

TRIUMPHS Final Evaluation Report: Executive Summary
Prepared by Kathleen M. Clark (PI, (formerly of) Florida State University)
and Janet Heine Barnett (PI, Colorado State University Pueblo)

Introduction

The Transforming Instruction in Undergraduate Mathematics via Primary Historical Sources (TRIUMPHS) project began August 1, 2015 and activities for the project concluded July 31, 2023. Originally funded as a five-year collaboration, all seven PIs were granted a one-year no-cost extension (2020–21). Two PIs were granted additional no-cost extensions: Diana White at Colorado University Denver (2021–22) and Dominic Klyve at Central Washington University (2021–23). The other five participating PIs and their institutions were: Janet Heine Barnett (Colorado State University Pueblo), Kathleen M. Clark (Florida State University), Jerry Lodder (New Mexico State University), Danny Otero (Xavier University), and Nicholas Scoville (Ursinus College).

The project’s Evaluation-with-Research (EWR) Working Group has provided formative and summative evaluation concerning all components of the TRIUMPHS project, including formative evaluations from the conclusion of Year 2 through the conclusion of Year 6 (with a combined formative evaluation for Years 1 and 2). In addition to evaluating the progress made and outlining recommendations for subsequent project activities, the Year 6 report also provided summative evaluation of grant activities that were finalized at the time.

The Final Evaluation Report provides an overall assessment of the project for Years 1–8. That report is organized around the five general goal areas (Appendix A of this Executive Summary) and the seven specific measurable outcomes originally identified in the project proposal narrative (Appendix B of this Executive Summary). The assessments provided for each goal area are heavily supported by supplemental documentation provided in the Appendices of the full report. The closing section of that report also provides a brief evaluation of the project’s prospects for long-term sustainability.

This Executive Summary highlights information from the Final Evaluation Report regarding the project’s achievements and shortfalls relative to its goals and measurable outcomes, and its prospects for long-term sustainability.

Project Achievements

In summary, the TRIUMPHS project met or exceeded nearly every aspect of the measurable outcomes in each of the project’s five goal areas. These achievements include the following.¹

¹ The order in which these items are listed does not completely follow the organization of the full report, as several measurable outcomes applied to more than one goal area.

- **A total of 99 Primary Source Project (PSPs) were developed**, including 46 full-length PSPs (20 were promised) and 53 mini-PSPs (30 were promised).²
 - Three projects also exist in multiple versions aimed at different audiences; including those alternate versions in the count brings the total number of PSPs developed to 102.
 - Before being made available via the TRIUMPHS website for classroom testing, all projects passed through a **rigorous two-stage peer/expert review process** supervised by the Development Cycle Working Group.³
- **All but 10 of the 80 PSPs that existed at the close of formal site testing had been tested in non-author classrooms**, and seven of those ten had been tested by their authors.⁴
- **All PSPs developed under the grant have been published on Digital Commons**, where they are freely available for download and use by instructors and students. Additionally,
 - 33 mini-PSPs and 1 full-length PSP have also thus far been published in *Convergence*, the Mathematical Association of America’s (MAA) online journal for the history of mathematics and its use in teaching;
 - A print volume of 24 PSPs (for real analysis, topology, and complex variables) will be available by the end of 2023 as part of the Classroom Resource Materials Book Series of the MAA Press imprint of the American Mathematical Society. A second volume of PSPs (for precalculus, calculus, and differential equations) is currently in preparation for possible publication in the same book series.
- **Both the number of formal site testers (128, excluding PSP authors who tested only their own PSPs) and the proportion of those who site tested more than one PSP (70 out of 128, excluding self-authored PSPs) were well above the targets of 50 and 33%, respectively.**
 - If author testing of PSPs and repeated use of PSPs by an instructor across semesters are also included in these counts, 133 instructors officially used PSPs during the first 6 years of the grant, for a total of 436 distinct implementations in over 240 classrooms at 109 different institutions across the US and in Canada.
 - Excluding PIs and the initial set of external authors from that total, 29% of the formal site testers also officially implemented PSPs during at least two semesters.
 - An Author/Site Tester Protocol was developed to ensure that all formal site testers were offered off-site implementation support via e-mail, Zoom conference calls, and phone communications. Eight testers also received on-site support from a member of the team during classroom implementation.
 - Beginning in Year 3, greater attention was also paid to the “Notes to Instructors” section of individual PSPs as a means to provide targeted and detailed implementation advice and support.

