

## Final Report

Carla B. Howery Teaching Enhancement Fund-American Sociological Association

### Advancing Quantitative Reasoning among First-Generation and Racial/Ethnic Minority Sociology Students

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#### I. Summary: activities and findings

*Background summary.* The quantitative literacy (QL) movement along with other education advocates urges social science disciplines to improve numerical literacy, especially among first-generation, and racial and ethnic minorities. To improve numerical literacy, this project incentivized students at our HSI to participate in a research methods/ statistics tutorial one month prior to the seminar based on the premise that *prior* exposure to/ engagement with quantitative course materials improves performance. Social science undergraduates, and sociology majors in particular, find quantitative methods courses both challenging and burdensome. Reasons vary but frequently arise from debilitating fear and anxiety about their putative inability to master numerical concepts.<sup>1 2 3</sup> First-generation and racial/ethnic minority undergraduates are no exception. Difficulties in acquiring numerical skills are compounded by their disadvantaged socioeconomic and culture status.<sup>4</sup> To overcome these barriers, we developed and tested an online pilot social science research methods/statistics tutorial to improve student quantitative reasoning in a required sociology/ public policy methods course.

*Social science research methods/ statistics, Soc 350/ Public Policy 350 and original tutorial intervention:* Social science research methods, Soc 350/ PbPI 350, at CMSV is largely quantitative. It emphasizes the rudiments of numerical analyses of hypothetical claims. The tools and skills for doing so are developed through readings of both scholarly and non-scholarly texts, exercises, group discussions and projects, peer-to-peer teaching, and, quizzes and exams. Statistical concepts for testing hypotheses range from comparing means, medians, and percentages to computing and interpreting measures of association, analysis of variance and regression.

*Aim of program.* The aim of our tutorial prototype was to reduce anxiety and fear and, in its place, promote working knowledge of quantitative analyses of social, economic and political data. The program divided students into experimentals and controls (and as it turned out, a second quasi-experimental/ control group of previously unregistered students). The research hypothesis yields the expectation that the students in the experimental group, who have been exposed to course content during five half-hour modules would master course material (measured by exams and quizzes at several timepoints) to a significantly greater extent than the control group who have had only limited exposure, or none at all, to the material.

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<sup>1</sup> See e.g., Bridges, G. S., Gillmore, G. M., Pershing, J. L., & Bates, K. A. 1998. Teaching quantitative research methods: A quasi-experimental analysis. *Teaching Sociology*, 26(1), 14.

<sup>2</sup> Sloodmaeckers, K., B. Kerremans, and J. Adriaensen. 2014. "Too afraid to learn: attitudes towards statistics as a barrier to learning statistics and to acquiring quantitative skills." *Politics* 34 (2): 191–200.

<sup>3</sup> Yet, cf. e.g., Wisecup, Allison K. 2017. Take it or leave it: Student attitudes about research methods. *Teaching Sociology*, 45(1) 73-79. Also, DeCesare, Michael. 2007. Statistics anxiety among sociology majors: A first diagnosis and some treatment options. *Teaching Sociology* 35(4): 360-367.

<sup>4</sup> Shapiro, D., Dundar, A., Huie, F., Wakhungu, P., Yuan, X., Nathan, A & Hwang, Y., A. 2017. A National View of Student Attainment Rates by Race and Ethnicity – Fall 2010 Cohort (Signature Report No. 12b). Herndon, VA: National Student Clearinghouse Research Center.

Because students at our institution experience a variety of socioeconomic and familial constraints, an incentive to engage with school and particularly this class prior to the start of the semester was necessary. Howery funds were crucial for student involvement in the experiment.

*Activities.* The timeline for project set-up and preliminaries extended from May/August 2020 with the development of teaching modules and materials, through the fall, and winter, 2020-2021. Completion of the project took place May 2021.

