

# The TRIUMPHS Project: Opportunities for History, Research, and Change in Undergraduate Mathematics Classrooms



Kathy Clark & Cihan Can  
(Florida State University)

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# Presentation Overview

Introduction to the TRIUMPHS Project

Overview of the Project Activities

Examples of Primary Source Projects

Evaluation with Research (EwR) Components

Additional Information & Resources

# TRIUMPHS Project

**TRIUMPHS: TR**ansforming **I**nstruction in  
**U**ndergraduate **M**athematics via **P**rimaries  
**H**istorical **S**ources

- **Janet H Barnett**, *Colorado State University Pueblo*
- **Kathleen M Clark**, *Florida State University*
- **Dominic Klyve**, *Central Washington University*
- **Jerry M Lodder**, *New Mexico State University*
- **Daniel Otero**, *Xavier University*
- **Nicholas A Scoville**, *Ursinus College*
- **Diana White**, *University of Colorado Denver*

# TRIUMPHS Project

- Funded by the National Science Foundation
- “Collaborative research project”
- Five-year, \$1.5 million, 7 institution effort in the United States
- Began 1 August 2015
- Project website:  
<http://webpages.ursinus.edu/nscoville/TRIUMPHS.html>

# Project Website



[Project Descriptions](#)

[Completed Projects](#)

[Site tester information](#)

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[Who we are](#)

Janet Barnett  
Kathleen Clark  
Dominic Klyve  
Jerry Lodder  
Danny Otero  
Nicholas Scoville  
Diana White

[Photos from September workshop in Denver now online!](#)

## Collaborative Research: Transforming Instruction in Undergraduate Mathematics via Primary Historical Sources (TRIUMPHS)

Mathematics faculty members and educational researchers are increasingly recognizing the value of the history of mathematics as a support to student learning. This collaborative project, involving seven diverse institutions of higher education, will help students learn and develop a deeper interest in, and appreciation and understanding of, fundamental mathematical concepts and ideas by utilizing primary sources - original historical writings by mathematicians on topics in mathematics. Educational materials for students will be developed at all levels of undergraduate mathematics courses, and will be designed to capture the spark of discovery and to motivate subsequent lines of inquiry. In particular, the student projects to be developed will be built around primary source material to guide students, including pre-service teachers, mathematics majors, and other STEM discipline majors, to explore the mathematics of the original discovery in order to develop their own understanding of that discovery. Mathematics faculty and graduate students from over forty (40) institutions will participate in the development and testing process, thereby ensuring a large national network of faculty with expertise on the use of these educational materials. The impacts of the materials and approaches to implementing them will be investigated in terms of teaching, student learning, and departmental and institutional change.

## Sponsor



National Science Foundation  
WHERE DISCOVERIES BEGIN

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# TRIUMPHS Information

→ [Project website](#) with projects ready for use;

[Site tester information](#);

[Additional resources](#).

# TRIUMPHS Project:

## Aims, Topics, & Materials

- Aim: to **develop, test/implement**, and **evaluate** classroom materials based on primary sources (“Primary Source Projects”; PSPs) for teaching undergraduate mathematics courses
  - Plan to create 20 full-length PSPs and 30 “mini” PSPs over the course of grant project
- Topics addressed by the PSPs range from **pre-calculus** and **elementary statistics** to **abstract algebra, analysis**, and **topology**

# Aims, Topics, & Materials...

- The materials allow instructors to replace standard classroom lectures with PSPs that **directly engage students with the mathematics** they are studying
- Students **read source texts**, and through a **series of exercises** that are woven throughout the project, **develop** a fuller **understanding** of the mathematics they are studying



## Full-Length PSPs

Understanding the Trigonometric Functions

Investigating Difference Equations

[Pythagorean Theorem and Exigency  
of Parallel Postulate](#)

Failure of the Parallel Postulate

Dedekind and the Creation of Ideals

Primes, Divisibility & Factoring

Bolzano's Definition of Continuity, his Bounded Set Theorem, and an Application to Continuous Functions

Rigorous Debates over Debatable Rigor in Analysis (Monster Functions!)

