

Appendix A1

Overview of Research Methods for the IBL Mathematics Centers Study

A1.1 Introduction

We conducted a large, mixed-methods study of inquiry-based learning (IBL) in college mathematics, comprised of six linked sub-studies of inquiry-based and comparative courses that were developed and taught at four university IBL Mathematics Centers. The study was designed to examine the following questions:

- 1) What are the student outcomes—including learning, attitudes, beliefs, career and education plans—of IBL mathematics courses?
- 2) How do these outcomes vary among student groups, and how do they compare with other types of courses?
- 3) How do these outcomes come about? In particular, what is the role of students, instructors and teaching assistants, course materials, assignments, assessments, and other classroom practices?
- 4) What are the costs and benefits for instructors and departments who teach with IBL methods?

The full report described selected results from our analyses. Chapters 2-8 each focus on the results from a particular sub-study. To communicate these results efficiently, we do not provide technical details of our research methods in the chapters. Rather, we summarize our approach to each in Chapter 1 of the report, highlighting the strengths and limitations of each method. We strongly encourage readers to begin with this chapter to understand the study as a whole, as well as the purpose and scope of this report. We also briefly recap the sub-study conceptual design at the start of each findings chapter.

A1.2 Organization of the Appendices

Our methods of data-gathering and analysis, and the samples for each sub-study, are described in an appendix corresponding to each chapter, as listed in Table A1.1. Some of the tools that we developed may be useful to other evaluators or researchers, such as observation and interview protocols and survey instruments. These are included as exhibits, labeled E2.1, E2.2, and so on, and they follow the appendix to which they are relevant. These are also listed in Table A1.1. All the appendices are available online at:

<http://www.colorado.edu/eer/research/steminquiry.html#Reports>

Table A1.1: List of Appendices and Exhibits of Research Methods

Chapter	Appendix	Topic
1	A1	Introduction & background of the study; overview of methods
2	A2	Classroom observations E2.1 - summary sheet E2.2 - observer survey E2.3 - classroom log
3	A3	Student surveys E3.1 - attitudinal pre-survey E3.2 - learning gains post-survey (SALG-M)
4	A4	Linkages between observations and surveys
5	A5	Mathematics tests E5.1 - proof test questions E5.2 - instructor ratings, questions
6	A6	Student academic records
7 8	A7	Student interviews Instructor interviews E7.1 - instructor interview protocol E7.2 - student interview protocol

A1.3 Broad Design of the Study

As discussed in Chapter 1, the overall project addresses the broad question of whether, how, and for whom IBL teaching and learning approaches are effective in college mathematics. We sought to examine a range of student learning and affective outcomes as well as longer-term impacts on students' education and career paths. We studied the classroom context and the teaching and learning processes that took place in and out of class, and the contextual factors that influenced instructors' choices and the success and sustainability of the IBL programs on each campus.

With these goals, the study was designed as a checkerboard of sub-studies (Figure A1.1) that combine to build a detailed picture of where and how IBL methods do and do not “work” for students and their instructors. Classroom observations provide a foundation enabling us to describe the teaching methods in use and link student outcomes to particular teaching approaches. Surveys, tests, academic records, and interviews allow us to probe both student outcomes and learning processes using multiple methods. End-of-course measures focus on student outcomes, while pre-course measures let us assess whether students are selectively choosing (or being advised) into and out of IBL courses. Interviews with faculty and TAs provide their observations of student outcomes, crucial perspectives on teaching goals and methods, and document the costs, benefits and career impact of teaching an IBL course.

**Figure A1.1: Design Matrix for Investigation of Student Outcomes:
Approaches for Examining Outcomes for Key Student Audiences**

	<i>Math learning & thinking: Tests</i>	<i>Math learning & thinking: Self-report</i>	<i>Attitudes & beliefs</i>	<i>Career & educational outcomes</i>	<i>Classroom processes</i>
Math, science, & engineering majors	Proof test*	Survey* Interviews	Survey* Interviews	Academic records* Interviews	Observation* Interviews
Pre-service K-12 teachers	LMT test	Survey Interviews	Survey Interviews	Interviews	Observation Interviews

* Comparative data was gathered from non-IBL sections of some courses.

Table A1.2 shows the total amount of data gathered in the study. The numbers of participating IBL Mathematics Centers, course sections (IBL and non-IBL), and individuals (students, faculty or TAs; IBL and non-IBL) are itemized. By any measure, this is a large study.

Table A1.2: Data Gathered for IBL Mathematics Centers Evaluation Study, 2008-2010

INSTRUMENT	IBL Centers	IBL Sections	Non-IBL Sections	IBL Individuals	Non-IBL Individuals	Individuals Total
Attitudinal surveys						
Pre-survey	4	47	17	847	399	1246
Learning gains	3	6	1	112	88	200
Post-survey	4	55	18	840	325	1165
Mathematical Knowledge and Thinking						
LMT pre-test	2	9	-	187	-	187
LMT post-test	2	9	-	173	-	173
Proof test	2	8	8	87	35	122
Academic Records						
Transcripts	3	28	110	552	2866	3418
Interviews						
Students	4	15	-	68	-	68
Faculty	4	N/A	-	23	-	23
TAs	4	N/A	-	20	-	20
Observation						
Courses	3	36	15	213	89	302