- May- August 2020 - developed online tutorial prototype including 5 modules for course content; submitted IRB
- September - November 2020 - refined, tested and revised tutorial prototype, IRB accepted with provisions (Co-PI certification)
- December 2020 - January 2021 - instituted tutorial prototype, fulfilled IRB provisions
- January 2021 – May 2021 - concurrent assessment with real-time feedback to students
- May 2021 – August 2021 – data analysis, write-up for publication

Development of materials involved mastering QL best-practices research; meeting with colleagues in the math and education departments; fulfilling IRB protocols (some of which led a Co-PI to take a human subjects certification program – to be paid out of Howery funds); re-evaluating past methods course teaching strategies, and, setting up materials on the Canvas software platform we use in and outside the classroom at CMSV.

Structure of tutorial intervention: Students enrolled in the course were strongly encouraged to voluntarily participate in the tutorial one month prior to the beginning of the course. The nature of the tutorial program/ intervention was described in emails from the professor welcoming students to the class and offering each of them a unique opportunity to participate in “an experiment” during 5 hour-long sessions in January 2021. A financial incentive was offered as well, amounting to \$75 for all 5 of the sessions, or \$15 per session if students did not want to engage with all five of them.

The initial 22 students in the course were randomized into an experimental group (n=11) and a control group (n=11). During the first tutorial session, students in the experimental group were given a baseline methods/statistics exam covering course material. In subsequent modules, they were asked to read selections from course texts (e.g., textbook sections on calculating means or an article about coronavirus rates in the New York Times), then complete an exercise and/or quiz and/or exam, taken directly from the course. Each module contained a reading and then an exercise or quiz or exam. Students in the control group were also given a baseline exam during the first session. In subsequent modules, they were asked to read selections from course texts (the same selections as the experimental group e.g., textbook sections on calculating means or an article about coronavirus rates in the New York Times). However, the control group was not expected to answer any questions testing their knowledge of the tutorial material.

To get a sense of the degree of difficulty/ engagement, all students were asked to rate and discuss the selected texts. For the experimental group, they were also asked which questions on the exercises, quizzes and exams were the hardest/ easiest and why.

All students who participated in either group received a \$15 per module financial incentive, capped at \$75. Every involved student engaged with all five modules. However, of the 22 students, few (n=10) were initially willing to participate.

Tutorial program implementation part I: Of the 22 students enrolled in the class, 10 of them consented and engaged with the tutorial program. Subsequently, however, three dropped the course. Baseline participation was seven: 2 experimental group members and 5 controls. When we surveyed students to gain an understanding of non-participation, reasons varied. Three barriers emerged: 1. work and familial obligations, including hospitalizations and deaths related to Covid-19; 2. failure to understand the nature of the experiment; 3. resistance (“...if it’s not mandatory I wouldn’t participate”). An additional student who had enrolled in the class dropped out of the class (n=4 drops), and other students joined during the add/drop period (n=6), bringing the total number of students to 24 by week 3 of the semester. These 6 newer students noted in a questionnaire administered confidentially to the class they would have been glad to participate in the tutorial program had they enrolled in January 2021.

As a result of this initial misstep, the Co-PI and I reinitiated the tutorial intervention with a newer class consent document.<sup>5</sup> Randomization into new groups was implemented, a new baseline for statistical proficiency was established (i.e., first exam). The tutorial program was reformulated.

Tutorial program implementation part II - reformulated baseline: To determine whether exposure/ engagement with tutorial material could improve learning, we established a new baseline measure using the first exam- conducted at about 5 1/2 weeks into the course. All students took the exam. A few days later, we uploaded a video to students' online course platform. It was an hour-long explanation of each question on the exam, including why the incorrect answers were incorrect and why the correct answers were correct. Students in the experimental group were offered \$50 to view it, and correct their exams for additional points. For the controls, they too were offered \$50 to view an online video but the controls' video simply encouraged them to keep up their hard work in the class etc. It contained no tutorial material, but it did suggest students could correct their exam answers and re-submit them for additional points. Supplementary video material covering in-class exercises was developed and students incentivized to explore this tutorial material online, again, with the experimental group receiving content-related instruction and the controls receiving anodyne encouragement from the professor. Furthermore, students who had not engaged with the post-exam videos (either as experimentals or controls), were still offered \$50 to engage with supplementary video materials. Thus, students could garner a financial incentive through any combination of video-viewing.<sup>6</sup>

All students were promised and received the financial incentive for their engagement.

