Wikis in Evaluation: Using Wikis to Evaluate Theory Development in a Centers Context

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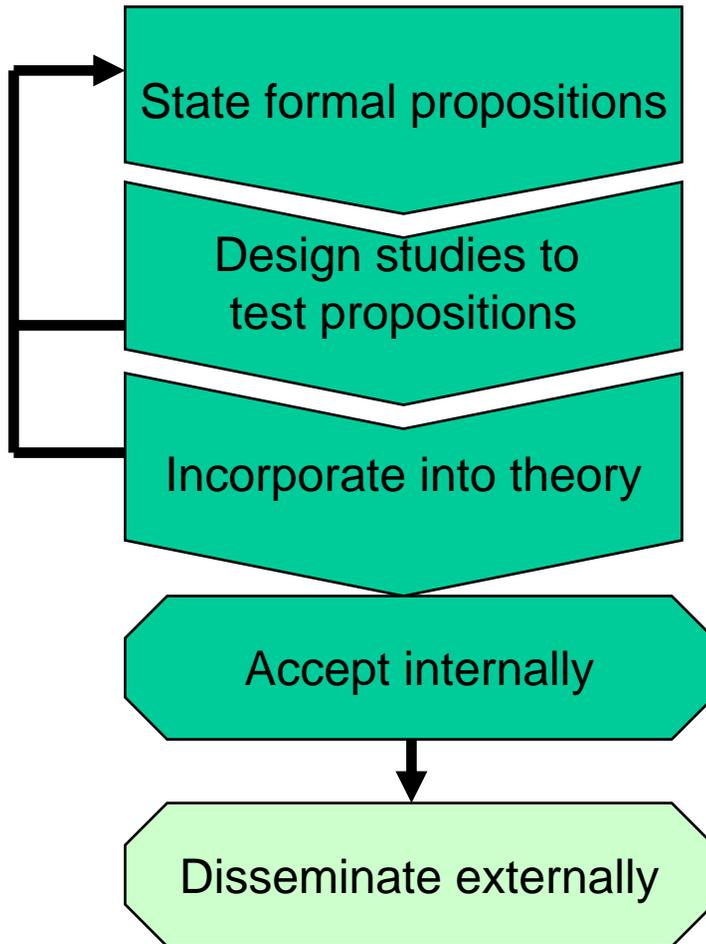
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Theory Development as Evaluation Challenge in Centers Context

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- Theory/theoretical framework development key element of research and research evaluation

- Centers programs often include development of new research areas/theory as program goal
  – NSF-funded Science of Learning Centers

> *"The Science of Learning aims to understand what learning is and how it is affected at all levels, ranging from the digital to the societal.... Every Center... must be organized around a unifying research focus... that extends the frontiers of research on the science of learning and builds on a broad base of relevant bodies of knowledge." (NSF 05-509)*

A Schematic Description of Theory Development

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State formal propositions

Design studies to test propositions

Incorporate into theory

Accept internally

Disseminate externally

Potential Evaluation Questions

- Who participates in theory development?
- To what is extent is development collaborative?
- When are key propositions stated/crystallized?
- How often are they updated?
- Which studies are vital to testing propositions?

- What is the process of acceptance internally?

- Which approaches are taken to dissemination?
- When/why is theory adopted by others?

Shortcomings of Common Data Collection Approaches in Assessing Theory Development

- Publications/content analysis
  - Publications tend not to describe theory development process
  - Long time lags
- Surveys/interviews
  - Timing, sampling frame critical
  - Generally administered at regular timepoints
  - Often can't capture key mechanics
- Participant Observation
  - Can capture theory development
  - Highly resource-intensive

