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CUR Focus

Peer Mentoring of Undergraduate Research in Community Colleges: A "Transplantable" Model for Workshops

This is the story of the challenges, development, evaluation, lessons, and working examples of a three-year project sponsored by the National Science Foundation to engage and prepare students for undergraduate research at two-year community colleges (CCs) across America. Peer mentoring was a hallmark of the project.

Community colleges (CCs) face many unique challenges: They enroll almost half of all college students (American Association of Community Colleges, 2010), and their enrollment numbers are growing rapidly. Returning veterans find CCs attractive because they provide accessible education that is helpful for their career plans. CC faculty members strive to engage more students in active inquiry even though their teaching responsibilities are demanding, equipment is expensive, budgets are tight, and space for dedicated labs may be rare or absent. Many CC students are working, attending part-time, and perhaps also raising families. Access to research experiences is often less than what faculty would like for their students, and the classroom may be the only place available where students can be engaged in inquiry. CC students may move on to four-year colleges just when they are ready to engage in full-scale undergraduate research.

Project Overview

Project Goal. The goal of the NSF project was to promote undergraduate research during the first course in psychology and evaluate ways to promote such research, with CC faculty members as partners in the project (Kincaid et al. 2007). The approach included what Jenkins and Healey (2010) in a recent issue of the *CUR Quarterly* described as important *research-oriented ways* that develop research skills and techniques and methods that *introduce students to inquiry and engage students in research discussion*.

Project Structure in a Nutshell. The project's structure had five stages, as shown in Figure 1.

First, participating faculty were pre-tested on the same measures they would be post-tested on at the conclusion of the study in order to have a baseline for later evaluation of the project. Second, faculty members participating in a national workshop were provided with (a) equipment to train with and take back to campus and (b) experience with peer mentoring of one another to convey new research knowledge and skills. In the third stage, faculty returned to campus where they implemented in their classes the new technical research knowledge and skills they learned at the workshop from presenters and through peer mentoring. In the fourth stage, students engaged in investigative activities in class. In the fifth stage, participating faculty and students were post-tested to learn what worked and were compared with control groups.

Control-comparison groups consisted of wait-listed faculty members who did not participate in the workshops, along with their students. Faculty members in the control groups received all the workshop information at the conclusion of the project in appreciation for their help. An important research step would be longitudinal follow-up of the students involved in the project, with the hope that these students engaged in additional research activity as they moved into their majors and on to four-year colleges.

Figure 1. Project Structure

Pre-test → Workshop → Faculty implement in classes → Students engage → Post-test

The goal of the project was to increase *faculty comfort* in introducing new research knowledge and skills to their students, and to increase *student sense of competency* in the knowledge and skills. The project was conducted in collaboration with Project Kaleidoscope (http://www.pkal.org/documents/TriedTrueSplash.cfm) and enriched by the participation of five consultants known for their expertise in ways to promote undergraduate research: Diane Halpern (Halpern 2009), Chandra Mehrotra (Dunn, Mehrotra and Halonen 2004), Jeanne Narum (Narum 2006), Louis Tassinary (Cacioppo, Tassinary and Berntson 2007), and Carole Wade (Wade and Tavris 2010).

Project Hypotheses

- *Hypothesis 1*. The workshop model would effectively address *needs* identified by national standards for research training in science, technology, engineering and mathematics (STEM) fields, illustrated by *burning questions* identified in advance by workshop participants.
- *Hypothesis 2*. The workshop model would increase faculty members' *sense of comfort* in introducing investigative laboratory experiences in psychophysiology in their classes, in order to help their students (a) think of psychology as a science, (b) take psychophysiological recordings, (c) see the role of science in all areas of psychology, and (d) learn and use the scientific method.
- *Hypothesis 3*. Students whose faculty members attended the workshops would increase their *sense of competence* in the basic principles of psychophysiology, and their skills in thinking as scientists think, more than control groups of students whose faculty were wait-listed for the project and did not participate in the workshops.

The Workshop Model. "Burning questions" were solicited from CC faculty before the workshops, which were used to make sure the workshops were in tune with faculty members' priorities. The questions fell into four clusters: (a) how to engage students by having them conduct investigative psychology as a science in the classroom; (b) how to help students build on their investigative work to see the role of science in all areas of psychology (c) how to use investigative psychophysiological activities to support any topic in the introductory psychology textbook; and (d) how to decide which investigative activities to include in one or two class meetings in the psychology course.

Workshop faculty share ideas for hands-on activities in their classes (left to right, Jennifer Nepper-Fiebig, Emmanuel CC, Boston, MA; Julie Penley, El Paso CC, El Paso TX; and Dana Leighton, Portland CC, Portland OR—now at the University of Arkansas.)

