Teaching Psychophiology Through Vertically Integrated
Student Research Groups

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Abstract

**Goals:** This project introduces freshman and sophomore students to methods and techniques of psychophysiological recording. Learning these recording methods in advanced courses provides inadequate mastery for use in student research. Our goal is to give students early experience with these methods and techniques, enabling competent use in advanced courses, independent research, and senior thesis projects.

**Methods:** Students acquire early psychophysiological recording experience in a vertically integrated research group. With PI supervision advanced students work with freshmen and sophomores to design and conduct psychophysiological experiments. Powerful, easy-to-use ActiveTwo hardware and software allows students to learn basic recording procedures quickly.

**Challenges:** Introduction of psychophysiological methods in several lower-level courses was harder than anticipated; nonetheless, these changes are being gradually achieved. Learning appropriate data analysis methods is an ongoing challenge for both the PI and students. A training workshop for and purchase of EMSE Suite software have helped address these challenges. Programming stimulus presentation and behavioral response recording in experiments is also challenging but is accomplished with LabVIEW and PsyScope, which students learn to use in their laboratory courses. Student and faculty time limitations are significant barriers, but the excitement of cutting-edge work is a powerful incentive to participation and achievement.

**Impacts:** The project has successfully introduced psychophysiological methods to freshman and sophomore students, a majority of them women. Over the past 2 years, 4 groups of 3-7 students, mentored by advanced students and the PI, have designed and conducted psychophysiological experiments that have led to three presentations at our annual institution-wide student research symposium. Several of these students are now developing their psychophysiological recording and data analysis skills through further independent research or senior theses. Other impacts include two posters at the 2007 Sigma Xi Student Research Conference and six completed senior theses with psychophysiological methods.

**Dissemination:** I have presented my use of vertically integrated research groups to a local faculty seminar on collaborative inquiry. A psychophysiological methods wiki that we are creating will be submitted to the developers of the software package EMSE Suite. An article for the Journal of Undergraduate Neuroscience Education (part of the NSDL) is also planned.

**Evaluation:** Student use of psychophysiological methods in laboratory courses, independent research, and senior theses has resulted in papers, posters, and oral presentations. Students have presented their work in local symposia and in national student research conferences. Questionnaire instruments have provided data on psychophysiological knowledge and attitudes toward science. Using these outcomes, a team of two STEM faculty conducted annual formative evaluations and recently completed a summative evaluation (July, 2008). Results indicate gains on all measures. Notably, two senior theses have earned local awards, and one poster received an award at the 2007 Sigma Xi Student Research Conference.
Introduction

Vertical integration is a concept that has been developed in a number of areas of higher education. The National Science Foundation itself has encouraged this approach to research and education through a grants program in mathematics (NSF, 2005).

The concept has also been applied in engineering (Marchman, 1998), medical education (Brynhildsen et al., 2002; Sawyer et al., 2006; Kennedy, 2006), and food science (Duster & Water, 2006).

Vertical integration may be viewed from a variety of perspectives (Kennedy, 2006), but the most pertinent for this project is that of the learner - students and researchers at a variety of levels working together.

This educational approach, though surely used, is poorly documented in STEM education. This project is an attempt to apply this approach to the problem of mastering complex measurement technologies for undergraduate students engaged in laboratory research.

Institutional Framework
http://www.bethelks.edu/academics/undergrad_research/index.php

Undergraduate Research Program at Bethel College

Undergraduate research provides students direct experience with the methods and processes of inquiry of the student’s discipline. The undergraduate research program at Bethel College is based on collaboration between students and faculty and between students and other students. All students at Bethel College have the opportunity and are encouraged to participate in at least one undergraduate research experience. Students are offered four ways to participate in undergraduate research:

- Class-oriented projects
- Bethel College Study and Research Awards (competitive grants for summer research following the sophomore or junior year)
- Directed study courses taken during the summer
- Senior Seminar Courses (senior theses, performances, etc.)

A New Undergraduate Research Component of General Education:

Collaborative Inquiry Seminar (3 hrs). Courses are taken in your sophomore or junior year [for lower or upper level credit], with an emphasis on inquiry-based, collaborative learning, and will develop your ability to:

- Gather, interpret, and evaluate information from a wide variety of sources.
- Collaborate in an inquiry-based learning community
- Develop and apply a research methodology
- Communicate findings in an effective, professional manner.
URICA (Undergraduate Research, Internships and Creative Activity) Symposium

Designed as an opportunity to celebrate and showcase the many forms of in-depth, individual research and creative endeavor college-wide, this forum includes senior thesis presentations across the curriculum, along with culminating recitals and art shows, or lecture-performances with digital recordings or images. The symposium showcases the hard and creative work done by Bethel students. Free and open to the public. The 2009 symposium is scheduled from 9 a.m. to 1 p.m., Saturday, May 2, 2009.

