Scholarship of Teaching and Learning: What are the Best Methods of Conducting Research in Teaching?

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With contributions from
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Dairy Science Department
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Outline
1. Initial Thoughts: What is — and What Counts as — SoTL?
2. Conducting Classroom Assessment vs. Classroom Research
3. Social Sciences 101
4. Common Research Design in Social Sciences
   4.1. Experimental Study
   4.2. Field Survey
   4.3. Secondary Data Analysis
   4.4. Action Research
5. Common Limitations (Mistakes) of SoTL Publications
6. Final Thoughts: “The Best Method(s)”?

Scholarship of Teaching and Learning Educational Scientists vs. Faculty Perspectives

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean Score1</th>
<th>Ed. Sci.</th>
<th>Faculty</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>18. The scholarship of teaching is an activity that, in the context of promoting student learning, meets each of the following criteria: • It requires high levels of disciplinary expertise, • It breaks new ground and is innovative, • Can be replicated and elaborated, • Can be peer-reviewed, • Has significant impact ........................................</td>
<td>6.1</td>
<td>5.3</td>
<td>&lt;.01</td>
<td></td>
</tr>
</tbody>
</table>

1: On a scale of 1= Strongly disagree to 7 = Strongly agree.

What Counts as Research? / Who Benefit from it?

<table>
<thead>
<tr>
<th>Goals</th>
<th>Type</th>
<th>Beneficiaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>To inform broad community of educators with critique and public review of findings.</td>
<td>Educational Issues</td>
<td>Educational Community at Large</td>
</tr>
<tr>
<td>To inform personal, departmental, and (or) institutional stakeholders involved in teaching and learning.</td>
<td>Curricular Issues</td>
<td>“Local”</td>
</tr>
<tr>
<td>To inform one’s own personal practice.</td>
<td>Classroom Issues</td>
<td>Personal</td>
</tr>
</tbody>
</table>

Adapted from Trigwell and Shale (2004).

Animal Scientists’ Views on Excellence in Teaching

<table>
<thead>
<tr>
<th>Survey Item &amp; Evaluation Criteria</th>
<th>R\textsuperscript{a}</th>
<th>R\textsuperscript{b}</th>
<th>Over-emphasis\textsuperscript{c}</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>30: Authoring peer-reviewed publications</td>
<td>0.44</td>
<td>-0.9</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>31: Authoring an undergraduate textbook or book chapter</td>
<td>-0.44</td>
<td>-0.4</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>32: Obtaining funding for teaching-related projected</td>
<td>-0.32</td>
<td>0.9</td>
<td>&lt;0.05</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a}Respondent’s perception of institutional priorities: R = Research more important than teaching, RT = Both research and teaching are equally important.

\textsuperscript{b}Respondents indicating the criteria “SHOULD BE” used versus respondents indicating the criterion “IS” currently used in the evaluation of teaching for the purpose of promotion and tenure, %.


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CK + PK = PCK

Modified from Paulsen, M. B. 2001. New Directions for Teaching and Learning 86:19-29

Reflective Practices
Course Evaluations
Faculty Development
Trials and Errors
Pedagogical Content Knowledge
Pedagogical Knowledge
Student learning
Formative Classroom Assessment
Field Tested Learning Assessment Guide (FLAG)
http://www.flaguide.org

Attitude Survey
Concept tests
Concept mapping
Conceptual diagnostic
Interviews
Minute paper
Mathematical Thinking
Multiple choice test
Performance assessment
Portfolio
Scoring rubrics
SALG
Weekly report

Formative Classroom Assessment
Student Assessment of Their Learning Gains (SALG)
http://www.salgsite.org

Welcome to the SALG Website for Instructors!
The SALG website is a free course evaluation tool that allows college-level instructors to gather learning-focused feedback from students. Once registered, you can:
1. Create and use a survey to measure students' learning gains in your course
2. Create and use an optional baseline survey to discover students' starting point relative to course goals
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Social Science 101

<table>
<thead>
<tr>
<th>Term</th>
<th>Short Definition</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory</td>
<td>A set of systematically interrelated constructs and propositions intended to explain and predict a phenomenon or behavior of interest within certain boundary conditions and assumptions.</td>
<td>Behaviorist or Constructivist Learning Theory</td>
</tr>
<tr>
<td>Construct</td>
<td>An abstract concept that is specifically chosen (or “created”) to explain a given phenomenon.</td>
<td>Written communication skills</td>
</tr>
<tr>
<td>Concept</td>
<td>Generalizable properties or characteristics associated with an object, events or people (unit of analysis).</td>
<td>Vocabulary, syntax, spelling</td>
</tr>
</tbody>
</table>
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**Research Design**

*External Validity*

- **Causality**: whether the observed change in a dependent variable is indeed caused by a corresponding change in hypothesized independent variable.