A detailed *National Workshop Manual* developed for the project (available from the authors) includes ideas that can be easily transplanted to other institutions and adapted across disciplines. A seven-minute streamed video is available at the following URL that shows the workshop model in action and parallels the *National Workshop Manual* (requires QuickTime 7 for Mac or PC; http://xstream.stolaf.edu/psych/NSF-CC-Part-2-264B.mov)

Workshop Content. Psychophysiology was chosen as the exciting content and methodology for the workshops, although the discipline and content could conceivably be anything. Psychophysiology is the study of the mutual influence of mental activity and physiology (Cacioppo, Tassinary and Berntson 2007). A prior proof-of-concept NSF project on which the current project was built showed that psychophysiology was a powerful approach for engaging students (Hébert 2002 11-15), although, again, any content could be used for which future workshop planners have a passion. In the enthusiastic words of one CC faculty participant, "Students think psychophysiology is cool. … It generates all kinds of buzz, interest, excitement, questions—even from other faculty and administrators—and physiology appeals to many students in related disciplines, creating opportuni-

Faculty workshop participant Robin Musselman at Lehigh Carbon Community College (Schnecksville, PA) introducing some of her students to hands-on investigation.

ties for cross-disciplinary collaboration among faculty and student."

The workshops engaged faculty in hands-on training with state-of-the-art equipment during which they learned basic principles, research techniques and methodology for psychophysiological mind-body interactions, each involving reciprocal psychological and physiological influences. Faculty were encouraged to circulate, share ideas, and learn basic principles from project team members, including student assistants with extensive experience in psychophysiology.

Four physiological systems were selected as platforms to help faculty stimulate their students to think about the science of psychology using psychophysiological skills and techniques. These were sensory systems, the central and autonomic nervous system, the cardiovascular system, and the skeletal-muscular system. In psychological scientific research, the four systems are involved either alone or in combination in such psychological processes as cognition, arousal, emotion, eye tracking, attention, and stress/relaxation (Cacioppo, Tassinary, and Berntson 2007; Hugdahl 1995; Stern, Ray, and Quigley 2001).

In addition to faculty recording their own physiological responses to cognitive and emotional stimuli, the workshops' investigative psychophysiological activities opened up powerful ways for faculty to examine, think critically about, and understand human thought, emotions, and behavior. Examples of investigative activities included: (a) eye movements while reading text (measured using electrooculography, (b) visual attention and brain activity (brain-wave desynchronization measured using electroencephalography), (c) muscle-performance strength and brain control (muscle motor-unit recruitment measured using electromyography), and (d) stress and the autonomic nervous system (sympathetic and parasympathetic nervous system influence on heart-rate variability measured using electrocardiography).

Peer Mentoring. Faculty members worked together at the workshops as peers to discuss why engaging undergraduates in classroom investigative activities matters. For example, students learn research skills best when they have choice in what they are investigating, work collaboratively in peer-mentored settings, and are challenged to connect to and beyond what they already know. Faculty also worked together as peer mentors to practice how to engage students actively in inquiry, using their new research knowledge, skills, and techniques.

At the workshops, presenters at plenary sessions and panels provided tips on how to promote a passion for the science of psychology using materials and processes that promote undergraduate research. Active listening skills are important among peers conducting research, and those skills were emphasized throughout the workshop as important for faculty to demonstrate and encourage their students to use. Active listening was emphasized when faculty partnered with other faculty with similar interests in *birds-of-a-feather* conversations about ideas for integrating psychophysiology into classroom activities in order to build research skills and engage students.

Time was provided for faculty at the workshop to collaborate on revising their individual syllabi so that when they returned to their campuses they knew *what, when, where* and *how* they would implement their new ideas for engaging students in investigative research in one or two class meetings.

Following the workshops, the faculty participants returned to their CCs to implement the workshop materials and processes in their own classes.

Project Assessment

Participants. Figure 2 shows the geographic distribution of faculty from the 52 CCs in 27 states who participated in the workshops or served as comparison-controls, including faculty from two of the 36 Tribal Colleges (U.S. Department of Education 2010). The project included a student assessment sample (n = 1745) with 30 percent from underrepresented groups. The students' ages ranged from 16 to 51 years (mean = 21.7 years of age, SD = 6.7 years).

