not overwhelmingly so (see Appendix online at www.nsta.org/college/connections.

aspx). For example, students tended to agree only moderately (mean score of 3.52) with the statement “Valid sports medicine procedures are only those that have been verified by research.” Examination of pre–post responses indicate significant changes occurred in response to 9 of the 45 (20%) statements (all $p < .05$; displayed in Table 2 and Appendix). Of the significant changes in attitudes that occurred, some can be attributed to students forming a response to a statement postcourse that precourse they were unsure about. For instance, 55.7% of students agreed or strongly agreed that “use of research methodology is basic for progress in sports medicine” before the course (mean = 3.51), which changed to 76.9% after the course (mean = 3.79; see Table 2 and Appendix). There was a shifting of students from the “undecided” (36.5%–17.3%) to the “agree” or “strongly agree” category postcourse with little change in the “disagree” category (7.7%–5.8%; see Table 2). Other changes in attitude were the result of students changing their mind about a particular statement. To illustrate, 30.1% of students either agreed or strongly agreed that “facts can be established only through scientific research” before the course (mean = 2.81), which changed to 47.2% postcourse (mean = 3.19). There was a sizeable shift from the “disagree” (49.1%–34%) to “agree” (30%–47.2%) category, with little change in the “strongly disagree” (3.8%–0%) and “undecided” (17%–18.9%) categories. Finally, some of the significant changes were the result of attitudes getting stronger as a result of the course. For example, there was a significant change in the percentage of students who disagreed with the statement that “scientists often use unethical methods in their research” following the course (mean = 2.76 precourse to 2.49 postcourse). The

TABLE 3

Student’s perceptions of class impact on gains in content knowledge measured in SALGains.

Responses on end-of-semester surveys. Response choices were <i>Great Gains</i> (5), <i>Good Gains</i> (4), <i>Moderate Gains</i> (3), <i>Little Gains</i> (2), <i>No Gains</i> (1), and <i>Not Applicable</i> .				
As a result of your work in this class, what gains did you make in your understanding of each of the following:				
	Mean	SD	Mode	Good/ Great Gains
The purpose of research in sports medicine	4.1	0.83	4	82%
The relationships between research and treatment of injuries and illness in science	4.0	0.82	4	79%
How ideas from this class relate to ideas encountered in other classes within the subject area	3.8	0.83	4	68%
Please comment on how your understanding of research methods will help you in your college career and health care profession:				
<ul style="list-style-type: none"> • <i>I think it was helpful to learn how to do research, and what I learned in this class can definitely be helpful in other classes.</i> • <i>I understand that it is important to question why things are done because through research we can find better ways to treat injuries that could help the patient.</i> • <i>This class was a good way to help us understand the general information about conducting a research project in sports medicine.</i> • <i>With any health care field we would go into comes the need for research and the knowledge in this class will carry on with me.</i> 				

Note: SALGains = Student Assessment of Their Learning Gains.

change in attitudes largely occurred in the “strongly disagree” category (1.9%–11.3%), whereas no movement occurred in the “disagree” category (50.9%–50.9%). Collectively, these results suggest that student attitudes regarding research and research methods improved following completing the course.

Students’ perception of content and skill gain

Tables 3–5 display the descriptive statistics generated from the end-of-semester SALGains survey as well as representative student quotations. Table 3 represents the students’ perceptions of their gains in content knowledge from the course. As a result of the course, 82% of students felt they made good/great gains in understanding the purpose of research in sports medicine. In addition, a majority (79%) of students felt they had a strong understanding of the relationships between research and treatment of injuries and illness in science. Sixty-eight percent expressed good/great gains in relating ideas from the course to ideas encountered in other classes within the subject area. The student quotes reflected positive perceptions on how they felt the course would help them in their college career and health care professions.