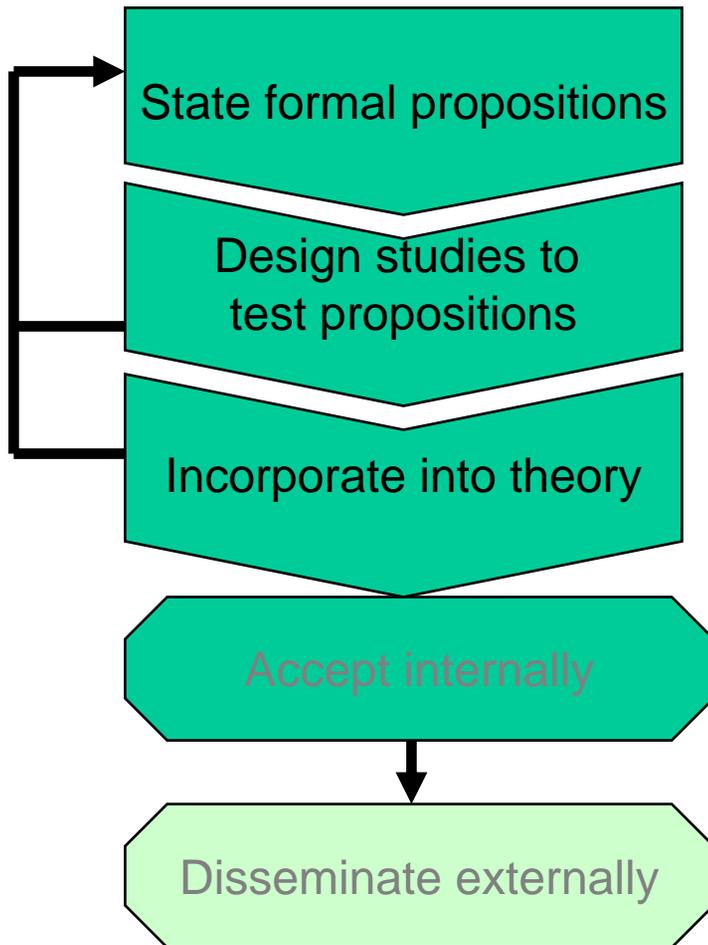# *Wikis as Potentially Valuable Evaluation Data Source*

- Online resources such as blogs and wikis increasingly being used to describe results of research
- Potentially offer new data source to evaluators
- Wikipedia™ created in 2001
  - Software/Internet site containing content
  - Public can edit (with supervision)
  - Continuously updated by geographically diverse group of individual editors
  - Leading to online community of users, content reflecting community's collective knowledge

http://en.wikipedia.org/wiki/Wikipedia:Why_Wikipedia_is_so_great;
http://en.wikipedia.org/wiki/Wikipedia:What_Wikipedia_is_not

If A Group of Theory Developers Uses a Wiki, It Can Be Mined for Evaluation Purposes

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┌──────────────────────────────┐
│   State formal propositions   │
└──────────────────────────────┘
┌──────────────────────────────┐
│        Design studies to      │
│        test propositions      │
└──────────────────────────────┘
┌──────────────────────────────┐
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└──────────────────────────────┘

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If the wiki is being used in "wiki-like" fashion, analysis provides insights into both process and content of theory development

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Examples of Using the Wiki to Evaluate Theory Development

- Who participates in theory development?
  - Identities of participants, frequency of edits
- To what is extent is development collaborative?
  - Extent of repeated editing of specific pages/content
  - Social network analysis
  - Discourse analysis
- When are key propositions stated/crystallized?
  - Timing and frequency of changes
 - Content analysis of changes