² PSP authors included all collaborating PIs with the exception of PI Clark, who had primary responsibility for the EWR component of the project, as well as 13 faculty external authors (Abe Edwards, Mary Flagg, Sarah Hagen, Keith Jones, Toke Knudsen, Carl Lienert, Kenneth Monks, Adam Parker, Dave Ruch, Michael Saclolo, James Sellers, Naveen Somasunderam, and Beverly Wood) and 5 student co-authors (Charlotte Bolch, River Bond, Joshua Eastes, Negar Janani, Alan Kappler).

³ Members of the Development Cycle Working Group were PI Barnett, PI Klyve, and PI Otero.

⁴ Formal site testing closed at the end of Year 6. Data on classroom use of PSPs during Years 7 and 8, including the 18 new projects that were developed after the close of formal site testing, is not available.

- **Three research initiatives related to Student Change** were carried out as part of the project’s Evaluation-with Research component over the course of the grant:⁵
 - A qualitative study of **student perceptions on the nature of mathematics**, with a focus on a multi-layer approach with the aim to make assertions about students’ reported mathematical worldviews (i.e., according to Törner’s (2000) schema, process, applications, and formalism worldviews), and to investigate potential shifts.
 - An examination of **students’ learning experiences while using PSPs in undergraduate mathematics courses from a “mathematical transgressions” perspective**, including the development and refinement of conceptions for how to apply the transgressions framework as a tool to understand the extent to which the use of PSPs in undergraduate mathematics classrooms promote what Koziol (1986) defined as transgressive actions.
 - An extensive **Meta-Discursive Rules (MDR) Investigation** that examined evidence of students’ progress in “figuring out” (Sfard, 2014, p. 201) the meta-level rules that govern a new mathematical discourse as a result of studying specific mathematical concepts using primary source projects.
- **Three research initiatives related to Faculty Expertise** were carried out as part of the project’s Evaluation-with Research component over the course of the grant:⁶
 - An investigation of **instructors’ classroom use of PSPs and its effects** based on an analysis of Instructor Implementation Reports, with results reported in three general areas: implementation of PSPs, changes in instructor teaching tendencies, and instructors’ perception of the impact of PSPs.
 - An investigation of the **role of faculty development workshops as support for incorporation of new teaching techniques** based on the “unfreeze, change, refreeze” framework of instructional change developed by Paulsen and Feldman (1995).⁷
 - An analysis of **features of the TRIUMPHS project that influenced tertiary mathematics instructors’ adoption of PSPs into their ordinary practice** based on frameworks from the relatively new field of implementation research.
- **Research results obtained in connection with the project’s EwR component were widely disseminated**, with members of the EwR workings groups delivering a total of 23 presentations⁸ and 12 peer-/editor-reviewed publications to date, with a 13th manuscript currently under revision for resubmission.

⁵ All three of the Student Change investigations were carried out by the Student Change EwR Working Group (or some subset thereof). That working group also developed, and when necessary, revised the data collection instruments required for the duration of the grant. The Student Change EwR Working Group was led by PI Clark, who also held lead responsibility for project evaluation; the other permanent member of this group was PI Barnett, with FSU doctoral graduate Cihan Can and FSU doctoral students Matt Mauntel and Mark Watford serving as members at various times.

