Overview: Educational Research Components

QEM NETWORK: Proposal Development Workshop on Broadening Participation Research in STEM Education, April, 2017

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Grounding Your Project in Research and Theory

Linkages to theory and extant research in the field:
All research proposals should be located in a body of literature to which a contribution would be made. The proposal should make the case for why the proposed line of inquiry is fundamental in nature. The PI's should include a discussion of the theory or theories grounding the research and how the proposed research will add to this theoretical grounding. The program will allow descriptive studies of phenomena that could lead to the development of a theory or model or that contribute to theory.

Contributions to foundational knowledge and theory:
Proposals should include a coherent and persuasive chain of reasoning that shows how the research claims will be warranted and how the results have the potential to add new evidence based insights to theory, and where appropriate practice.
Some definitions of theory:

- a set of statements or principles devised to explain a group of facts or phenomena, especially one that has been repeatedly tested or is widely accepted and can be used to make predictions about natural phenomena;
- the branch of a science or art consisting of its explanatory statements, accepted principles, and methods of analysis, as opposed to practice;
- a set of theorems that constitute a systematic view of a branch of mathematics;
- an assumption based on limited information or knowledge; a conjecture.

http://www.thefreedictionary.com/theory
Social Cognitive Career Theory (SCCT) attempts to address issues of culture, gender, social context and unexpected life events that influence career-related choices. It’s based on Social Cognitive Theory (SCT) which describes learning in terms of the interrelationship between behavior, environmental factors, and personal factors.


Cultural Capital refers to the social assets of a person (education, intellect, style of speech etc.) that promote social mobility in a stratified society. As a social relation within a system of exchange, cultural capital includes the accumulated cultural knowledge that confer social status and power.

https://en.wikipedia.org/wiki/Cultural_capital

A Trilogy for Student Success posits that there are three broad factors, Engagement, Capacity and Continuity, which together are essential for student advancement. They form a trilogy, a foundation from which student STEM success can rise.

Searching for Research Studies

- Define your topic.
- Generate keywords.
- Use Google to test your keywords.
- Select appropriate data bases to search: i.e. ERIC, PsycINFO, Gender Studies, Chicano Database, Child Development & Adolescent Studies.
- Pray your institution has access to the full articles (if not check to see if you can access articles through your professional organizations (i.e. AERA, APA)).
- “Snowball” your search: check the references of the most useful articles you’ve found and/or use Google Scholar to find articles that cite those most useful articles.
The National Center for Education Statistics (NCES) is the primary federal entity for collecting and analyzing data related to education.

http://nces.ed.gov/

NAEP Data Explorer allows you to explore the results of decades of assessment of students' academic performance, as well as information about factors that may be related to their learning and to create statistical tables, charts, and maps to help you find answers.

http://nces.ed.gov/nationsreportcard/naepdata/

*NSF’s Women, Minorities, and Persons with Disabilities in Science and Engineering* provides statistical information about the participation of women, minorities, and persons with disabilities in science and engineering education and employment.


The WebCASPAR database provides easy access to a large body of statistical data resources for science and engineering (S&E) at U.S. academic institutions.

https://webcaspar.nsf.gov/
Online Evaluation Resource Library (OERL) provides instruments that are grouped by respondent (e.g., teachers/faculty, students) and by type (e.g., questionnaires, surveys, interviews, assessments).

http://oerl.sri.com/home.html

The Test Collection at ETS is a database of more than 25,000 tests and other measurement devices.
https://www.ets.org/test_link/about

The Mental Measurement Yearbook provides timely, consumer-oriented test reviews including documentation of test technical quality.
http://buros.org/mental-measurements-yearbook
Research Plan

Proposals should include:

- well-focused research questions and/or testable hypotheses that reflect the current state of knowledge in the area and the theory or conceptual framework being used;
- methods used to answer the research questions and/or test the hypotheses posed, along with the types of data to be collected and methods for data collection;
- methods should directly link to the theory or theories being used;
- if a population sample is used, this should be described along with the rationale for sample selection, and the investigator's access to the sample.

The proposal should address whether the design is premised on special needs and interests due to educational level, gender, race, ethnicity, economic status, or disability, and to what extent data will be disaggregated for multiple characteristics.
Using the Literature in the Proposal

Document the need for the research including:

- the problem/knowledge gap that the proposed research will address;
- that it is a problem/there is a knowledge gap;

Show that which has already been done and how the proposed research builds on or corrects previous work and moves the knowledge base forward. Even exploratory research builds on other work.

Provide rationales for the proposed study’s hypotheses.

Indicate the validity and reliability of measures selected.