- One of six NSF-funded Science of Learning Centers

- Core of center at Carnegie Mellon University and University of Pittsburgh

- STPI serving as formative evaluator since 2005

- PSLC began formal theoretical framework development in summer 2005

- Established internal wiki fall 2006

Structure of the PSLC Theory Wiki As of September 2007
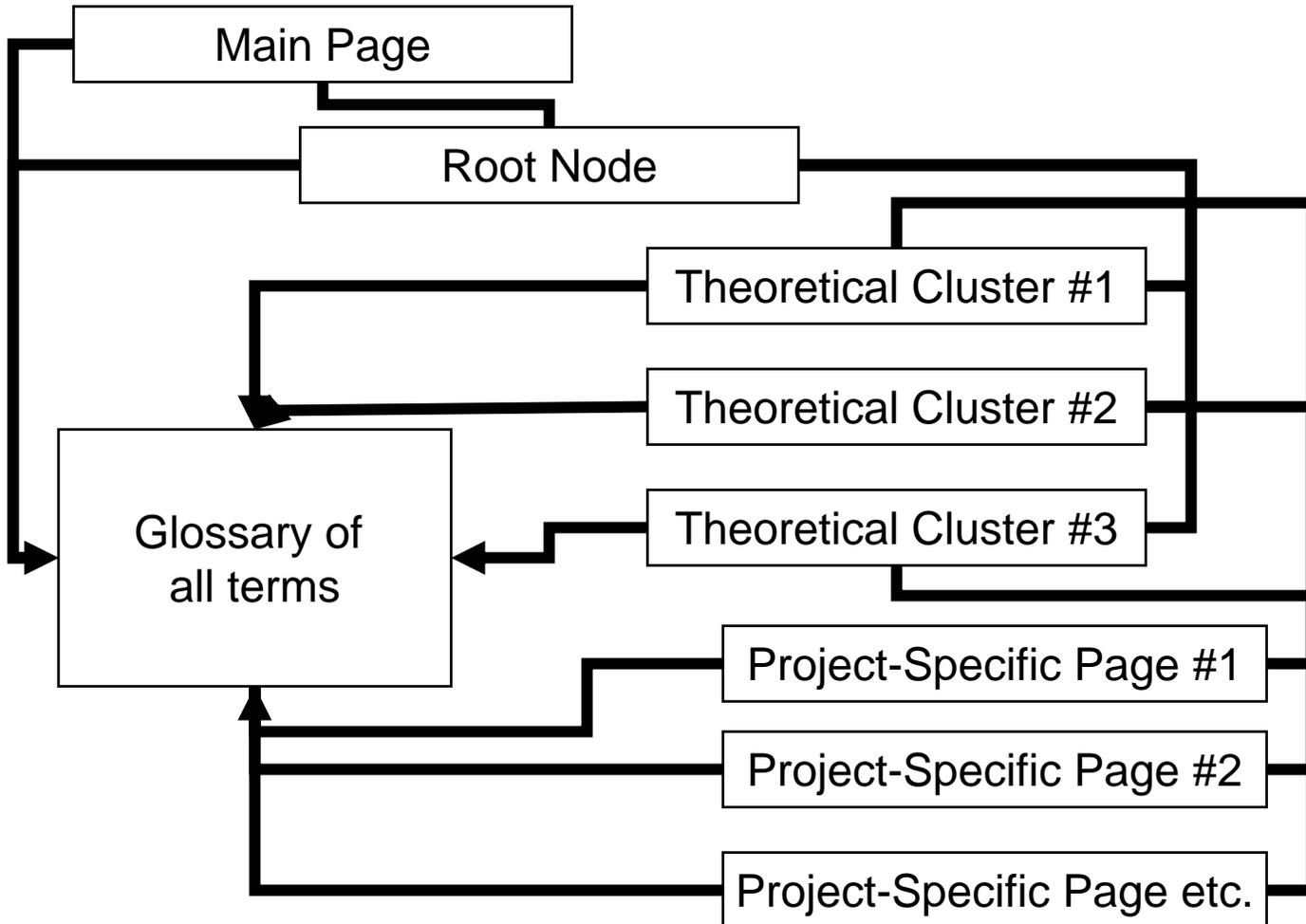
Nature of Pilot Test by STPI

- For 2005-6 collected information on theory development using traditional approaches
  - Document analysis (theoretical framework iterations)
  - Participant survey includes question on collaboration in theory development
  - Key participant interviews
- Wiki analysis begins winter 2006
  - PSLC provides access to wiki (currently for internal use only), which includes page edit logs
  - PSLC provides list of user IDs for edit-to-participant matching
  - STPI at quarterly intervals downloads current iterations of major pages and page edit logs for analysis

Summary Statistics: Registered Users of the PSLC Theory Wiki by Quarter

- Counts of wiki users shows substantial increase, then plateau, in first year

- As ~250 participants in PSLC, currently ~40% of participants have wiki logins

- Wiki internal, but beginning to open (advisory board, NSF site visit team)

# of Users by Quarter	PSLC Users	Center Interns and Summer School Participants	External Users	Total Users
2006 Q4	46	0	0	46
2007 Q1	58	0	0	58
2007 Q2	95	44	8	147
2007 Q3	97	44	9	150

Summary Statistics: PSLC Theory Wiki Edits of "Public" Versus "Project" Pages

- In wiki structure, both "public" (e.g., root-level, over-arching theoretical construct-level, glossary) pages and project-specific pages
- Most users who contribute edit both project and public pages
- As number of users has increased, % of users editing has decreased