⁶⁶ The first two Faculty Expertise investigations in this list were carried out by the Faculty Expertise EwR Working Group, which was led by PI White, who also held lead responsibility for the multi-day faculty training workshops described later in this summary; other members of this group included PI Klyve, PI Otero, and PI Scoville. The third investigation in this list was carried out by the Student Change EwR Working Group.

⁷ Although a manuscript reporting these results was under development in Year 5 of the grant, its completion was regrettably not possible due to issues related to the COVID-19 pandemic (described below).

⁸ With regard to the dissemination of TRIUMPHS materials and research results, it is important to note that due to the COVID-19 pandemic, the number of presentations for purposes of research dissemination was significantly impacted,

- The PIs, external authors, and site testers undertook a **robust program of PSP and general project dissemination**, with a total of 93 presentations and 44 peer-/editor-reviewed publications to date.
 - The TRIUMPHS website, created and maintained by PI Scoville, also continues to serve as an important dissemination tool (e.g., as a venue for making the PSPs widely available), with a total of **107,157 visits to the TRIUMPHS website and 110,417 downloads of TRIUMPHS PSPs** registered since its inception (through June 29, 2023).
- The project team delivered a **coordinated program of faculty support aimed at the development of faculty expertise in the use of PSPs**, including:
 - Eight on-site visits with site testers during their implementation of PSPs;
 - Eight webinars to build a community of TRIUMPHS PSP users and to recruit and support faculty in the use of PSPs in undergraduate mathematics instruction, recordings of which are available on the TRIUMPHS website;
 - Fifteen workshops and mini-courses offered at regional, national, and international conferences;
 - Two multi-day TRIUMPHS workshops held at Colorado University Denver (CU Denver) in Fall 2016 (35 Participants) and Fall 2018 (35 participants).⁹
- **Substantive graduate student training in the use and development of PSPs** was provided by members of the project team during Years 1–6 of the project, with
 - A multi-day TRIUMPHS workshop specifically targeted at training graduate students in the classroom use of PSPs held at New Mexico State University (NMSU) in Summer 2019 (24 participants).¹⁰
 - Six mathematics doctoral students and three mathematics education doctoral students were provided with co-teaching experiences that involved the teaching of eleven different courses in which PSPs were used, as well as the development of four new PSPs.¹¹
 - Two additional students co-authored PSPs under the mentorship of external authors.¹²
- Regarding the **development of future mathematics education researchers**, five students at Florida State University (FSU) received mentoring from PI Clark over the course of the grant.
 - Prompted by his work with TRIUMPHS, the doctoral research of one of these students, Cihan Can, investigated aspects of instructor growth resulting from teaching with PSPs. Dr. Can defended in Fall 2019, making his dissertation the only one produced in the History and Pedagogy of Mathematics / Research in Undergraduate Mathematics Education domain in the US for many years.

particularly in Years 5 and 6 as there were several presentations (accepted and) planned for delivery at the ICME and HPM meetings (scheduled to take place in China in July 2020).

⁹ PI White served as the lead organizer for both CU Denver workshops, assisted by PI Barnett and PI Otero in 2016 and by PI Otero and PI Scoville in 2018.

¹⁰ PI Lodder served as the lead organizer for the NMSU workshop, assisted by PI Otero, PI Scoville, and Advisory Board member David Pengelley.

¹¹ These experiences took place at FSU, NMSU, and CU Denver under the mentorship of PI Clark, PI Lodder, and PI White, respectively. The authorship of new PSPs was completed by PI White and her students River Bond, Joshua Eastes, and Negar Janani during one of the courses taught at CU Denver.

¹² These were a mathematics education graduate student and high school student, under the mentorship of Beverly Wood and Sarah Hagen, respectively.

- The project **significantly contributed to the development of expertise in PSP authorship.**
 - Over the course of the grant, the number of external authors grew from the original 4 external authors included in the grant proposal to a total of 13 external authors (excluding student co-authors).
 - The Author Workshop Planning Team¹³ also provided:
 - Two series of virtual group discussion in Summer/Fall 2020 (15 participants) and early Summer 2021 (17 participants).
 - A written advice document entitled “How to Start Writing a Primary Source Project (PSP)” that was disseminated in AY 2020–21 to the original invited workshop participants (and has since been shared with several new external authors who were recruited by Advisory Board member David Pengelley).
 - Personalized author mentoring with nine of the original invited workshop participants.