Control groups provided baseline data to determine if this approach to promoting undergraduate research made a statistically significant difference. At the same time that workshop participants were including psychophysiological activities in their classes, comparison-control faculty members at other colleges continued to teach their courses in the same way they had been doing. During the course of the project, faculty from both the workshop and control groups, and their respective students, provided feedback on surveys distributed via an Internet Web form (used to streamline and increase accuracy of data collection). After mailing in signed informed-consent forms, faculty and students proceeded to send in quantitative and qualitative responses about their experiences via the Internet. (SPSS was the statistical software used in all analyses.)

Results of Workshop Assessment. Results showed that faculty participants (a) would recommend the workshop to other faculty ~89 percent, (b) thought the psychophysiological activities would be useful to helping them teach their students research skills, ~98 percent, and (c) stated the workshop was applicable to their interests,100 percent.

Results of Faculty Assessment. In the year following their attendance at a workshop, faculty were surveyed concerning the ways they changed and engaged in the psychophysiological investigative activities, compared to the wait-listed control faculty who did not attend a workshop. An a *priori* cluster of questions we named the *Comfort Factor* included questions using a 6-point Likert scale (1 = Not at All Comfortable to 6 = Very Comfortable) about how comfortable the faculty were with: (a) helping students to think of psychology as a science, (b) helping students take psychophysiological recordings, (c) helping students see the role of science in all areas of psychology, (d) teaching the scientific method, and (e) conducting science activities in their classes. The Cronbach Alpha was .643.

The faculty-survey data were analyzed as a simple Interrupted Time Series Design (Cook and Campbell 1979). *Gain scores* provided information about the amount of change from the pre-test administered before the workshops, to post-tests after the workshops during Year 2 (post-test minus pre-test score). Pre-test scores were taken from the pre-workshop data for the faculty in the workshop group, and from the Year 2 fall pre-test scores for faculty in the control group. Post-test scores were taken from whichever was the last post-test that a particular faculty member returned.

Nonparametric Mann-Whitney *U* tests were used in order to determine whether or not groups differed at pre-test and at post-test because of unequal sample sizes between workshop and control groups due to missing data from faculty, resulting in a final sample of participating and wait-listed institutions (had workshop, n= 24 institutions; had no workshop, n = 9 institutions).

As predicted, at *pre-test* there were no statistically significant mean differences between the workshop group and the control group. At *post-test* a statistically significant mean increase of 16.9 percent was observed between these groups on the *Comfort* factor (U = 59.00, p = .049). On a six-point Likert scale (1 = Not at All Comfortable, to 6 = Very Comfortable), the control group registered a post-test mean = 4.356, SD = .963, and the group mean rank = 11.56. The workshop group registered a post-test mean = 5.092, SD = .581, and the group mean rank = 19.04. The effect size via Cohen's d = .420.

Results of CC Student Assessment. Prior to their participation, a sample of students was sent a letter explaining the project and seeking their voluntary participation. Students were asked to consider signing a consent form and photo release. Ultimately, 1,745 signed consent forms were received. Those who signed the consent form agreed to send in periodic quantitative and qualitative reports via Internet Web forms about their experiences during the project.

A Solomon Four-Group Design (e.g., Cook and Campbell 1979) was used to contrast results of students whose faculty attended the workshops to the same measures of control students of wait-listed faculty who had not attended the workshops.

Sense of Competence was an a *priori* factor, constituted by four variables, in the measurements of students' sense of competency in basic principles of psychophysiology. On a 6-point Likert scale (1 = Not At All Competent, to 6 = Very Competent) each variable was preceded by the following question stem: "Please rate how competent you feel in your understanding of the basic principles of ….," followed by either the term (a) electrocardiogram, (b) electromyogram, (c) electroencephalogram, or (d) electrooculogram. These were the four specific psychophysiological methodologies selected and presented to their teachers at the workshop. The Cronbach alpha was .935. We are aware that an alpha of .935 is very high and could indicate excessive redundancy among factor items, except for the fact that, indeed, each variable relates to a unique and non-redundant psychophysiological interacting system.

A General Linear Model was used with the 2 x 2 Groups x Pre-/Post-test design to analyze the mean difference between students whose faculty were selected and attended a workshop (mean = 4.044, SD= 1.37, n= 301), and students whose faculty were wait-listed (mean = 3.19, SD = 1.57, n =175). The mean difference was statistically significant ($F = 38.582$, $df = 1, 474$, $p < .001$, eta-squared = .08), and represented a gain of about 27 percent over controls.