Table 4 demonstrates students’ perceptions of the skills gained as a result of the course. A large number (82%) of the respondents felt good/great gains were made in their knowledge of what is contained in a research article (Introduction, Methods, Results, Conclusion), and 50% felt comfortable finding articles relevant to a particular problem in professional journals or databases. When analyzing specific skills, 73% of students felt that they made good/great gains in their ability to create Excel spreadsheets, graphs, and poster presentations. In addition, the student quotes demonstrated many

improvements in skills gained in the course (see Table 4).

Students’ perception of attitudes regarding research methods

Table 5 displays the descriptive statistics and representative student comments regarding attitudes toward research methods. The results demonstrate a positive perception of the effect of the course on student attitudes. For example, as a result of work in the class, 50% of respondents stated they made good/great gains in having interest in research in sports medicine and interest in doing another research project (see Table 5). A large majority (76%) of respondents stated that they felt good/great gains regarding confidence understanding the material and felt comfortable (71%) working with research and reading articles. Indeed, as displayed in Table 5, student quotes

reflected these improvements in comfort and interest in research methods.

Discussion

Historically in the life sciences, programs have reserved research method courses for the senior year, but recently there has been a shift to introduce research concepts earlier in the curriculum (Rambur 1999). We implemented a research methods course in the freshmen year using an active and collaborative project as a basis for the course. Our students increased their content knowledge of research methods on average by 26% from pre- to post-course. Overall, our students performed quite well in the course, with the mean grade for the entire class resulting in a B+ (87.3%), and the lowest grade equaling a C+ (two students; 77%). Although we did not directly compare performance fol-

TABLE 4

Students’ perceptions of class impact on gains in skill acquisition measured in SALGains.

Responses on end-of-semester surveys. Response choices were Great Gains (5), Good Gains (4), Moderate Gains (3), Little Gains (2), No Gains (1), and Not Applicable.				
As a result of your work in this class, what gains did you make in the following skills:				
	Mean	SD	Mode	Good/ Great Gains
Finding articles relevant to a particular problem in professional journals or/and databases	3.4	0.93	4	50%
Knowing what is in a research article Introduction, Methods, Results, Discussion	4.1	0.81	4	82%
Creating Excel spreadsheets and graphs	3.8	1.11	4	73%
Creating a poster	3.9	1.02	4	73%
Please comment on three skills you have gained as a result of the course and project:				
<ul style="list-style-type: none"> • Gained on how to make an accurate poster, become more recognized with Excel, and I am now able to properly research information on a specific project or injury. • I learned what to look for when reading research articles, what goes into each section of a poster for research, and I learned the steps it takes to set up a research project. • Understand Excel better, can use a bioimpedance scale, and I know the different types of research designs there are. • I can identify the types of research, understand why they are done, and am better at taking blood pressures. 				

Note: SALGains = Student Assessment of Their Learning Gains.

lowing active learning with that following the more traditional lecture-based teaching style, historical data has suggested that the two pedagogies are both effective. For example, the course average following active learning is the approximate average we observed previously when the course was taught in the more traditional lecture-based format (87.9% over the previous four years). However, previous work has demonstrated that active learning improves knowledge retention (Berry 1991; Fredericksen 1998). Therefore, we are actively tracking these students to examine how well they retain content knowledge over time. Moreover, results from qualitative surveys that students completed postcourse suggest that they enjoy an active teaching style more than the traditional lecture format.

The majority (>50%) of students felt that they made good/great gains in content knowledge, skill acquisition, and overall confidence and comfort for major concepts in

the research methods course (see Tables 3–5). Previous literature has indicated that students with positive learning attitudes and motivation can enhance their academic achievement (Prince 2004). In addition, student learning attitudes can be improved through a successful classroom experience (Hwang and Kim 2006). Our data indicates that student attitudes and perceptions of research improved from pre- to postcourse assessments. This result is supported by previous findings that demonstrated students who engaged in active learning projects had positive attitudes about the content (Prince 2004).