Project Shortfalls

While the majority of the project’s goals and proposed measurable outcomes were met or exceeded, certain aspects of these were only partially fulfilled. These shortfalls can be attributed to overly ambitious/unrealistic goal setting at the proposal stage or to circumstances beyond the control of the PI team.

For instance, **progress on the research investigations** undertaken by the Student Change and Faculty Expertise EwR Working Groups (Goal Area 3) was slower than hoped for by members of those groups. In hindsight, this was to be expected given the limited personnel¹⁴ available to pursue these investigations were also responsible for managing the project’s data collection needs during site testing semesters and for providing regular evaluation reports on all aspects of the project. As well, many of the research investigations that were undertaken employed qualitative methodologies which, while more appropriate for the research questions being pursued, require more time for analysis than do quantitative approaches. In the final years of the grant, the COVID-19 pandemic placed additional demands on members of these working groups (professional, personal, and medical) that further slowed plans for the analysis and dissemination of data collected in Years 1–6.

While members of the Student Change and Faculty Expertise EwR Working Groups originally anticipated making additional research progress by the close of the grant, and despite the challenges described above, the stated measurable outcomes for the EwR component of the project were met and adequate progress was made on all subgoals for this component of the grant. It is also worth noting that the Investigation carried out by Student Change EwR Working Group pursued research at the confluence of two distinct and fairly new domains of mathematics education research: commognitive theory and the use of primary sources in mathematics education. Given the paucity of such research prior to 2015, members of that group began their initial efforts as pioneers at this confluence. Similarly, the mathematical transgressions research strand is based on a theory that had not previously been taken up in the field of educational research broadly or

¹³ Members of the Author Workshop planning team were PI Barnett, PI Klyve, PI Otero, and Advisory Board member David Pengelley.

¹⁴ As the primary focus for the efforts of most project personnel (including the external authors) was on the development and promotion of new PSPs, only three individuals (PIs Clark, Barnett, and White) were substantively involved in the project’s EwR component over the course of the grant.

mathematics education research in particular, and there were no empirical examples to serve as models for employing this theory prior to that carried out by the Student Change EwR Working Group. Especially given the personnel and time resources available, the group's contributions to STEM educational research as a result of its MDR Investigation and mathematical transgressions work over the life of the grant has laid a solid foundation for future explorations of this new and promising line of research, by members of the TRIUMPHS team and others.

The following three shortfalls of the project with regard to the stated measurable outcomes were due to factors similar to those that slowed the project's research initiatives.

- With regard to the **development of support resources for new and beginning users of PSPs**, Measurable Outcome 5 specified that a general manual on the use and development of PSPs and approximately 8 workshop and model teaching videos would be made available via the TRIUMPHS website.
 - The resources needed to produce model teaching videos (e.g., acquiring student consent, recording and editing videos, curating resulting videos) were ultimately deemed to be too prohibitive.
 - Similarly, the General Instructor Guide was not completed due to other project demands for which the individual assigned with this task (PI Barnett) was responsible.

- With regard to **project dissemination**, Measurable Outcome 6 specified that each author would disseminate each of their PSPs at least once at either the Joint Mathematics Meetings or MathFest.
 - At the end of Year 8 (July 2023), approximately 72% of the PSPs that were then available (71/99) had been disseminated in some way at least once, and approximately 42% of the PSPs that were then available (40/99) had been disseminated at two or more venues.¹⁵
 - Given that the total number of PSPs reached nearly 100 with some authors contributing as many as 10–14 PSPs to the collection, a more realistic (yet still adequately ambitious) goal would have been for each PI to contribute to project dissemination via presentations or publications at least once per year, and for external authors to do so at least once during the lifetime of the grant.