*Internal Validity*

- **Generalizability**: whether the observed relationships can be generalized from the sample to the population.

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**Maximizing Internal and External Validity**

1. **Manipulation (intervention)**:
   - Manipulation of independent variables ("treatment") whose effects are compared against a control group.

2. **Elimination (controlled setting)**:
   - Eliminating the effects of "extraneous" variables by holding them constant.
   - Factorial design / covariate "adjustment" (e.g., age group, gender, etc.)

3. **Randomization (controlled error)**:
   - Sample selection.
   - Subject assignment to control and treatment groups.

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Popular Research Designs: #1 Experimental Studies

#1 — Experimental Studies:
* Intended to test cause-effect relationships (Hypothesis)


Citation

Guiding Question
When students answer an in-class conceptual question individually (Q1) using clickers, discuss it with their neighbors, and then revote on the same question (Q1ad), the percentage of correct answers typically increases. This outcome could result from gains in understanding during discussion, or simply from peer influence of knowledgeable students on their neighbors.

Study Design
To distinguish between these alternatives in an undergraduate genetics course (n=330), we followed the above exercise with a second, similar (isomorphic) question (Q2) on the same concept that students answered individually.

Results

Conclusions
Peer discussion enhances understanding, even when none of the students in a discussion group originally knows the correct answer.
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Popular Research Designs: 
#2 Field Survey

#2 — Field Survey:

- NON-EXPERIMENTAL design and thus change cannot be attributed to intervention (weakness: Low internal validity).
- Strength: High external validity
- Field survey capture snapshots of practices, beliefs, or situation from a random samples of subjects in field settings through a survey questionnaire.


Popular Research Designs: 
#2 Field Survey — An Example

Citation

Objectives:
1. To outline the design of a course aimed at (a) increasing students' awareness of the multi-dimensionality and multi-functionality of livestock agriculture in a global context and (b) increasing students' critical thinking skills by exploring the inter-dependencies between the US and Mexico using the dairy industry as a case study.
2. To determine retrospectively the influence of student’s major, standing, cohort on their self-reported level of knowledge and worldviews at the beginning of the semester; the end of the semester, and the change in these variables as result of participating in the course.
Materials and methods:
1. Course outline and Design (Figure 1).
2. Students (n=60) of diverse background and demographics
   1. Majors: Dairy Sci., and four other majors;
   2. Standing: Fr, So, Ju, Sr;
3. Survey instrument (Likert-scale) to capture self-reported:
   1. Level of knowledge (7 items),
   2. Worldviews (7 items),
   3. Administered the first day of class (Pre) and the last day of class (Post).

Results: Level of Knowledge

<table>
<thead>
<tr>
<th>Item</th>
<th>Pre</th>
<th>Post</th>
<th>Chg</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Agriculture in developing countries</td>
<td>4.28</td>
<td>7.40</td>
<td>3.09</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>2. Agriculture in general in Mexico</td>
<td>3.97</td>
<td>7.49</td>
<td>4.04</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>3. US – Mexico Agricultural Relations</td>
<td>3.97</td>
<td>7.49</td>
<td>4.04</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>4. Structure and diversity of Mexican dairy industry</td>
<td>2.99</td>
<td>7.80</td>
<td>4.70</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>5. Structure and diversity of the US dairy industry</td>
<td>5.70</td>
<td>7.64</td>
<td>1.76</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>6. Mexico, its people and its cultures</td>
<td>5.55</td>
<td>6.87</td>
<td>1.33</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>7. Issues related to poverty in Mexico</td>
<td>5.04</td>
<td>7.19</td>
<td>2.20</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

1 Measured on a 1-10 Likert-type scale where 1-2 = Not at all, 3-4 = A little, 5-6 = Somewhat, 7-8 = A lot, and 9-10 = A great deal.