Construction of Figurate Numbers

Investigations Into d'Alembert's Definition of Limit

An Introduction to a Rigorous Definition of Derivative

Investigations Into Bolzano's Formulation of the Least Upper Bound Property

The Mean Value Theorem

Abel and Cauchy on a Rigorous Approach to Infinite Series

The Definite Integrals of Cauchy and Riemann

## Mini-PSPs

Babylonian Numeration

[Why be so critical? Origins of Analysis](#)

Topology from Analysis: Making the Connection

Connecting connectedness

The Cantor set before Cantor

Henri Lebesgue and the Integral Concept

Euler's Rediscovery of  $e$

# Project Depository

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Mathematics and Computer Science

## MATHEMATICS AND COMPUTER SCIENCE FACULTY RESEARCH PROJECTS

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Department Chair: April Kontostathis

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# TRIUMPHS: Overall Plan

- **Develop and rigorously test classroom materials** to teach standard topics in the university undergraduate mathematics curriculum through primary historical sources,
- **Train faculty to implement them, to promote their use as widely as possible** through widespread dissemination via conference talks and training workshops, and
- **Study diverse aspects of their implementation and efficacy.**

# TRIUMPHS Project:

## Evaluation with Research

The Evaluation with Research (EwR) Component will provide formative and summative evaluation for TRIUMPHS to aid in the understanding of:

- \* How student **mathematical world views** evolve;
- \* How / in what ways do individual PSPs may **promote student learning of the meta-discursive rules** that govern mathematical practice; and
- \* How to **support faculty in developing expertise implementing** this instructional approach

# Sample Research Questions

## “Student Change” Piece

- RQ1a: *In what ways does the use of **PSPs influence mathematics students’ beliefs and perceptions** about mathematics?*
- RQ1b: *In what ways does the use of PSPs **influence mathematics education students’** beliefs and perceptions about mathematics?*
- RQ1c: *In what ways does the use of PSPs **influence other students’** (taking Calculus II and below) beliefs and perceptions about mathematics?*

# RQs, *continued*

- RQ2a: What is the potential of a given PSP (specifically the original source material within the PSP) to **promote the learning of meta-discursive rules in mathematics?**
- RQ2b: What is the potential of a given PSP to **promote student reflection on meta-rules in conception formation?**

[Sfard (2001): meta-rules include those rules that underlie the uniquely mathematical ways of defining and proving; rules that regulate and guide interpersonal exchange and self-communication; the way symbolic tools should be used in the given type of communication, etc.]

- RQ3: In what ways does student engagement with PSPs influence **student retention in mathematics?**

# RQs, *continued*

## “Faculty Expertise” Piece

- RQ4: What **faculty characteristics** may **predict or explain** which faculty and graduate students choose to attend training workshops and to implement PSPs?
- RQ6: In what ways does the use of **PSPs change instructors’** (and graduate teaching assistants’) **approach to teaching** other topics/courses?



# Data Sources

(Sample for “Student Change” piece)

Students	Instructor
Pre-Course Survey	Pre-Course Survey
<b>PSP student work</b>	
Post-PSP Survey (for max of 2 per course)	Post-Implementation Report (per PSP)
Post-Course Survey	Post-Course Survey
** Student “matched set” requires each of the above. **	
<b>Note: Collect 10% -20% of participating students’ work.</b>	
<i>(Interviews possible.)</i>	<i>(Interviews possible.)</i>

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# *Thank you!*

- Questions about being a site tester of a PSP?  
Contact Janet Barnett  
([janet.barnett@csupueblo.edu](mailto:janet.barnett@csupueblo.edu))  
and Dominic Klyve ([klyved@cwu.edu](mailto:klyved@cwu.edu))
- Please direct questions/comments on the EwR aspect of TRIUMPHS to:  
Kathy Clark  
[kclark@fsu.edu](mailto:kclark@fsu.edu)