# of Users Editing the Wiki by Quarter	2006 Q4	2007 Q1	2007 Q2	2007 Q3
Total users	46	58	147	150
Users editing project pages only	7	5	9	11
Users editing public and project pages	22	30	40	43
Percentage of total users editing at least one page	63%	60%	33%	36%

- PIs, post-docs, senior graduate students most likely to actively be involved in wiki

- Underlying research questions and hypotheses of the Center

- Content of theoretical framework

- Definitions of terms

- Study hypotheses and designs

- Study results and implications for the theoretical framework

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- ## Underlying Research Questions:
  - Until August 2007, "What instructional activities or methods cause students' learning to be robust?"
  - A second Center-wide, top-level research question for the PSLC was added to the theoretical framework in August 2007

- ## Theoretical Cluster #1:
  - Diagram (right) links individual studies and micro-elements of the theoretical framework
  - Once developed, immediately posted to wiki for future debate rather than waiting 4 months for next iteration of strategic plan

Coordinative Learning Theory Study Linkages

Studies	Course	Theme	Visual-verbal coordination	Example-rule coordination	Prompted self-explanation	Tutoring feedback	Personalization	Feature focusing	Optimal Scheduling	Error correction support	Knowledge component analysis	Learning event analysis	Normal post-test	Transfer	Long-term retention	Accelerated future learning	Leads
Contiguity	Geometry	V&M	v		b	b			b		✓+	✓+	✓	✓+		✓	Butcher et al.
Integratedhints	Geometry	V&M	v	v	b	b		v	b		✓+	✓+	✓	✓+		✓	Butcher et al.
Multimedia	Chemistry	V&M	v			b					✓	✓+	✓	✓+			Davenport et al.
Cotraining	Chinese	V&M	v										✓				Liu et al.
Talking head	Chinese	V&M	v										✓				Liu, Massaro et al.
Corrective	Algebra	E&E		v	v	b			b	v	✓	✓+	✓	✓+	✓		Booth et al.
Example-Pers	Chemistry	E&E		v	b	b	v				✓		✓				McLaren et al.
Notes	Statistics	E&E		b	b			v			✓		✓		✓		Bauer, Koedinger
REAP-Pers	ESL	E&E		b			v					✓+	✓	✓	✓		Eskenazi et al
Example-Alg	Algebra	E&E		v		b			b		✓+		✓	✓	✓		Anthony et al.
Example+Rule	Physics	E&E		v	v	b					✓+		✓	✓+	✓		Nokes, VanLehn
Example-Fade	Geometry	E&E		v	b	b		v			✓+	✓+	✓	✓+		✓	Renkl et al.

Key

Theme:
V&M = Visualization & multi-media sources
E&E = Examples & explanations

Macro: Treatment Variables
v = varied between control and treatment conditions
b = present in both control and treatment condition.

Micro: Analysis
✓ = project builds on existing analysis
✓+ = project involves new or innovative analysi

Learning Measures
✓ = project includes measure
✓+ = project includes measure and innovative research on measure

But Limited Insights into Process Given Wiki Use Patterns

- Few examples of multiple edits to single page/content element
  - Little online collaboration in process of theoretical framework development and refinement

- Interviews with participants suggest that collaboration in theory development is occurring, but that the wiki plays a different role:

- Example: wiki use around cluster meetings
  - Cluster meetings as forum for face-to-face discussion of theoretical framework
  - Wiki as common reference source to which participants refer in advance of meetings
  - Single individual usually tasked with updating wiki after meetings

- Geography of center (most participants at neighboring universities) as partial explanation?

Wikis as a Data Source in Evaluation: Strengths and Limitations

Strengths

- Longitudinal

- Granular

- Broad measure of participation

- Highlights points of contention

- Analysis cost-effective relative to participant observation

Weaknesses

- Selection effects

- Highly descriptive, requiring theory to guide analysis

- Best used when complemented by interviews to <u>explain</u> observations

Wiki analysis can be always be used to make evaluative statements about the <u>content</u> of theory development, but can be used meaningfully to assess the <u>process</u> of theory development if used in "wiki-like" fashion

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Concluding Observations

- Theory development hard to evaluate using traditional data collection approaches

- Initial pilot test suggests that wiki analysis can be integrated with traditional R&D evaluation tools

- To the extent to which scientific publication as a whole shifts to online journals/communities, similar analyses should become increasingly valuable to track performance of research
  - Will use of wikis/online collaboration tools change the process of theory development?