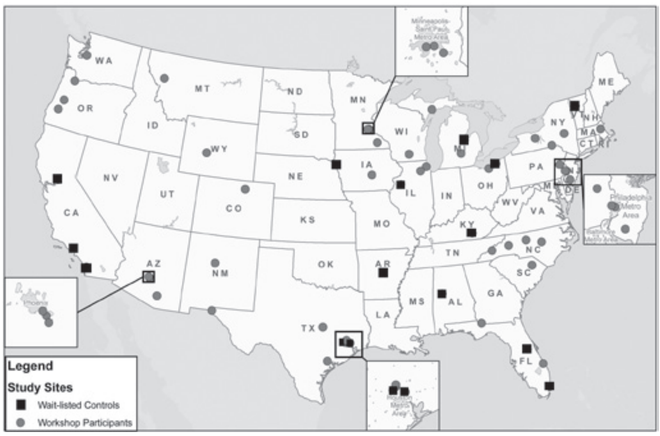
Discussion

Benefits for Faculty. The workshop provided a socially supportive and peer-mentoring milieu for faculty to develop skills and knowledge of new psychophysiological content, research skills, and techniques for use in supporting undergraduate research. It also provided participants with time to help one another learn the psychophysiological technology. It was very important that time was provided for faculty to integrate what they learned about the foci of the workshop into their own classes.

Some specific published examples follow of how students were engaged in CCs across the country after the workshops:

- John Rutledge and John Hardin, students of faculty participant Mark Coe, Lancaster University of South Carolina, Lancaster Campus, co-authored with others a presentation at the 50th Annual Meeting of the Society for Psychophysiological Research (SPR). It was titled *Physiological correlates of hostility: Changes in regulation of sympathetic tone after exposure to light in a right-lateralized motor stressor.*
- Faculty member Jason Kaufman of Inver Hills CC in Minneapolis took his experience at the workshop, created new partnerships at Inver Hills CC, and developed a psychology lab, found space for it, and received support from his institution. For details about what Kaufman has done with his students see http://www.psychologicalscience.org/observer/getArticle.cfm?id=2683
- Students of Dana Leighton at Portland Community College measured differences in the brain's electrical activity between individuals in relaxed states and when individuals were engaged in a problem-solving task. They built on the research literature and developed a hypothesis. In the community college's newsletter, Leighton says, "I immediately recognized the potential value of creating activities using psychophysiology experiments to develop just these skills. … The benefit to the students is that they get to directly experience the research process, which is rare at community colleges." See http://news.pcc.edu/2008/04/faculty-innovation-dana-leightons-psyche-out/
- Robin Musselman of Lehigh Carbon Community College in Pennsylvania reported developing a hands-on, active-learning laboratory experience for her students that would "incorporate aspects of the first three chapters of our textbook (science of psychology and research methods, brain and behavior, sensation and perception). Every small group collected data on reaction time using the BIOPAC equipment to measure muscle activity using electromyography. As a follow-up to this activity, I asked students to use our library databases to find an article about psychophysiology. In class, the small groups first discussed what they thought we meant by the term psychophysiology. Then each member of the group shared something about the article they had found. Students brought copies of the article abstract for the other group

Figure 2. Geographic Distribution of the 52 Participating CCs in National NSF Project.



members. As a group, I wanted them to decide on a question that was of interest to them. This question then became the basis of their project." See http://resources4psych.wikispaces.com/Psychophysiology

- Ly Tran Nguyen of Mesa Community College in Arizona has been incorporating psychophysiological techniques in all her courses since her involvement in the NSF workshop, including Introductory Psychology, Statistics, Research Methods, and Biopsychology. See http://tinyurl.com/2c3pn3m

Benefits to CC Students. Students whose faculty members had attended a workshop grew in their self-reported sense of research competence more than did control-group students whose faculty had not attended a workshop. Metacognitive growth—knowing that they have grown in competence—is an important outcome of the knowledge and techniques their faculty members learned at the workshops. Specifically, the students grew in terms of understanding basic principles of psychophysiology, research content, and skills that were at the heart of the workshops: electrocardiogram, electromyogram, electroencephalogram, and electrooculogram. Benefits of the approach for students included hands-on engagement with the scientific method—thus increasing their opportunities to discuss practical issues and understand challenges in data collection in science.

Conclusion

Peer mentoring played a key role at three levels. First, the workshops provided a socially supportive milieu for faculty members to peer mentor one another. Second, faculty participants increased their *comfort* in transferring the psychophysiological research knowledge and skills they developed together at the workshop to their students. Third, students peer-mentored one another in ways that increased their *sense of competence* in basic psychophysiological principles learned from their faculty.

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Jeanne L. Narum, founding director of Project Kaleidoscope, served as project consultant, workshop presenter, and external evaluator for the NSF Phase 2 project described in this article. Narum and Project Kaleidoscope have provided leadership at the institutional and national levels aimed at insuring that all American undergraduates have access to robust learning experiences in all STEM (science, technology, engineering, and mathematics) fields.