Indicate the appropriateness of the analytic methods selected.
<table>
<thead>
<tr>
<th></th>
<th>Research</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Questions</strong></td>
<td>Grow out of previous research, theory or user</td>
<td>Grounded in the everyday realities of organizations</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Move the knowledge base forward</td>
<td>Assess program quality/effectiveness</td>
</tr>
<tr>
<td><strong>Context</strong></td>
<td>Political &amp; organizational context less dominant</td>
<td>Political &amp; organizational context are dominant</td>
</tr>
<tr>
<td><strong>Generalizability</strong></td>
<td>Results generalize to groups similar to the study population</td>
<td>Results not generalizable outside the evaluated program</td>
</tr>
<tr>
<td><strong>Findings</strong></td>
<td>Contribute to scientific knowledge base</td>
<td>Assess program quality/improve program design</td>
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</table>

*Both draw from the same designs, measures and analytic methods (Campbell & Hill, 2013).
Research Questions vs. Evaluation Questions

- Does this hands-on summer program increase student retention?
- What are the similarities and differences among demographically matched African American boys who are more or less successful in math?
- Does integrating students in faculty research efforts impact their interest in and/or commitment to science careers?
- What is the relative impact on students’ stereotype threat after one, two or three affirmations?
- Is Social Cognitive Career Theory (SCCT) an effective model to predict African American career choice?
Refining Your Current Project Question(s)

- What is your research question(s)?
- What is the base of research/theory that motivates the question(s).
- How will it contribute to scientific knowledge base
- Is the question a research question or an evaluation question? Why did you categorize it that way?
- Within that same content area, how you revise the question to strengthen it?
## The Right Design for the Question

<table>
<thead>
<tr>
<th>Study Type</th>
<th>Design</th>
<th>Representation</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quantitative Case Study</strong></td>
<td>One-shot Post-test only Design</td>
<td>( X \ O )</td>
<td>Takes fewer resources</td>
<td>Doesn’t look at change</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Can present a “snapshot” of a point in time</td>
<td></td>
</tr>
<tr>
<td><strong>Quasi-experimental Study</strong></td>
<td>One-shot Pre-test-Post-test Design</td>
<td>( O_a \times O_b )</td>
<td>Looks at change over time</td>
<td>Other things besides treatment could be causing change</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Quasi-experimental Study</strong></td>
<td>Post-test Only Intact Group Design</td>
<td>( X \ O \ O )</td>
<td>Compares to another group</td>
<td>Doesn’t control for any initial differences in groups</td>
</tr>
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</table>
# The Right Design for the Question

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<tr>
<td>Ethnography</td>
<td>Observer examination of group behaviors and patterns</td>
<td>Explores complex effects over time</td>
<td>Resource intensive Story telling approach may limit audience Potential observer bias</td>
</tr>
<tr>
<td>Case Study</td>
<td>Exploration of a case (or multiple cases) over time</td>
<td>Provides an in-depth view Elaborates on quantitative data</td>
<td>Limited generalizability</td>
</tr>
<tr>
<td>Content Analysis</td>
<td>Systematic identification of properties of large amounts of textual information</td>
<td>Looks directly at communication Allows for quantitative and qualitative analysis</td>
<td>Tends too often to simply consist of word counts Can disregard the context that produced the text</td>
</tr>
<tr>
<td>Mixed Methods</td>
<td>Use of more than one design</td>
<td>Can reduce design disadvantages</td>
<td>None</td>
</tr>
</tbody>
</table>
Making Comparisons: Why Bother

Precent of Under-Represented STEM Students in 17 Project Colleges

Percent of Under-Represented STEM Students in 17 Project and 17 Comparison Colleges
What is the Best Design for Your Question?*

- Experimental designs
- Quasi-experimental designs
- Mixed methods designs
- Ethnography
- Case studies
- Others?

Why did you chose the design that you did?

*NSF does not promote one design, rather it wants the design that will do the best job answering your research questions!
## Collecting and Analyzing Data
(See http://www.beyonddrigor.org/PDF/411651_guide2.pdf
http://www.beyonddrigor.org/PDF/411651_guide2.pdf for this and similar tables)