- With regard to the **development of faculty expertise in the use of PSPs**, Measurable Outcome 4 specified that at least four training workshops will be held, with at least 12 graduate students and 8 early career faculty participating in the workshops aimed at this audience, and at least 20 faculty (excluding PIs) participating in each of the faculty training workshops.
 - Only three of the four promised workshops were offered (Fall 2016, Fall 2018, Summer 2019), reaching a total of 90 individuals: 63 faculty and instructors from a wide variety of college and university teaching contexts (including 9 early career faculty) and 27 graduate students.
 - Planning for the fourth workshop, a five-day Author Workshop that was slated to be held at Central Washington University in May 2020, was well underway with 22 participants confirmed to take part when a decision to postpone was reached in April 2020. Plans for an in-person Author Workshop were ultimately replaced by the virtual discussion series and individual author mentoring described earlier in this Executive Summary.

¹⁵ These figures are based on a broadened definition of dissemination, adopted by the evaluation group in Year 4, which includes dissemination by site testers of given PSPs (i.e., not only PIs and authors), as well as dissemination through sectional meetings and via refereed publication (i.e., not only MathFest and JMM).

The ongoing need to postpone plans for an in-person Author Workshop also allowed the planning team for that workshop to carefully think through the intended goals of that effort. Primary among these was the goal of identifying a group of individuals among the workshop participants who would be interested in supporting the teaching and learning with primary source projects beyond the end of the TRIUMPHS award period. In support of this goal, PIs Barnett, Klyve, and Otero began working in Summer 2021 with a small cohort of individuals who had been highly active in TRIUMPHS as site testers and external authors and had expressed an interest in serving as leaders in the “Teaching Mathematics with Primary Sources” community. This group’s progress in building an infrastructure that will attract instructors to the community and support their efforts both to use PSPs in their classrooms and to author their own PSPs is discussed in the next section of this Summary.

Expectations for the Future

In broad terms, the aims of the TRIUMPHS project were two-fold:

- Expand the use of PSPs as a resource for teaching and learning undergraduate mathematics by supporting the development of high-quality student projects and promoting their use in a broad range of courses; and
- Expand the understanding of the STEM education community by contributing to the general knowledge base through research on the effects of teaching and learning with PSPs on students and their instructors.

This section of the report reflects on the project’s success with respect to these two aims in the context of future directions which have been opened up by the achievements that were achieved over the past eight years.

Use of PSPs as resource for teaching and learning undergraduate mathematics

Several initiatives were begun during the final years of the TRIUMPHS grant that will continue to disseminate PSPs and promote their use beyond the funding period. These include ongoing conference presentations by individual PSP PIs, authors, and site testers, continued publication of the *Convergence* series of TRIUMPHS mini-PSPs, and the forthcoming print volume of 24 PSPs through the MAA’s Classroom Resource Materials Book Series (with the possibility of at least one additional volume to appear in that same series). Additionally, at the invitation of the editor of *The Mathematics Enthusiast*, a special issue will appear in that journal on the theme of teaching mathematics with primary historical sources with a focus on the work that has come out of the TRIUMPHS project since 2015.

To further enhance the prospects for the long-term sustainability and expansion of TRIUMPHS’s achievements, a three-day in-person “next generation” work retreat¹⁶ was held in November 2022 during which significant progress was made towards launching a society and journal that would continue to encourage and support the development, use, and dissemination of classroom resources based on primary historical sources, and to promote the proliferation of primary source-based pedagogy in mathematics

¹⁶ This work retreat was organized by PI Barnett, PI Klyve, and PI Otero, and was also attended by PI Clark, external authors Abe Edwards, Ken Monks, Adam Parker, and Michael Saclolo, and FSU doctoral student Mark Watford.