In previous studies, it has been documented that active learning pedagogy requires a significant time commitment and effort when compared with a traditional lecture-based approach (Weimer 2002; Casem 2006). In our course, we integrated many in-class group activities and Blackboard reflections to allow students to collaborate with each other and the instructors. These activities

provided students with the opportunity to work through problems and begin to apply research methods concepts to their project. We believe that students would not have been able to understand the difficulties and complications of conducting research if they had not participated in this active and collaborative project. As instructors, we felt that there was an increased demand on our time for the organization, implementation, and grading of these activities. As a result, we were not able to cover as much course content; however, we felt that the activities were more important and meaningful for students' learning and understanding of the research topics.

One limitation of the current project was the lack of a grade tied to the pre- or postcourse content knowledge test. Although the majority of students demonstrated significant improvements on the postcourse test (see Figure 2), a large percentage (45%) of students scored $\leq 59\%$ correct on the posttest. Because this test did not influence their overall course grade, it is possible that some students did not make an effort to complete the posttest to the best of their ability. In addition, despite the high reliability and validity of the attitude survey, some of the items could have been constructed more clearly.

In this study, collaborative learning captured undergraduate attention by actively involving students in research methodology. In many science lecture and laboratory courses, active learning can be an effective method to improve student learning and understanding as well as improve student attitudes about a subject. Additionally, the education literature challenges professors to be more creative and innovative in their active learning exercises (Michael 2006). Incorporating a team-based research project into a research methods courses is one such creative

TABLE 5

Student's perceptions of class impact on gains in interest, confidence, and comfort in research methods measured in SALGains.

Responses on end-of-semester surveys. Response choices were <i>Great Gains</i> (5), <i>Good Gains</i> (4), <i>Moderate Gains</i> (3), <i>Little Gains</i> (2), <i>No Gains</i> (1), and <i>Not Applicable</i>.				
As a result of your work in this class, what gains did you make in the following:				
	Mean	SD	Mode	Good/ Great Gains
Interest in research in sports medicine	3.4	1.23	4	50%
Interest in doing another research project	3.2	1.28	4	50%
Confidence that you understand the material	3.9	1.04	4	76%
Your comfort level in working with research and reading articles	3.8	1.10	4	71%
Please comment on how this class has changed your attitudes toward research methods:				
<ul style="list-style-type: none"> • <i>Less hesitant towards reading or experimenting.</i> • <i>I will carry the knowledge on how to properly put together an effective research project.</i> • <i>I always thought research was basic and boring. Now I know that research is quite interesting.</i> 				

Note: SALGains = Student Assessment of Their Learning Gains.

approach. Finally, our study suggests that first-year undergraduate students can benefit from such an approach, perhaps leading to improved retention in the sciences and better understanding of material in subsequent courses. ■