Departmental Characteristics

• Research methods introduced in four sets of laboratory courses

• Honors sections of lower-level courses (some now becoming Collaborative Inquiry Seminar courses - see “Institutional Framework) provide opportunities for research participation.

• Ongoing research projects involving students at all levels

• Active participation in URICA Symposium - presentations by psychology students at the May 3, 2008, symposium:


  - Sarah Buller, “Seasonal Variation in Daily Ratings of Pain and Rash of a Lupus Patient” (also presented at NCUR 2008)

  - Becky Buchta, “Emotional and Physiological Responses to Music are Stronger Than Those to Lyrics Alone” (2007 Sigma Xi Student Research Conference Award Presentation)

  - Rondell Burge, “Music-Elicited Frontal EEG Asymmetry and Pleasantness Responses are Altered in Schizophrenia” (2007 Sigma Xi Student Research Conference Presentation)

  - Laurie Steffen, “Efficacy of Imagined Dialogue Model of Written Emotional Expression as a Means for Coping with Acculturative Stress” (Outstanding Psychology Senior Seminar, 2008)

  - José Rojas, Aimee Siebert, Matthew N. Stucky, “Physiological Changes Produced by Imagined Hostility or Understanding”

  - Katie Robertson, “Environmental Factors’ Influence Upon the Deception Task in Theory of Mind” (also presented at NCUR 2008)
Summary of Approach

**Overarching goal:** That students be able to think conceptually and creatively about a research problem requiring a complex measurement technology

**Means for achieving this goal:** Early introduction of the measurement technology to allow mastery BEFORE the research problem is addressed

**Specific technology:** psychophysiological measurement and analysis

**Critical program elements:**
- Vertically integrated student research groups
- User-friendly hardware and software

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Bethel students (Becky Buchta, left; Aimee Siebert, right) with our ActiveTwo recording system (Biosemi, Amsterdam, The Netherlands)
Outcomes

I. Student Presentations (examples)
   A. On-campus (URICA Symposium)
   B. National Symposia

II. Senior Theses (examples)

III. Functioning Research Groups: The Psychophysiology Research Group for 2007-2008

IV. Publications (in progress):

Pictured left to right: Matthew N. Stucky, Kacy Canady, Jose Rojas, Aimée Siebert, Rondell Burge; not pictured: Becky Buchta, Ilona Mellekh, Mark Abrahams
II. A. Comparison of therapeutic effects of participant-chosen and experimenter-chosen music
- Emma Lewis, senior thesis (received on-campus award)

Effects of Music on Self-Reported and Physiological Aspects of Emotion (Lewis, 2007)

- Participant-chosen
- Rachmaninoff
- Silence

II. B. Comparison of EEG responses to music in schizophrenia patients and controls
- Rondell Burge

Controls

Schizophrenia Patients
I. A. Comparison of imagined hostile (A) and understanding (B) responses to a personal affront
- Jose Rojas, Matthew N. Stucky, and Aimee Siebert

Post-Imagination Psychological Ratings

Physiological Changes

I. B. Comparison of emotional and physiological responses to choral music with those to lyrics alone
-Rebecca Buchta (Sigma Xi Student Res. Conf. award, 2007)
Repli(cability / Transportability

Vertically integrated student research groups might be employed in helping students achieve mastery of any complex procedure or technique.

Examples within psychology:
- Statistical analysis software and techniques
- Observational recording and analysis software
- Administration of complex questionnaire instruments

Examples in other disciplines:
- Single-cell recording techniques
- High performance liquid chromatography
- Nuclear magnetic resonance spectroscopy

Conditions for success:
- Institutional structures that provide incentives for freshman and sophomore student participation in research
- An ongoing research program that provides a framework for student work

Conclusions

Vertically integrated student research groups have provided an effective mechanism for teaching psychophysiological techniques resulting in:
- Involvement of freshman and sophomore students in research
- Enhanced mastery permitting creative work as evidenced in
  - presentations on campus and at national symposia
  - improved senior theses and other student papers

Similar approaches may prove fruitful at other institutions and in other disciplines.

References