through conversation and professional development. During that work retreat, a set of by-laws and a preliminary website (<https://triumphssociety.org/about>) were created for the TRIUMPHS Society (TRansforming Instruction: Understanding Mathematics via Primary Historical Sources) and an initial slate of officers selected, with PI Barnett, PI Klyve, PI Otero, and external author Adam Parker serving in lead roles. A founding document for the associated journal, the *Annals of the TRIUMPHS Society*, was also developed and an initial editorial board appointed, with external authors Kenneth Monks and Michael Saclolo serving as editors-in-chief. In addition to the publication of new PSPs for classroom use, the *Annals* will archive and curate the current PSP collection from TRIUMPHS and its antecedent grants, and provide resources to support PSP authorships and their implementation. Several options for the publication platform of the new journal are being studied by the leadership team of the society and journal. Efforts to obtain 501(c)(3) status and open a bank account for the society are also currently underway, with a formal announcement and call for new members to take place at MathFest in August 2023.

Research on effects of teaching and learning with PSPs

During Years 6 and 7, as the Student Change EwR Working Group (which included FSU doctoral graduate Can, FSU doctoral student Watford, and FSU undergraduate student Rubis) achieved a small but intense collection of educational research publications, they began to take stock of the potential for further research resulting from the quite large TRIUMPHS data set. In particular, the Student Change Working Group anticipates pursuing the following potential directions for future publications:

- The continued exploration of the Fall 2016 small group work from an Analysis course, to identify and explore the role of instructor intervention micro-episodes in students' figuring out MDRs; and
- Pairing an analysis of open-ended items from student surveys (connecting students' experiences with PSPs and worldviews) with results informed by the TRIUMPHS transgressions research.

In addition to further examination of the existing TRIUMPHS data and further explorations in the three research domain foci (worldviews, transgressions, MDRI), there is the potential of future impact from the TRIUMPHS EwR efforts. For example, FSU doctoral student Watford has continued to develop as a mathematics education researcher and has taken the lead on the transgressions component of the Student Change Working Group. He has also collected data using the interview protocol from two subsequent course offerings of *Calculus and Its History* (a course taught almost entirely with PSPs), inspired by his engagement with and contributions to TRIUMPHS (and which has thus far led to two conference proceedings papers).

Additionally, there has been a recent (January 2023) National Science Foundation grant proposal, which has a focus on the professional development of undergraduate mathematics instructors to learn about commognition and the affordances of this framework and the use of PSPs on student learning in mathematics. Development of this proposal was a second strand at the Fall 2022 work retreat described above, during which TRIUMPHS PIs Clark and Barnett met extensively with the PI of the new proposal, external author Abe Edwards (Michigan State University), to discuss the proposed research and related issues. Although not funded on the first submission, Edwards is pursuing a future submission, and this effort has significant potential for a *another* "next generation" research effort with connections to a direction begun as part of TRIUMPHS, that is, the MDR investigation (see subgoal (c) of Major Goal Area 3). Specifically, the research proposed by Dr. Edwards has two aims: to investigate classroom implementation of PSPs as a means to explicitly attend to nurturing mathematical discourse, and to investigate student participation in classroom discourse and changes to students' mathematical identities that occur while learning from PSPs. Both

investigations will employ the commognitive theory of learning as a framework; with regard to the second aim, for example, the proposed project will explore several aspects of students' mathematical discourse based on that theory, including their discursive shifts, awareness and adoption of meta-discursive rules, and transitions from ritualized mathematical work to more exploratory work. An important component of the proposed project that binds the two aims together will be an extensive program of professional development for the participating instructors, in order to prepare them to attend to mathematical discourse throughout a course by providing an introduction to cognitive theory and guidance in the implementation of PSPs. If successful, the highly specialized research that the project proposes holds great promise for contributing to the domains of commognitive research and the role of primary sources on undergraduate mathematics teaching and learning.

Non-TRIUMPHS Works Cited

Kozielecki, J. (1986). A transgressive model of man. *New Ideas in Psychology*, 4(1), 89–105.