<table>
<thead>
<tr>
<th>Format</th>
<th>Description</th>
<th>Strengths</th>
<th>Weaknesses</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online Data Collection Systems</td>
<td>Individuals who are surveyed use online forms to submit data over the internet</td>
<td>1. Cost-effective&lt;br&gt;2. Respondents enter own data&lt;br&gt;3. Automatic updates&lt;br&gt;4. Ensure data completion&lt;br&gt;5. Automatic data checking&lt;br&gt;6. Verified skip patterns&lt;br&gt;7. Password-free&lt;br&gt;8. Possible to edit&lt;br&gt;9. Simple to publicize</td>
<td>1. Requires web access&lt;br&gt;2. Integration with paper&lt;br&gt;3. Limited length&lt;br&gt;4. Unrestricted access&lt;br&gt;5. Best for new data only</td>
<td>Useful when collecting data from many individuals or institutions and when surveys or measures are relatively short. Less useful when gathering existing data or when respondents need to see entire survey instrument.</td>
</tr>
<tr>
<td>Downloadable Data Collection Templates</td>
<td>An electronic file (usually Microsoft Excel or Access) is provided to each project. Projects complete the data entry and return the electronic file of records to the evaluation team, who merge files for analysis.</td>
<td>1. Cost-effective&lt;br&gt;2. Respondents enter own data&lt;br&gt;3. Automatic data checking&lt;br&gt;4. Easy to manipulate&lt;br&gt;5. Password-free&lt;br&gt;6. Multiple ways to deliver</td>
<td>1. Possible delivery problems&lt;br&gt;2. Possible user errors&lt;br&gt;3. Requires technical competence from respondents</td>
<td>Useful when data to be collected already exist and may be electronically imported, or when respondents need to double-check data they have previously submitted. Less useful when new data are being collected or respondents have little technical knowledge.</td>
</tr>
<tr>
<td>Paper or Fax Forms</td>
<td>Print surveys or questionnaires are distributed and completed, then returned to the evaluation team.</td>
<td>1. Easy for respondents&lt;br&gt;2. No technical skills required</td>
<td>1. Time-intensive&lt;br&gt;2. Difficult to distribute</td>
<td>Useful when data are collected from participants without access to or knowledge of technology. Can be used in conjunction with other formats to increase response rates.</td>
</tr>
<tr>
<td>Telephone Data Collection</td>
<td>Survey or interview questions are asked of participants by phone. Interviewer either tape records respondents’ answers or enters them electronically.</td>
<td>1. Easy for respondents&lt;br&gt;2. Higher response rates&lt;br&gt;3. Complicated questions are possible&lt;br&gt;4. Easy clarification&lt;br&gt;5. More inclusive</td>
<td>1. Relatively expensive&lt;br&gt;2. May annoy participants</td>
<td>Live phone conversations can be useful when following up with non-respondents or when more complex, open ended questions are being asked.</td>
</tr>
<tr>
<td>Collecting Data in Person</td>
<td>Individuals or teams of evaluators go to project locations to interview participants and other stakeholders, observe project operations, validate submitted data, and collect new data.</td>
<td>1. Easy for respondents&lt;br&gt;2. High response rates&lt;br&gt;3. Wide-ranging questions&lt;br&gt;4. Easy clarification&lt;br&gt;5. Variety of data</td>
<td>1. Very expensive</td>
<td>Collecting data in person is a useful format when there is no other way to get the data that are needed.</td>
</tr>
</tbody>
</table>
Beyond Rigor: Swimming in a Sea of Context
Tip: Ask for demographic information ONLY at the end of measures. There may be exceptions in cases for people with disabilities who will need accommodations in order to complete the measures.

Tip: Have participants define their own race/ethnicity and disability status; rather than having the identification done by data collectors or project/program staff.

Tip: Whenever possible, use measures that have been tested and validated with groups similar to the groups who will be given the measures.

Tip: Have members of the target population review affective and psychosocial measures for clarity. Ask them what concepts they think are being measured. If what is being measured is obvious, consider using a less obvious measure, if an equally valid measure is available.

Tip: As appropriate, prior to the data collection, provide the observer or interviewer with as little demographic information as possible about the participants.
**Tip:** If there are known or expected differences by subgroup that could skew the overall findings, then disaggregate by those subgroups.

**Tip:** Be aware that there can be heterogeneity within subgroups. For example, while people who are visually impaired, hearing impaired, and learning disabled are all classified as having disabilities, the differences among them are very large and it may be appropriate to disaggregate by different categories of disability.

**Tip:** When interpreting demographic differences, consider such conceptually relevant and possibly confounding factors as socioeconomic status, individual and family educational backgrounds, immigrant status, and place of residence. Where possible include statistical controls.

**Tip:** Make comparisons across more and less effective projects/programs. Factors common across effective programs may also be common across ineffective projects/programs.
The Right Data

**Tip:** Discuss with stakeholders what demographic information to collect. Consider providing stakeholders with a fairly comprehensive list of demographic possibilities and have them select their top priority categories.

**Tip:** When asking adults about disability status and type of disability, consider asking the time of onset of the disability.

**Tip:** Review the proposed metrics and measures to ensure that not only do they document changes in areas such as numbers of underrepresented STEM students graduating or numbers of women going on to graduate school in the sciences, they also document any individual or institutional changes that could have contributed to changes in numbers.

**Tip:** Use interviews, focus groups, and/or open-ended questions to document possible positive and negative unintended project/program outcomes.
Context

Context might best be described as the interrelated conditions in which something exists or occurs. Contextual factors include individual factors such as age, race and ethnicity and environmental factors such as climate.

Researchers need to:

- have knowledge and understanding of the contextual factors that are important to the research. If that knowledge and understanding is lacking, then people with the needed experience and expertise need to be hired or another team should do the research.
- be aware of their own world view and the assumptions they make especially for data analysis and interpretation. They also need to be aware of the world views and assumptions of participants and stakeholders. Having members of targeted groups involved in conceptualization of the research and having a mechanism for checking interpretations with participants can correct inaccurate assumptions.