Data for the modules and class exercises inundated the PI and Co-PI with administrative responsibilities. It was decided to add an administrator to the project. Our master's level administrator was CITI certified, and an amended IRB was submitted and approved. We began training concurrently. A small portion (12%) of Howery funds were used to cover some of the hours for administrative assistance.

*Results:* Table 1 (below) provides results of the QL tutorial intervention. For analytic purposes, the two initial groups, experimentals and controls, were subsequently divided into two experimental groups (Group II and Group III, in Table 1) and one control group (Group I, in Table 1). We examined three groups for better insight into the nature of the tutorial/intervention. The first experimental group had some exposure to or engagement with tutorial material, either as a member of the initial experimental cohort or as a member of the second first-exam-randomization process (n=8). The second experimental group was exposed/ engaged with tutorial material both prior to the class and during the second wave of the experiment (n=4). The control group consisted of students who had limited exposure to course material prior to the class and who did not receive the post-exam tutorial instruction the experiment groups received (n=12). That is, some of the final control group had some exposure to material, prior to the course itself and during the course itself, but they were not shown the video explaining first-exam corrections.<sup>7</sup>

Baseline scores used to differentiate the groups show that prior to the tutorial intervention the groups did not significantly differ on their exam 1 scores. That is, while the experimental groups did have slightly higher median scores than the controls on exam 1, prior to the tutorial intervention, the difference was not significant.

Then each group watched their respective videos.

As expected, outcome scores, for both exam 2 and the overall class totals, were significantly higher for the experimental groups compared to the controls. The two experimental groups did not significantly differ between themselves with respect to the two outcomes.

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<sup>5</sup> An addended IRB was submitted and approved by the CMSV IRB committee, January- March 2021.

<sup>6</sup> Video-viewing was selected as an implementation mechanism because it involved the same kind of routine interaction students were accustomed to during the class itself. It may be that expecting students to read through material and master it independently of a structured lesson was a barrier to participation in the tutorial/intervention.

<sup>7</sup> Note however that students in the control group could interpedently contact the professor or their peers to re-work first exam answers and receive additional credit. We did not try to identify any of these outliers, if there were any.

**Table 1.** Descriptive and Nonparametric Multiple Comparisons of Independent Groups: Kruskal-Wallis and Dunn's Tests

	Group I Controls No Engagement (n=12)	Group II Experimental T1 or T2 Engagement (n=8)	Group III Experimental T1 and T2 Engagement (n=4)
<b>Baseline Variables- Time 1</b>			
Prior semester mean GPA	2.60	2.86	3.57
Significant differences in mean rank Z-score at <.05?	I vs. II No	II vs. III No	I vs. III Yes
Percent Senior Class	83%	50%	50%
Significant differences in mean rank Z-score at <.05?	I vs. II No	II vs. III No	I vs. III No
Median score first exam (74 total points)	37.5	39.3	43.0
Significant differences in mean rank Z-score at <.05?	I vs. II No	II vs. III No	I vs. III No
<b>Outcomes- Time 2</b>			
Median score second exam (95 total points)	51.0	63.8	77.3
Significant differences in mean rank Z-score at <.05?	I vs. II Yes	II vs. III No	I vs. III Yes
Median score overall course (479 total points)	193.0	291.0	396.3
Significant differences in mean rank Z-score at <.05?	I vs. II Yes	II vs. III No	I vs. III Yes

*Conclusion:* Because of problems with program implementation of the original QL tutorial intervention, impact of the intervention on outcomes depicted in Table 1 must be considered with caution. The data show that students who undertook the tutorials (either before the beginning of the course or after the first exam) were more likely than students who did not, to score higher on the second exam, and to score higher overall in class.

