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A Case Study of the Pedagogical Implementation of Primary Sources in undergraduate mathematics

Abstract

In this presentation, we will report on a case study of two different university mathematics classes that implemented the same primary source project (PSP) as part of the *Transforming Instruction in Undergraduate Mathematics via Primary Historical Sources* (TRIUMPHS) project. One Linear Algebra course was taught by the author of the PSP and the other Linear Algebra course took place at a second university. We will present a comparison of survey results of the two implementations of the PSP and discuss how PSP implementations affected students' perceived mathematical gains.

Primary source projects (PSPs) are ready-to-use curriculum materials in the form of classroom projects based on primary source materials through which students learn a wide variety of standard topics in university mathematics classes. The *Solving a System of Linear Equations using Ancient Chinese Methods* PSP (Flagg, 2017) was administered in fall 2017 and students were given a pre-course survey to determine their beliefs about mathematics, prior experience with primary source materials, views about mathematics learning and general demographic information. The post-PSP survey contains questions that capture students' perceived gains in skills relating to linear algebra, general mathematical skills including reading and writing about mathematics, and attitudes and confidence in mathematics. Additional questions ask about the interaction of students with peers, the instructor, and the primary source material inside and outside of class. Finally, several open-ended questions ask students to reflect upon their experience with the PSP, including their perception of benefits and obstacles of learning mathematics using primary sources, and their attitudes towards using primary sources in a linear algebra course.

We collected both pre-course and post-PSP survey responses from 11 students in the author's course and from seven in the non-author's course. Both classes consisted of students who had taken at least Calculus 2 and a majority of students had taken higher-level mathematics courses. The majority of students were mathematics, computer science, or physics majors. The size of each institution was similar, and each course was almost equally male and female, with the author's course being significantly more racially diverse than the non-author course.

On average, students reported between "moderate" and "good" gains in almost every category. Higher gains were reported by those students who interacted with the instructor outside of class. Students with a dominant Schema world view of mathematics (Törner, 1998) had more difficulty with the course and the PSP did not seem to change this worldview. The nature of students' negative and positive comments was similar from both implementations of the PSP, with several students commenting that they had difficulty grappling with texts translated from a foreign language (into English). Several students in the author's course commented about the amount of time it took to grapple with the primary source material, while students in the non-author's course did not.

In addition to survey responses, student work from the PSP was also collected. Students were asked to choose between the Fangcheng method and the modern method of back substitution and students chose equally from the two methods. One student observed:

Both the Fancheng Rule solution and modern technique will give the same answer. The Fancheng Rule

involves more tedious steps that prevent us from dealing with fractions till the last step. The Modern Method has less steps but can get complicated and tedious when dealing with fractions early on. Personally, if using manual calculation, I prefer the Fancheng Rule because it gives easier calculations to do by hand (especially without the ability to use the calculator). (Student Response, Author course, Fall 2017)

In his response, the student was able to compare the two methods, assess that both methods are equivalent, and explain his preference. This response was typical of most students in the class, with students noting their comfort level with fractions as being a determining factor of the method.

We began this particular analysis as an investigation into whether differences exist when the instructional materials are implemented by the PSP author when compared to other site-testing instructors. In our presentation, we explore additional data sources that informed our analysis, and the ways in which we are attempting to make sense of students' experiences with PSPs.

We will discuss the differences we identified from each implementation of the *Solving a System of Linear Equations using Ancient Chinese Methods* PSP, the ways in which the two course populations reported similar student gains, and the ways in which students' reported benefits and obstacles for learning with primary source materials can inform future implementations in the TRIUMPHS project.

References

Flagg, M. (2017). *Solving a system of linear equations using ancient Chinese methods.* Retrieved from https://digitalcommons.ursinus.edu/triumphs_linear/1/

Törner, G. (1998). Views of German mathematics teachers on mathematics. In E. Cohors-Fresenborg, H. Maier, K. Reiss, G. Törner, & H.-G. Weigand (Eds.), *Selected papers from the Annual Conference of Didactics of Mathematics* (pp. 116–130). Osnabrück, Germany: FMD.

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