Results: Change (Post – Pre) in Level of Knowledge

<table>
<thead>
<tr>
<th>Item</th>
<th>P value Major</th>
<th>P value Standing</th>
<th>P value Cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Agriculture in developing countries</td>
<td>0.10</td>
<td>0.07</td>
<td>0.08</td>
</tr>
<tr>
<td>2. Agriculture in general in Mexico</td>
<td>NS</td>
<td>NS</td>
<td>0.83</td>
</tr>
<tr>
<td>3. US – Mexico Agricultural Relations</td>
<td>NS</td>
<td>NS</td>
<td>0.84</td>
</tr>
<tr>
<td>4. Structure and diversity of Mexican dairy industry</td>
<td>0.01</td>
<td>NS</td>
<td>0.05</td>
</tr>
<tr>
<td>5. Structure and diversity of the US dairy industry</td>
<td>&lt;0.01</td>
<td>0.08</td>
<td>NS</td>
</tr>
<tr>
<td>6. Mexico, its people and its cultures</td>
<td>NS</td>
<td>NS</td>
<td>0.09</td>
</tr>
<tr>
<td>7. Issues related to poverty in Mexico</td>
<td>NS</td>
<td>NS</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Non-parametric: Kruskal-Wallis Test.
1 Dairy Science majors versus other majors.
2 Freshmen, sophomore, junior or senior.

Wattiaux and Crump. 2013. NACTA. 57(3):83-90
Popular Research Designs:  
#2 Field Survey — An Example  

Conclusions
- Measured as change in self-reported level of knowledge, learning gains averaged 64%, but ranged from 24 to 157% across course topics.
- The course changed students' worldviews on food security, livestock agriculture as a means to reduce poverty in rural Mexico and the relative benefits for Mexico and the U.S. to engage in dairy trade, but not on immigration and environmental issues.
- At the beginning of the semester, self-reported level of knowledge varied between majors (dairy science vs. non-dairy science) and among standings (freshman, sophomore, junior or senior), but worldviews varied between majors only.
- By the end of the semester, relationships had subsided, but cohort had risen in influence.
- More than the major, the cohort shaped a student's self-reported learning gains and changes in worldviews during the semester.

Conjecture
- These outcomes may reflect the impact of an instructional design aimed at engaging students from diverse backgrounds in a discussion-driven classroom throughout the semester.

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Popular Research Designs:  
#3 Secondary data analysis

#3 — Secondary data analysis:
- Analysis of national statistics databases, etc.
- Analysis of data previously collected and tabulated (Meta-analysis)

- Study 1
- Study 2
- Study 3
- …
- Study n
- Statistical Analysis
- Treatment Effect

Popular Research Designs:
#3 Secondary data analysis — A meta-analysis

Citation

Guiding Question
To test the hypothesis that lecturing maximizes learning and course performance.

Study Design
Meta-analysis of 225 studies that reported data on examination scores or failure rates when comparing student performance in undergraduate STEM courses under traditional lecturing versus active learning.

Kernel Density plot of failure rates. Means failure rate under active leaning was 21.8 but mean failure rate under lecturing was 33.8%.

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Popular Research Designs:
#4 Action Research

- Solution-oriented investigation that provides deep “insight” into a phenomena.
- Assumes that complex social phenomena are best understood by introducing interventions or “actions” into the phenomena and observing the effects of those actions.
- Excellent method to bridge research and practice.
- Particular suited for social problems that cannot be replicated outside that context.
- Generalizability is limited to the context where the study was conducted.

Figure: http://valenciacollege.edu/faculty/development/Bhattacherjee, A. 2012.

Popular Research Designs:
#4 Action Research — An Example

Citation

Objective
Our objective was to describe attempts to develop an effective discussion-based classroom environment and to study students' attitude and perception of the learning environment when class time was reserved primarily for discussion of pre-assigned reading material.

Study Design
a) Data (n=57) were collected in year 2003 (1st year discussion), 2004 (2nd year discussion) and 2005 (3rd year discussion). Each year “something “different” was done.
b) Survey tool was modified from Student Assessment of Learning Gains (SALG).
c) Survey tool was administered on week 3 (Sur) and week 15 (Ev.) of the 15-week semester.
d) 72% of total students were included in data analysis (n=41).

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Popular Research Designs:
#4 Action Research — An Example

**Conclusions**
- Student-reported learning gains from discussion-related activities increased over the course of the semester, but varied with student cohort.
- Although students indicated a preference to using class time for discussion rather than lecture, the degree of consensus was low.
- Reading assignments and in-class discussions contributed positively to the perception of learning and both were correlated positively with level of interest in learning.
- Graduates students reported a higher interest, more learning from discussion-related activities, and less desire for lecture than undergraduates.

**Implication/Conjecture**
- Depending on students' level of motivation discussion format could be altered:
  - Toward student-centered discussions when the level of motivation is low,
  - Toward subject-centered discussions when the level of motivation is high.