Paulsen, M. B., & Feldman, K. A. (1995). *Taking teaching seriously; Meeting the challenge of instructional improvement (ASHE-ERIC Higher Education Report No. 2, 1995)*. ERIC Clearinghouse on Higher Education.

Sfard, A. (2014). University mathematics as a discourse—why, how, and what for? *Research in Mathematics Education*, 16(2), 199–203.

Törner, G. (2000). Views of German mathematics teachers on mathematics. In H.-G. Weigand, E. Cohors-Fresenborg, K. Houston, H. Maier, A. Peter-Koop, K. Reiss, G. Törner, & B. Wollring (Eds.), *Developments in mathematics education in Germany: Selected papers from the Annual Conference on Didactics of Mathematics, Regensburg, 1996* (pp. 121–136). Franzbecker Verlag.

APPENDIX A: List of Five Major Goal Areas

Goal 1: The **authorship** of curricular materials for undergraduate mathematics courses, based on primary historical sources.

Goal 2: Classroom testing of these curricular modules at a variety of universities and colleges and by a variety of instructors, graduate teaching assistants, and faculty members.

Goal 3: An **evaluation-with-research study** to provide formative and summative evaluation for TRIUMPHS along with achieving (i) a general understanding of how, based on the use of primary source materials in instruction, student perceptions of the nature of mathematics evolve, (ii) an examination of evidence of students' progress in "figuring out" (Sfard, 2014, p. 201) the meta-level rules that govern a new mathematical discourse as a result of studying specific mathematical concepts using primary source projects, and (iii) a general understanding of how instructional faculty can be supported in the development and implementation of this research-based, active learning approach in undergraduate STEM education.

The subgoals of the evaluation-with-research component of the TRIUMPHS grant include:

- a) Providing formative and summative evaluation concerning all components of the TRIUMPHS project;
- b) Understanding how student perceptions of the nature of mathematics evolve when primary historical texts are a main tool of instruction;
- c) Examining evidence of students' progress in "figuring out" (Sfard, 2014, p. 201) the meta-level rules that govern a new mathematical discourse as a result of studying specific mathematical concepts using primary source projects;
- d) Determining how to support faculty in developing and implementing this research-based, active learning approach in undergraduate STEM education; and
- e) Developing all necessary data collection instruments (e.g., surveys, Instructor Implementation Reports).

Goal 4: Dissemination of materials and results at conferences, workshops, and in electronic formats.

Goal 5: Recruitment and training of instructors, graduate students, and interested faculty in the use of these curricular materials at specialized workshops.

APPENDIX B: List of Specific 5-year Measurable Objectives from Original Proposal

The specific measurable objectives of TRIUMPHS explicitly described in the original TRIUMPHS proposal (p. 15 of proposal narrative) include (**emphasis added**):

- 1) At least **20 full-length PSPs** and at least **30 mini-PSPs** will be written, tested, and published.
- 2) At least **50 faculty** will participate as site testers; **33% of these** will implement **at least two PSPs** during the project period.
- 3) At least **four** summer training workshops will be held, with at least **12 graduate students** and **8 early career faculty** participating in the summer workshops aimed at this audience, and at least **20 faculty** (excluding PIs) participating in each of the faculty summer training workshops.
- 4) **Resources** to support new and beginning users of PSPs will be developed and made available (both during and following the grant period) via the TRIUMPHS website, including a general manual on the use and development of PSPs and approximately 8 workshop and model teaching videos.
- 5) Each author will **disseminate each of their PSPs at least once** at one of the two primary national meetings aimed at mathematicians, namely, the Joint Mathematics Meetings or MathFest.
- 6) An **evaluation-with-research study** will be used to make adjustments as needed throughout the project and to contribute to the STEM education knowledge.
- 7) Evaluation and research results will be disseminated **at least once per year** during the project period at annual meetings of organizations such as: RUME, PME-NA, CERME, and HPM-Americas.