References

- American Association for the Advancement of Science (AAAS). 1993. *Benchmarks for science literacy: Project 2061*. Washington DC: AAAS.
- Association of American Colleges and Universities (AACU). 2007. *College learning for the new global century*. Washington DC: AACU.
- Berry, Jr., L. 1991. *Collaborative learning: A program for improving the retention of minority students*. ERIC Document Reproduction Service No. 384 323.
- Burrowes, P. A. 2003. A student-centered approach to teaching general biology that really works: Lord's constructivist model put to a test. *The American Biology Teacher* 65 (7): 491–502.
- Casem, M. 2006. Active learning is not enough. *Journal of College Science Teaching* 35 (6): 52–57.
- Clark, M. C., H. T. Nguyen, C. Bray, and R. E. Levine. 2008. Team-based learning in an undergraduate nursing course. *Journal of Nursing Education* 47 (3): 111–117.
- Fredericksen, E. 1998. *Minority students and the learning community experience: A cluster experiment*. ERIC Document Reproduction Service No. 216 490.
- Hake, R. R. 1998. Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics* 66 (1): 64–78.
- Handelsman, J., D. Ebert-May, R. Beichner, P. Bruns, A. Chang, R. DeHann, J. Gentile, S. Lauffer, J. Stewart, S. M. Tilghman, and W. B. Wood. 2004. Scientific teaching. *Science* 304 (5760): 521–522.
- Hwang, S. Y., and M. J. Kim. 2006. A comparison of problem-based learning and lecture-based learning in an adult health nursing course. *Nurse Education Today* 26 (4): 315–317.
- Knight, J. K., and W. B. Wood. 2005. Teaching more by lecturing less. *Cell Biology Education* 4 (4): 298–310.
- Johnson, D., R. Johnson, and K. Smith. 1998a. *Active learning: Cooperation in the college classroom*. 2nd ed. Edina, MN: Interaction Book Co.
- Johnson, D., R. Johnson, and K. Smith. 1998b. Cooperative learning returns to college: What evidence is there that it works? *Change* 30 (4): 26–35.
- Michael, J. 2006. Where's the evidence that active learning works? *Advances in Physiology Education* 30 (4): 159–167.
- Mierson, S. 1998. A problem-based learning course in physiology for undergraduate and graduate basic science students. *Advances in Physiology Education* 20 (1): S16–S27.
- National Research Council (NRC). 1999. *Transforming undergraduate education in science, math, engineering and technology* (Executive Summary). Washington DC: National Academies Press.
- National Research Council (NRC). 2003a. *Bio 2010: Transforming undergraduate education for future research biologists*. Washington, DC: National Academies Press.
- National Research Council (NRC). 2003b. *Evaluating and improving undergraduate teaching in science, technology, engineering and mathematics*. Washington, DC: National Academies Press.
- National Science Foundation (NSF). 1996. *Shaping the future: New expectations for undergraduate education in science, mathematics, engineering, and technology* (NSF 96-139). Washington, DC: NSF Directorate for Education and Human Resources.
- Niaz, M., D. Aguilera, A. Maza, and G. Liendo. 2002. Arguments, contradictions, resistances, and conceptual change in students' understanding of atomic structure. *Science Education* 86 (4): 505–525.
- Prince, M. 2004. Does active learning work? A review of the research. *Journal of Engineering Education* 93 (3): 223–231.
- Rambur, B. 1999. Fostering evidence-based practice in nursing education. *Journal of Professional Nursing* 15 (5): 270–274.
- Rash, E. 2005. A service learning research methods course. *Journal of Nursing Education* 44 (10): 477–478.
- Seymour, E., D. J. Wiese, A. B. Hunter, and S. Daffinrud. 2000. Creating a better mousetrap: On-line student assessment of their learning gains. Paper presented at the National Meeting of the American Chemical Society Symposium, San Francisco, CA.
- Springer, L., M. Stanne, and S. Donovan. 1999. Effects of small group learning on undergraduates in science, mathematics, engineering and technology. *Review of Educational Research* 69 (1): 21–52.
- Student Assessment of Their Learning Gains. 2009. Retrieved from www.salgsite.org.
- Towns, M. H., and E. R. Grant. 1997. I believe I will go out of this class actually knowing something: Cooperative learning activities in physical chemistry. *Journal of Research and Science Teaching* 34 (8): 819–835.
- Vodopivec, I., A. Vujaklija, M. Hrabak, I. K. Lukic, A. Marusic, and M. Marusic. 2002. Knowledge about and attitudes towards science of first year medical students. *Croatian Medical Journal* 43 (1): 58–62.
- Weimer, M. 2002. *Learner centered teaching: Five key changes to practice*. San Francisco: Jossey-Bass.

Jay Campisi (jcampisi@regis.edu) is an assistant professor in the Department of Biology at Regis University in Denver, Colorado, and **Kevin E. Finn** is an assistant professor in the Department of Health Sciences at Merrimack College in North Andover, Massachusetts.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.