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Views of a “Trained” Educational Scientists on “small-scale” Published Classroom Research

**Mistake # 1 — Lack of Theoretical Framework:**
- A compilation of facts may lead astray if not interpreted through and/or contribute to a theoretical framework.

**Mistake # 2 — Lack of Recognition of the Type of Research Conducted:**

<table>
<thead>
<tr>
<th>Type of Research</th>
<th>What is it about?</th>
<th>Is it Scholarly?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td>Done over decades to build and refine theories</td>
<td>YES</td>
</tr>
<tr>
<td>Applied</td>
<td>Effectiveness of a theory to solve everyday educational problems</td>
<td>YES</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Effectiveness of courses, programs or practice</td>
<td>NO</td>
</tr>
<tr>
<td>Res. &amp; Dvlpment</td>
<td>Development of effective educational materials</td>
<td>NO</td>
</tr>
</tbody>
</table>

Kanuka H. 2011. International Journal for the Scholarship of Teaching and Learning Vol. 5: No 1, Article 3
Views of a “Trained” Educational Scientists on “small-scale” Published Classroom Research

Mistake # 3 — Insufficient usage of existing literature:
• The literature helps create coherent bodies of knowledge.
• Published work should be built upon, added to, replicated, and challenged.

Mistake # 4 — Faulty method (anecdotal, biased and/or unethical):
• Professor/Researcher should not use their position of authority to influence the outcomes of the research.
• How were students selected?
• Were students free to reject participation? (consent form).
• Were students manipulated in a way to influence their honesty?

Mistake # 5 — Lack of recognition of the scope of generalization:
• “This method works for me, you ought to use this method.”
• Extrapolation from one “context” to another is fraught with risks!

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The Best Design? Questions of Epistemology
(Which theory of knowledge do you adhere to?)

<table>
<thead>
<tr>
<th>Objective</th>
<th>Interpretive</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Truth is singular and absolute</td>
<td>• Truth is subjective and contextual</td>
</tr>
<tr>
<td>• Behavior is largely pre-determined</td>
<td>• Behavior is largely about choice</td>
</tr>
<tr>
<td>• Teaching and learning is about - right and wrong - cause and effect</td>
<td>• Teaching and learning is about - Shades of understanding - construction of knowledge</td>
</tr>
<tr>
<td>• learning is about acquisition through individual effort</td>
<td>• Learning is about participation in a team effort</td>
</tr>
<tr>
<td>… Quantitative methods</td>
<td>… Qualitative methods</td>
</tr>
</tbody>
</table>
"The Best Design"? Comparing Methods
(Oversimplification, overgeneralization, but helpful distinctions)

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Quantitative Research</th>
<th>Qualitative Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Usage</td>
<td>To test hypothesis.</td>
<td>To generate hypothesis.</td>
</tr>
<tr>
<td>Goal</td>
<td>To predict, control, confirm.</td>
<td>To understand, describe, gain meaning.</td>
</tr>
<tr>
<td>Design</td>
<td>Predetermined, structured.</td>
<td>Flexible, recursive, evolving.</td>
</tr>
<tr>
<td>Instrument</td>
<td>Inanimate and automated data collection tool...</td>
<td>Researcher himself is the data collection tool...</td>
</tr>
<tr>
<td>Methods</td>
<td>• Experimental Study</td>
<td>• Interview</td>
</tr>
<tr>
<td></td>
<td>• Survey</td>
<td>• Focus group</td>
</tr>
<tr>
<td></td>
<td>• Secondary Data Analysis</td>
<td>• Ethnography</td>
</tr>
<tr>
<td></td>
<td>• Action Research</td>
<td></td>
</tr>
<tr>
<td>Sample</td>
<td>Random and representative.</td>
<td>Non-random, purposeful.</td>
</tr>
</tbody>
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<tr>
<td>Analysis</td>
<td>Deductive (goes from more general (theory) to more specific; observations are used for confirmation purpose)</td>
<td>Inductive (goes from specific observations to generalization (theories); observations are used to detect pattern).</td>
</tr>
<tr>
<td>Difference</td>
<td>Significant.</td>
<td>Relevant.</td>
</tr>
<tr>
<td>Presentation of findings</td>
<td>Uses numerical statistics and reports “precise conclusions”</td>
<td>Cite the words of individuals and highlight “themes”</td>
</tr>
<tr>
<td>Generalization</td>
<td>Generalize results to larger population.</td>
<td>Limit scope of conclusions to the study.</td>
</tr>
</tbody>
</table>

Thank you!