**Classroom Design Studies**

* Methodology for systematically studying the development of those practices (computational knowledge) in the context in which they emerge, which includes the designed means of support.
  + Pragmatically: involve investigating and improving a design for supporting learning
  + Theoretically: involve developing, testing, and revising conjectures about both the learning process and the means of supporting that learning
* Historically, design studies were described in the 1980s and 1990s as “design experiments”.
  + Cognitive psychology departed from using “experiment” to overcome the perceived limitations of experiments that compared treatment and control groups.
* Design studies are appropriate when,
  + the practices considered rarely occur in situ, so are difficult if not impossible to study through observations, and
  + current research is inadequate and does not formulate the reliable instructional methods.
    - Thus, a methodology in which designs are improved during iterative cycles of design and analysis is appropriate.
* Broad features:
  + help to address problems that arise from practitioners' attempts to support student learning,
    - thus they aim to contribute directly to improving the quality of students’ statistical computing education
  + account for interventionist nature of developing instructional methods,
    - researchers intentionally engineer the forms of development they seek to understand
    - can differ substantially from those that are typically found in situ
    - the researchers have considerable control, compared to naturalistic investigations, and the opportunity to identify forms of support that are necessary to develop the focal practices
  + hold strong theoretical and pragmatic orientations,
    - develop a practical design for supporting the development of increasingly sophisticated practices, and
    - a theory that comprises substantial conjectures about both processes of development and the means of supporting those developments
  + involve iterative cycles of design and analysis,
    - involve testing, and if necessary, abandoning conjectures about students’ development and the means of supporting those developments
    - improve an initial design or intervention for supporting learning by conducting iterative cycles of design and analysis
    - assessing (at each time point) if the current iteration of the design supports learning as conjectured
  + aim for generalizability
    - the intent is not merely to investigate the process of supporting a particular group of students’ learning
    - the initial design and developments it is intended to support as an instance of a broader class of phenomena
* *Its validation is internal and based on the comparison between the a priori and a posteriori analysis of the didactic situations involved.*

**Components of a Classroom Design Study**

1. Interpretive Framework
   * involve suppositions and assumptions about mathematical learning processes and about the aspects of the classroom learning environment that are potentially important for students’ learning
   * involve the important distinction of perspectives that characterize mathematical learning
     + individual constructive process (no)
     + situated with respect to classroom social norms and mathematical practices constituted collectively by the teacher and the students (yes)
     + focus on classroom tasks and tools, the nature of classroom norms, and the quality of classroom discourse as potential supports for student learning.
   * these assumptions are consequential because they influence the ongoing design and instructional decisions
2. Specifying Goals for Students' Learning
   * Need to question how the domain under question is typically represented in curricula by identifying central, organizing computational ideas.
   * Take into account *any* prior studies that have investigated the possibilities for students’ learning in the focal domains.
3. Documenting Instructional Starting Points
   * Identify aspects of students’ reasoning on which instruction can capitalize.
   * Prior research, such as interviews or observational studies, can be useful in indicating students initial reasoning.
4. Delineating an Envisioned Learning Trajectory
   * Formulating *testable* conjectures about both significant developments in students’ reasoning and the specific means of supporting those developments.
   * Envision how the tasks and tools might actually be enacted in the classroom, by considering the nature of classroom norms and discourse.
5. Placing the Study in a Theoretical Context
   * Classroom design studies aim for generalizability by producing a “humble theory”.
     + This places the study in a larger theoretical context by framing it as a paradigmatic case of supporting students’ development of particular computational capabilities.
6. Iterative cycles of design, data collection, and analysis
   * The objective of a design study *is not* to demonstrate that the envisioned learning trajectory works, or even to assess if it works.
   * The purpose of when experimenting to support learning is to improve the envisioned trajectory developed while preparing for the study by testing and revising conjectures about both students’ prospective learning processes and the specific means of supporting them.

Data Collection

* At a minimum the researchers must collect data that allow them to document both the process of students’ learning in the workshop sessions and the evolving workshop learning environment.
* Diagnostic assessments not only identify instructional starting points, but also help to track development of the participating students’ reasoning during the study.

Iterative Cycles of Analysis and Design

* + Each cycle involves designing instruction, enacting that design during a workshop session, and then analyzing what transpired in the workshop in order to plan for upcoming sessions.
  + The overall goal of the cycle is to test and improve the envisioned learning trajectory formulated during the preparation phase.
  + The researchers must have briefing meetings after each workshop session in which members of the team share and debate their interpretations of workshop events.
  + It is also useful to periodically have longer research team meetings, to outline a revised learning trajectory for the entire study that takes into account the revisions made thus far.

1. Retrospective Analysis
   * Involves drawing the entire data set generated while experimenting.
   * Seeks to place this learning and the means by which it was supported in a broader theoretical context by framing it as a paradigmatic case of a more encompassing phenomena.
   * It is important to differentiate the necessary aspects of the workshop learning environment from those that are contingent and might be varied by researchers working in other settings.
   * The process documents how:
     + each successive form of reasoning emerged as a reorganization of prior forms of reasoning, and
     + to identify the aspects of the workshop learning environment that supported the students’ development of these successive forms of reasoning.

Argumentative Grammar

* First step: demonstrate that the students would not have developed the documented forms of computational reasoning but for their participation in the design study.
  + Can draw on prior interview and observational studies to show that the documented forms of reasoning are relatively rarely.
* Second step: show the findings are potentially generalizable by delineating the aspects of the investigated learning process that can be repeated in other settings.
  + As researchers differentiate between the necessary and contingent aspects of the design, others will know which are essential when they customize the design to the settings they are working in.
* The generalizability of the findings from a classroom design study is broadly compatible with Lincoln and Guba’s influential notion of *transferability*.
  + This shows that the findings of qualitative studies have applicability to other contexts.
  + By developing thick descriptions of the phenomenon under investigation so that others can evaluate the extent to which the findings of a particular study are applicable to other contexts and people.
  + This makes explicit the conditions under which the intervention can be successfully implemented. (Lamberg & Middleton, 2009)

Trustworthiness

* Concerns the reasonableness and justifiability of claims and assertions about both the successive developments in the participating students’ reasoning and the aspects of the workshop learning environment that supported those developments.
* It is essential to analyze the *entire* data corpus systematically while simultaneously documenting all phases of the analysis process.
* Documentation of the data analysis process provides both an empirical grounding for the analysis and a means of differentiating systematic analyses in which sample episodes are used to illustrate general assertions from untrustworthy analyses in which a few possibly atypical episodes are used to support unsubstantiated claims.

Limitations

* Lack of agreed upon argumentative grammar (discussed previously).
* Limited attention given to equity.
  + complexity of the settings make it impossible to specify completely everything that transpires in the course of a design study
  + attending to issues of equity in the design study entails attending explicitly to the distribution of students’ learning opportunities and, perhaps, the development of their mathematical (computational) identities.
* Frequent failure of researchers to design for scale when preparing studies.
  + This limits the relevance of their work beyond the research community.
  + It is often the case that little attention is paid to the qualifications (knowledge and skills) of the instructor, which teachers would need to develop in order to enact the design effectively.
* Lack of attention to instructional practices of the teacher.
  + Analysis of their practices could therefore contribute to the delineation of crucial aspects of inquiry-oriented mathematics instruction.
  + This would help clarify the goals for teachers’ learning that could be targeted in teacher PD in general or in PD design studies.