Does this suggest the tutorials were effective in promoting student learning? Perhaps, but there is enough ambiguity in the implementation of the experiment to warrant concern. That is, the experimental outcome is suggestive but not definitive. Neither selection bias nor other confounding effects (e.g., processes of interaction in the class, learning) can be ruled out as factors impacting student learning in the class.

Moreover, given these limitations, incentives were essential in that most students would not have done extra work outside of the classroom nor downloaded the video and studied it, unless rewarded for doing so. That is, having the opportunity to get paid \$125 to participate in an ostensibly low-stakes experiment in a college class was, as students noted on their follow up evaluations, unheard of in their academic experience.

Thanks, therefore, to the institutional setting that provides Howery funds which enhanced student learning in this particular class, even if the effectiveness of the tutorials remains somewhat ambiguous.

Future tutorial interventions should correct flaws in the current design by: 1. requiring participation in the modules as a part of the course curriculum; 2. developing modules and activities to take place in person, to the extent possible, and after completion of the class roster; 3. controlling course attrition; 4. gathering background factors to create matched-pairs samples in case randomization fails.

In the end, we are optimistic that exposure/ engagement enhances outcomes. We simply need to develop and test a more rigorous execution of the program.

## **II. Impact**

The Co-PIs are deeply appreciative of the generosity of ASA and the Howery fund for providing students this opportunity to engage with the course at a level that would not have been possible without this funding.

The impact of the project, while beneficial for individual students in this class, will have long-term consequences within the department and institution in a number of areas:

- Papers – Co-PIs submitted a paper to ASA section on Teaching and Learning which will be developed for other publication(s) June- September 2021.
- Sociology departmental pedagogy – the department is re-assessing its prerequisites and sequencing of research methods, a lesson learned through discussion of other Howery-related projects at ASA
- Matching funds/ continuation of intervention – the Fishlinger Center has budgeted \$2500 each year for the next 2-years to conduct this research methods tutorial in order to conduct a more rigorous tutorial intervention.
- Intra-institutional collaboration – the sociology department is working with other academic divisions in the College (e.g., math, biology) to develop sustained funding for these kinds of modules in the social sciences.
- Inter-institutional collaboration – Co-PIs have begun to work with other colleges and universities to learn more about successful development of social science research tutorials/ seminars and courses.

## **III. Budget Outlays**

The Carla B. Howery Fund's \$2500 was used to incentivize 24 students enrolled in Sociology 350/ PbPL 300 to participate in tutorial modules prior to the course (during their winter break and throughout the course). Initially, \$750 was paid to 10 student participants (at \$75 for completion of the 5 hour-long modules, or \$15 an hour for each module), and another \$250 was used to reimburse the sociology department administrator for research assistance on the project. The Co-PIs IRB CITI certification cost \$250. That left a balance of \$1250 (\$2500- \$1250) as of March 1, 2021.

In our initial proposal we had estimated \$1875 for student participation (n=25 not 24) in the initial phase of the project, with the remainder (\$625) allocated for peer-tutors to devote time to working with other students to improve their skill-set.

Instead, due to unanticipated non-participation in the first-round of the experiment we used the March 1, 2021 remainder of \$1250 for a second- round mid-term impromptu experimental incentive for all 24 students \* \$50 = \$1200. The remaining \$50 was used to supplement the sociology administrator's initial \$250.<sup>8</sup> The terms were the same as before: they were expected to complete the module(s) covered by the incentive. The content of the module(s) varied for experimental compared with control groups, yet each group was incentivized to participate, regardless of group.

As of May 2021, all funds had been committed to these activities.

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<sup>8</sup> This amounted to administrative overhead of 12% (i.e., \$300/ \$2500)